Appendix 9-A

Murray River Coal Project: 2010 to 2013 Fisheries Baseline Report

MURRAY RIVER COAL PROJECT

Application for an Environmental Assessment Certificate / Environmental Impact Statement

HD Mining International Ltd.

MURRAY RIVER COAL PROJECT
2010 to 2013 Fisheries Baseline Report

hd Mining





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July 2014

MURRAY RIVER COAL PROJECT
2010 TO 2013 FISHERIES BASELINE REPORT

July 2014
Project #0194106-0003-0008

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Prepared for:

HD Mining International Ltd.

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Executive Summary

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Executive Summary

HD Mining International Ltd. (HD Mining) proposes to develop the Murray River Coal Project (the Project) as a 6 million tonne per annum (6 Mtpa) underground metallurgical coal mine. The property is located approximately 12.5 km south of Tumbler Ridge, British Columbia. The Project is located within the Peace River Coalfield (PRC), an area with a long history of metallurgical grade coal mining, mainly from open pit mining. HD Mining is proposing to access deeper zones of the coal field (600 to 1,000 m below surface) through underground mining techniques.

To support HD Mining's planning and development of the Project, and to fulfill the requirements of the environmental assessment process, environmental and socio-economic baseline studies were initiated by ERM Rescan (formerly Rescan Environmental Services Ltd.). Project-specific studies began in 2010 and have continued through 2013. As appropriate and available, historical data from government sources and neighbouring projects, as well as traditional use/knowledge information, have been compiled and incorporated into this analysis.

The purpose of this report is to present cumulative baseline fish and fish habitat data for the Murray River Project. Cumulative baseline data includes a review of existing information and Project-specific data collected from 2010 to 2013.

The objectives of the fish and fish habitat baseline program were to:

- summarize existing fish and fish habitat data collected at sites within the Infrastructure Investigation Area, Local Study Area (LSA), and Regional Study Area (RSA);
- complete baseline fish community and fish habitat data collection based upon mine design and engineering current to September 2013;
- establish reference sites used for future environmental monitoring of fish and fish habitat;
- characterize biological data for sentinel fish species, including tissue metals concentrations, and other data used for potential future Project; and
- locate and characterize potential sites for future habitat offsetting.

A total of 16 fish species have been documented within the Murray River and connecting tributary streams. Arctic Grayling, Brook Trout, Bull Trout, Burbot, Finescale Dace, Lake Chub, Longnose Dace, Longnose Sucker, Mountain Whitefish, Northern Pike, Rainbow Trout, and Slimy Sculpin were captured between 2010 to 2013 from the Murray River and streams within the Infrastructure Investigation Area and LSA. Arctic Grayling are 'yellow-listed' and Bull Trout are 'blue-listed in British Columbia.

Fish distribution in tributary streams within the Infrastructure Investigation Area and LSA is heavily influenced by the presence of permanent barriers to fish migration (i.e., water falls). Barriers delineate the upper and lower stream reaches, and determine habitat use by fish in M17, M19, M20, and Twenty creeks. The fish community of lower M17, M19, and M20 creeks is similar, and includes Arctic Grayling, Bull Trout, Burbot, Longnose Sucker, Mountain Whitefish, and Slimy Sculpin. Twenty Creek provides ephemeral habitat for Brook Trout, Mountain Whitefish, and Rainbow Trout. Lake Chub were most often associated with wetlands and lotic environments.

The Murray River was classified as an S1-large river. Sites within the Murray River generally provide good juvenile rearing and adult feeding habitat. LWD was the predominant cover-type for fish and provides good juvenile rearing habitat. Barriers to fish migration are not present along the Murray River within the Infrastructure Investigation Area and LSA.

The lower reaches of tributary streams within the Infrastructure Investigation Area were classified as S-2 to S-4. Tributary streams generally provide good juvenile rearing habitat; however, overwinter habitat and high quality spawning habitat were limited. The lower reach of M19 Creek may provide important annual spawning and rearing habitat, which may be a limiting habitat type for Arctic Grayling in the LSA. M19A Creek was classified as S4 (default) and rated as marginal fish habitat. Fish were not captured in M19A Creek despite significant fishing effort. The ability of M19A Creek to support fish may be limited by the presence of numerous beaver dams and ephemeral impediments to fish migration.

The fish-bearing and non-fish-bearing reaches of M20 Creek are delineated by a series of chutes and large waterfalls. The fish-bearing reach of M20 Creek was classified as S2. Spawning and adult feeding habitat within M20 Creek were rated as poor due to high turbidity and sediment load, and overall habitat was rated as marginal. Twenty Creek and M17 Creek contained marginal fish habitat. Habitat for most fish life-history stages were limited by shallow water depth and ephemeral flow.

Potential fish habitat offsetting sites were surveyed in the Murray River LSA in 2012 and 2013. A total of seven potential sites were surveyed for fish and fish habitat. Site CS1 was selected as the primary site for fish habitat offsetting for the Project.

Community, relative abundance, and fish biological data were collected in 2004, 2005, 2011, 2012, and 2013. Slimy Sculpin, Arctic Grayling, Mountain Whitefish, and Bull Trout were most abundant within the Infrastructure Investigation Area and LSA. Burbot and Northern Pike were most abundant at site CS1. Biological datasets were developed and analysed for Slimy Sculpin and Finescale Dace. For both species, mean fish length was consistent between sites and among sampling years. Length-frequency histograms developed for Slimy Sculpin generally showed a bi-modal distribution, while Finescale Dace histograms were uni-modal. Weight-length regressions calculated for Slimy Sculpin and Finescale Dace showed a significant relationship between weight and length, with adjusted r^2 values ranging from 0.72 to 0.99. Condition (as the slope of weight-length regressions) for Slimy Sculpin and Finescale Dace were also consistent among sampling sites and years.

Fish tissue metals data were collected from the Project area in four years from 2004 to 2012. In 2012, Slimy Sculpin and Bull Trout were sampled for tissue metal concentrations to expand upon existing baseline data. Mercury concentrations in Slimy Sculpin from all sites sampled in all years were lower than the Health Canada guideline of 0.50 mg/kg ww for maximum total mercury in fish tissue (CCME 1999; Health Canada 2011). Mercury concentrations in Slimy Sculpin tissues were highest at sites located on the main stem of the Murray River and lowest in tributary stream sites. Slimy Sculpin selenium showed opposite trends relative to mercury. Mean selenium concentrations in Slimy Sculpin were highest at tributary sites and lowest at Murray River mainstem sites. Mean selenium concentrations for whole-body Slimy Sculpin exceeded the provincial draft guideline of 4 mg/kg dw at several sites along the Murray River and at tributary streams within the LSA.

Acknowledgements

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Glossary and Abbreviations

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Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

BACI	Before-After-Control-Impact (study design)
BC CDC	British Columbia Conservation Data Centre
BC MOE	British Columbia Ministry of Environment
CI	Confidence Interval
CPUE	Catch per Unit Effort
CRM	Comparison with Reference Material
DELTs	Deformities, Erosions, Lesions, and Tumours
DFO	Fisheries and Oceans Canada
DQO	Data Quality Objectives
EA	Environmental Assessment
FHAP	Fish Habitat Assessment Procedure
FISS	Fisheries Information Summary System
FL	Fork Length
GLM	General Linear Model
GPS	Global Positioning Devise
Hz	Hertz
LSA	Local Study Area
MB	Method Blank
MDL	Method Detection Limit
MMER	Metal Mining Effluent Regulations
Mtpa	Million tonnes per annum
N	Sample size or number
NAD 87	North American Datum 87
QA/QC	Quality Assurance/Quality Control
PRC	Peace River Coalfield
RPD	Relative Percent Difference
RSA	Regional Study Area
SD	Standard Deviation

SE	Standard Error
TL	Total Length
UTM	Universal Transverse Mercator (grid)
V	Volts

1. Introduction

1. Introduction

HD Mining International Ltd. (HD Mining) proposes to develop the Murray River Coal Project (the Project) as a 6 million tonne per annum (6 Mtpa) underground metallurgical coal mine. The property is located approximately 12.5 km south of Tumbler Ridge, British Columbia, and consists of 57 coal licences covering an area of 16,024 hectares (Figure 1-1). The Project is located within the Peace River Coalfield (PRC), an area with a long history of metallurgical grade coal mining, mainly from open pit mining. HD Mining is proposing to access deeper zones of the coal field (600 to 1,000 m below surface) through underground mining techniques.

In October 2011, HD Mining submitted an application to the BC Ministry of Energy and Mines and Ministry of Environment seeking permission to complete a bulk sampling program as part of exploration of the property. In March 2012, HD Mining received approval to conduct a 100,000 tonne bulk sample for the purpose of conducting testing to assist in developing markets for the coal.

Beyond the bulk sample program, in order to develop a full mine at the proposed 6 Mtpa, the Project is subject to both the BC and Canadian environmental assessment processes. Development of any infrastructure for the full mine is not permitted before the requirements of these processes are met.

To support HD Mining's planning and development of the Project, and to contribute to the environmental assessment process, environmental and socio-economic baseline studies were initiated by ERM Rescan (formerly Rescan Environmental Services Ltd.). Project-specific studies began in 2010 and have continued through 2013. As appropriate and available, historical data from government sources and neighbouring projects, as well as traditional use/knowledge information, have been compiled and incorporated into analysis.

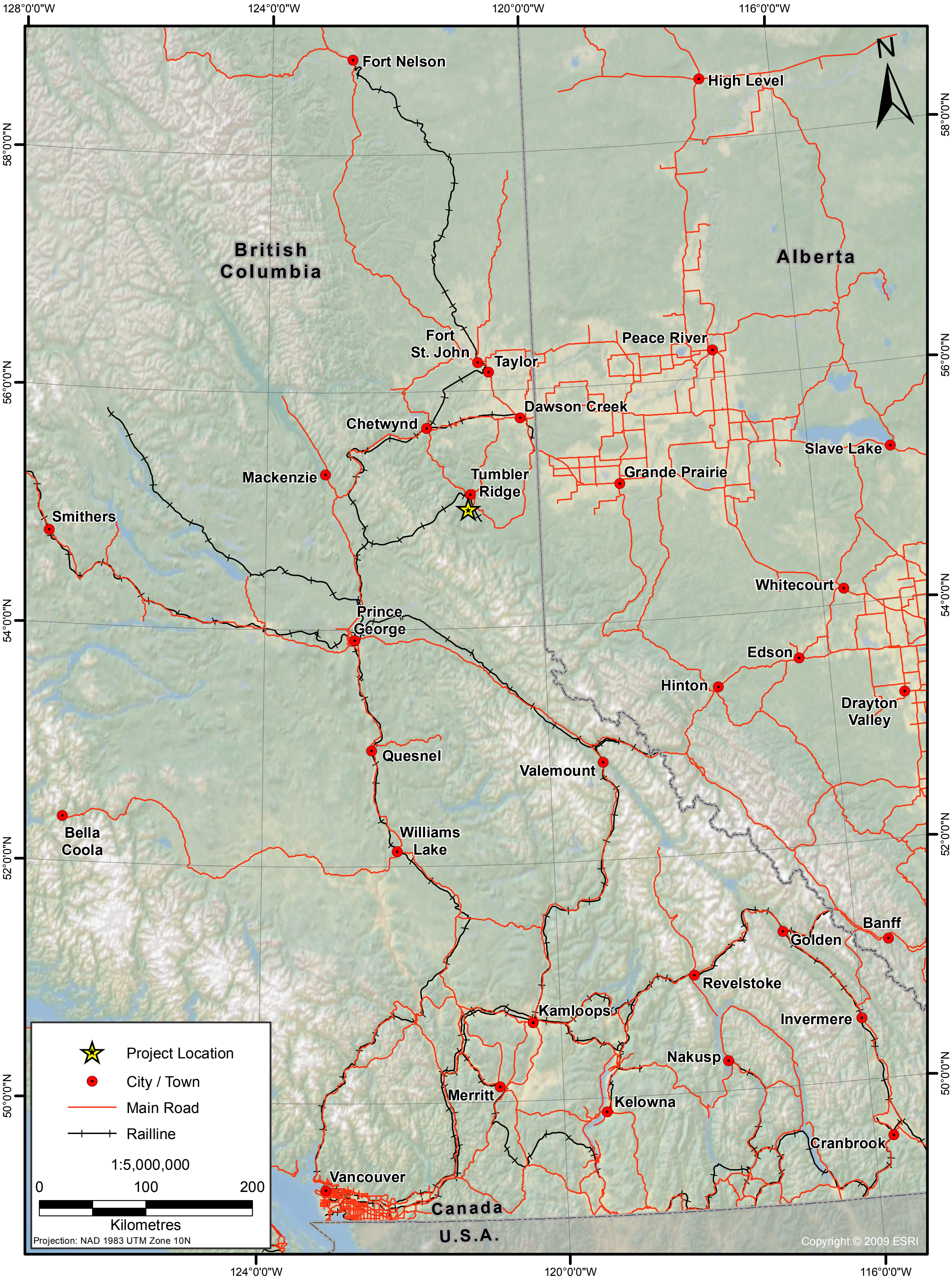
In order to help guide the scope of baseline studies, regional and local study areas (RSA and LSA, respectively) have been developed (Figure 1-2). The RSA is intended to encompass an area beyond which effects of the Project would not be expected. It is also intended to be ecologically relevant based on the home range of key wildlife species known to inhabit the region. The LSA encompasses an area surrounding the proposed Project infrastructure (Figure 1-3) within which direct effects from the Project may be anticipated. Its boundary has also been developed following natural terrain and drainage boundaries in order to be ecologically relevant. For consistency, the same RSA and LSA are used for all environmental studies.

This report presents a cumulative summary of all fish and fish habitat information compiled for the Project. This information is important for the preparation of an Environmental Assessment (EA) and a fish habitat offsetting plan for Fisheries and Oceans Canada (DFO); required under the *Fisheries Act* (DFO 1985). The objectives of the fish and fish habitat baseline program were to:

- summarize existing fish and fish habitat data collected at sites within the LSA;
- complete baseline fish community and fish habitat data collection based upon mine design and engineering current to September 2013;
- establish reference sites used for future environmental monitoring of fish and fish habitat;
- characterize biological data for sentinel fish species, including tissue metals concentrations, and other data used for Project monitoring; and

- locate and characterize potential sites for future habitat offsetting.

These objectives were achieved through a combination of field work from 2010 through 2013, and review of historical data and reports relating to fish and fish habitat distribution, relative abundance, and habitat use along the Murray River and its tributaries within the LSA.



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MURRAY RIVER COAL PROJECT

Project Location

Figure 1-1

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PROJECT # 0194106 GIS # MUR-15-058 VERSION # T0.10 April 10 2013

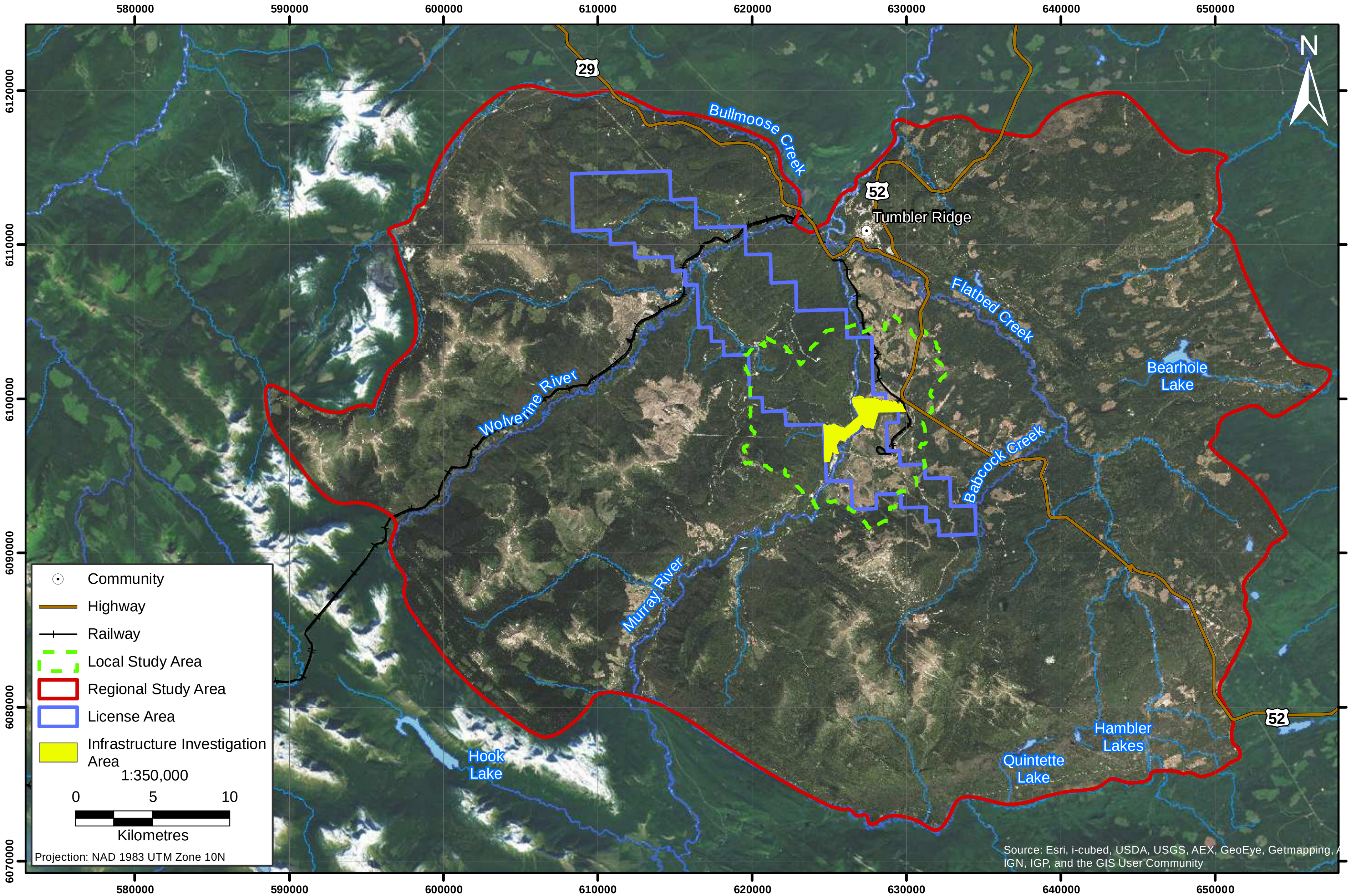

Figure 1-2

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MURRAY RIVER COAL PROJECT

Project Study Boundaries

Figure 1-2

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PROJECT # 0791-007-01 GIS # MUR-15-071 VERSION # T0.10 February 18 2013

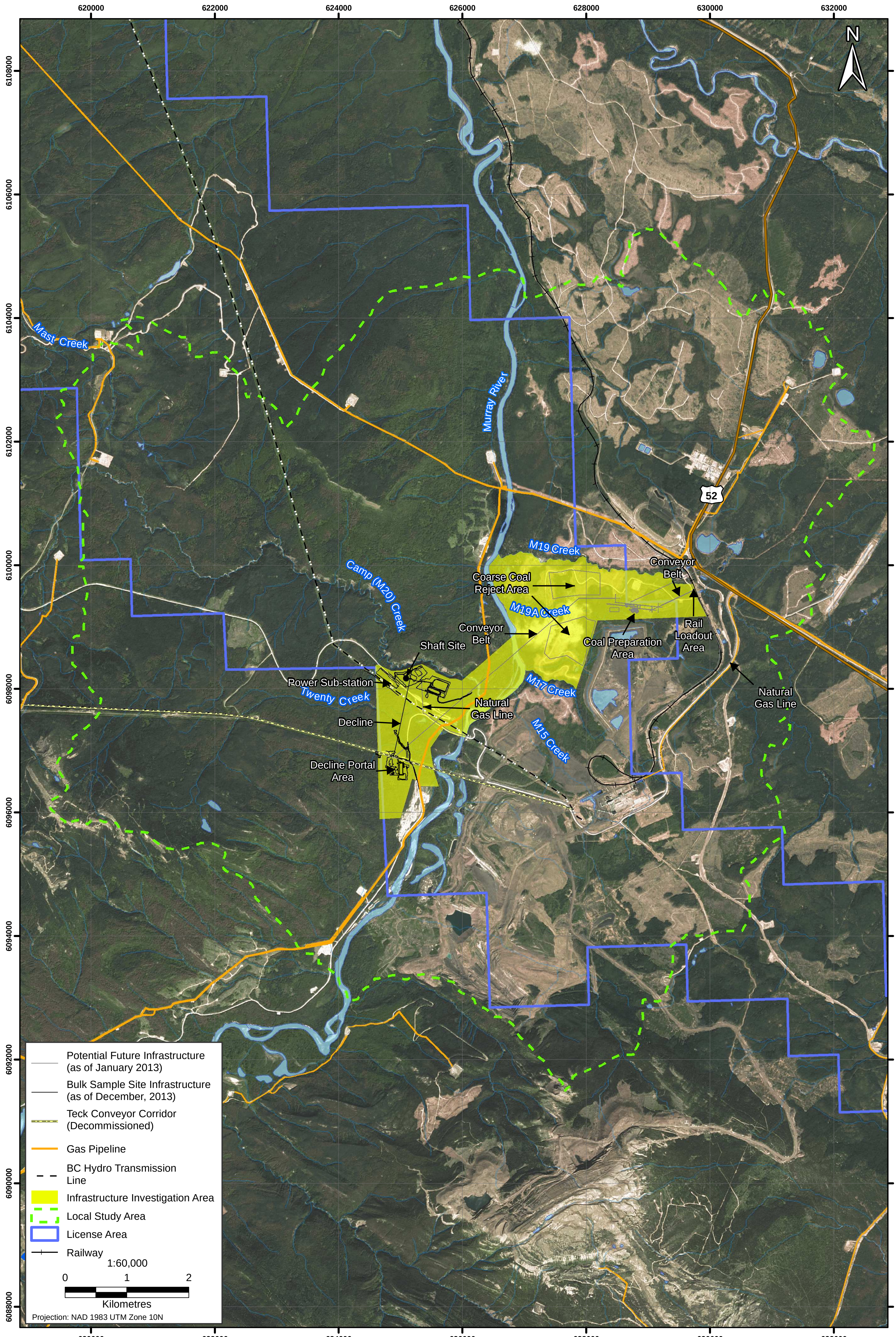

Figure 1-3

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MURRAY RIVER COAL PROJECT

Preliminary Site Layout

Figure 1-3

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2. Background Information

2. Background Information

2.1 APPLICABLE LEGISLATION, REGULATIONS, AND GUIDELINES

Fish and fish habitat are protected under a variety of federal regulatory acts, principles, and regulations. The following three documents were used to guide fish and fish habitat studies for the Project:

- the *Fisheries Act* (DFO 1985);
- the *Metal Mining Effluent Regulations* (MMER) guidelines (Environment Canada 2012).

The *Fisheries Act* (DFO 1985) was amended in November 2012 to shift the mandate of DFO from management of fish habitat to management of fisheries. The amended *Act* prohibits "serious harm to fish" that are part of a commercial, recreational, or Aboriginal fishery, or to fish that support such a fishery. "Serious harm" is defined to include the killing of fish by means other than fishing, permanent alteration of habitat, and destruction of habitat.

The amended *Act* focuses on "commercial, recreational, or Aboriginal fisheries, and fish that support those fisheries." These fisheries are defined as those fish that fall within the scope of applicable federal or provincial fisheries regulations, as well as fisheries that can be fished by Aboriginal organizations or their members for food, social, or ceremonial purposes, or for purposes set out in land claims agreements. Fish that support a fishery are those that contribute to the productivity of a fishery. These include prey fish and other fish species that may reside in water bodies that contain the commercial, recreational, or Aboriginal fishery, or in waters that are connected to such water bodies.

Under Section 35(2) of the *Fisheries Act* (DFO 1985), any project or activity that causes serious harm to fish may require an Authorization. Prior to issuing an Authorization, the Minister must consider four factors listed in Section 6 of the *Act*:

- the contribution of the relevant fish to the ongoing productivity of commercial, recreational, or Aboriginal fisheries;
- fisheries management objectives;
- whether there are measures or standards to avoid, mitigate, or offset serious harm to fish; and
- the public interest.

Serious harm to fish should be avoided or mitigated where possible. Avoidance measures may include relocating infrastructure or by timing certain activities to avoid harm to fish and fish habitat. Mitigation measures are used to reduce the spatial scale, duration, or intensity of an impact where serious harm to fish habitat cannot be completely avoided. Mitigation measures include the implementation of best management practices during all phases of a project.

The *Metal Mining Effluent Regulations* (Environment Canada 2012) stipulate environmental effects monitoring activities that must be undertaken by metal mines as a condition of depositing effluent. Coal mines do not currently fall under MMER; however their inclusion is under consideration. At this time, MMER provide best practice guidance for environmental effects planning. Data on fish biology and health were collected from 2010 through 2013 for use in future environmental monitoring programs for the Project.

2.2 REGIONAL SETTING

Planned Project infrastructure is located entirely within the Murray River Watershed. In the context of fish and fish habitat values, the RSA encompasses several major watersheds, including the Murray River, Wolverine River, and Flatbed Creek watersheds (Figure 2.2-1). The LSA is located primarily in the Murray River Watershed and also includes the headwaters of tributaries of the Wolverine River.

Planned infrastructure is predominately located in M20 (or Camp) Creek and Twenty Creek sub-watersheds on the west side of the Murray River and several small tributary streams (e.g., M15, M17, M19, M19A creeks) on the east side of the Murray River (Table 2.2-1). Fish and fish habitat studies conducted for the Project from 2010 to 2013 focused on 'Receiving Environment' sites within the LSA, as well as 'Reference Environment' sites located within the LSA and RSA.

Table 2.2-1. Stream Names and Associated Watershed Codes

Stream Name	Watershed Code
Murray River	234-323900
M15 Creek	n/a
M17 Creek	234-323900-57200
M19 Creek	234-323900-56200
M20 Creek	234-323900-57600
Twenty Creek	234-323900-58100
South Boundary Creek	n/a

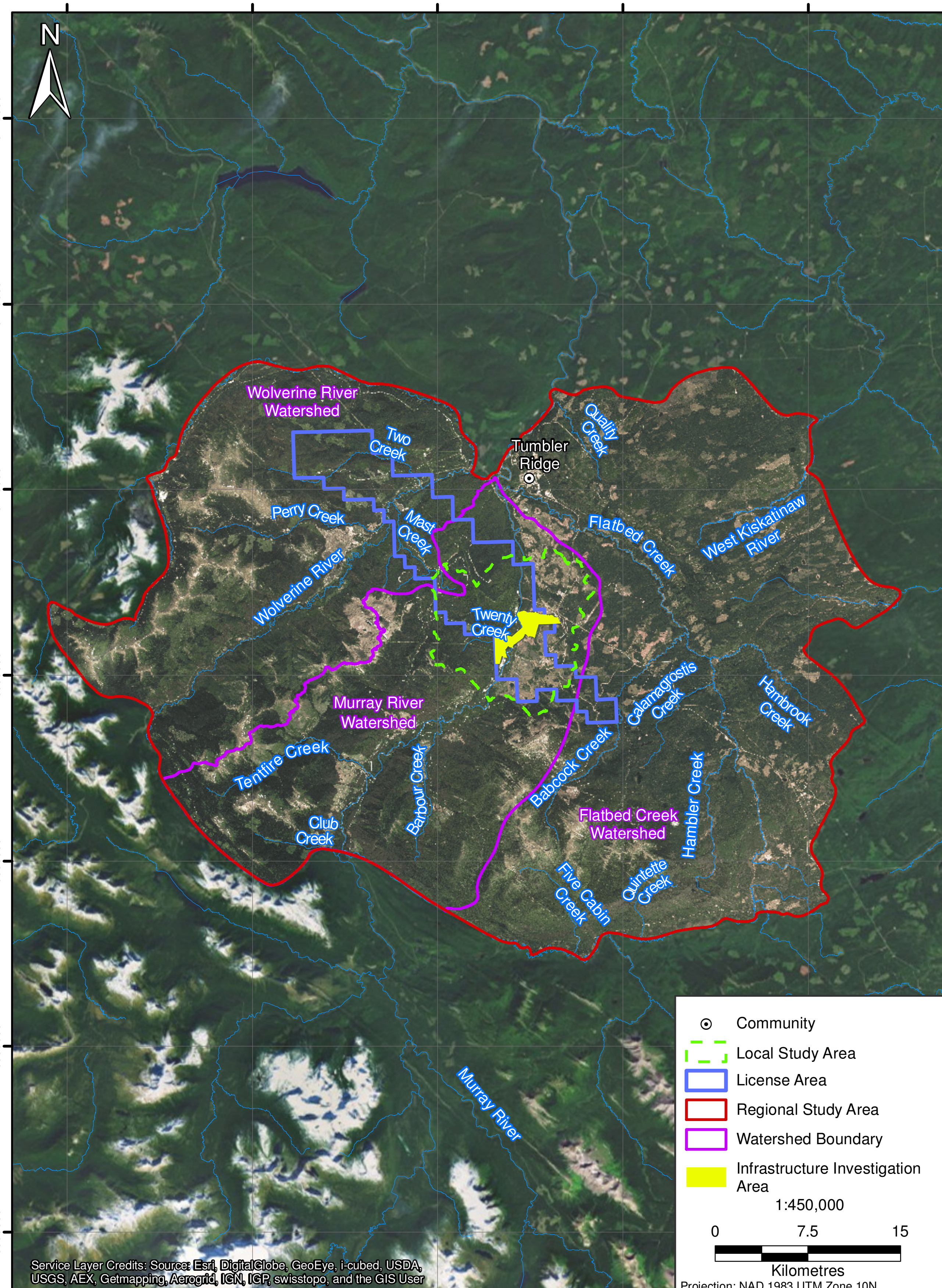
Source: Habitat Wizard

2.3 BACKGROUND REVIEW

The purpose of the literature review was to summarize data previously collected within the RSA and relevant to the Murray River Project. Several baseline studies have been completed on various properties in the vicinity of the Murray River Project. Historical data were used to reduce duplication of effort when establishing baseline conditions for the Project. Historical information relating to water bodies, fish communities, and fish habitat were compiled from a variety of sources, including:

- BC MOE's Fisheries Information Summary System (FISS) database (MOE 1998);
- BC Conservation Data Centre (BC CDC) Species and Ecosystem Explorer database;
- BC MOE EcoCat: the Ecological Reports Catalogue;
- Federal Species at Risk Public Registry;
- Fisheries and Oceans Canada (DFO) Mapster;
- BC MOE Habitat Wizard;
- Publically available information and sharing agreements with adjacent and nearby mine projects (e.g., Quintette Mine); and
- Personal communications with Omineca-Peace Region BC MOE staff.

PROJECT # 0194106-0003 GIS # MUR-06-016 VERSION # T0.10 July 10 2013



MURRAY RIVER COAL PROJECT

Figure 2.2-1

Major Watersheds in the Regional Study Area

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2.3.1 Summary of Historical Reports

The Peace Coal Field (PCF) and Murray River area has been developed for coal resources since the 1970s (Figure 2.3-1). Mining projects in the vicinity of the Murray River Project include Babcock, Hermann, Shikano, Window, and Windy coal sites associated with the Quintette Project. All historical sites were located upstream of the Murray River Project location.

<u>Hermann Project</u>

Fish and fish habitat information that was collected between 2004 and 2006 for Western Coal Corp. and reported in the WCC Herman Mine Application (WCC 2007) and contains applicable information for the Murray River Project.

2007 Appendix Part 1: Fisheries Sample Site Data and Stream Crossing Photos

- Habitat site cards and fish collection forms;
- Two streams: M20 Creek, M14 Creek;
- M20 Creek catch: Arctic Grayling (*Thymallus arcticus*), Brook Trout (*Salvelinus fontinalis*), Bull Trout (*Salvelinus confluentus*), Burbot (*Lota lota*), Mountain Whitefish (*Prosopium williamsoni*), Rainbow Trout (*Oncorhynchus mykiss*), Slimy Sculpin (*Cottus cognatus*);
- M14 Creek catch: Finescale Dace (*Phoxinus neogaeus*), Lake Chub (*Couesius plumbeus*), Longnose Sucker (*Catostomus catostomus*).

2007 Appendix Part 2: Fisheries Sample Site Data and Stream Crossing Photos

- Habitat site cards and fish collection forms;
- Three streams: South Hermann Creek (“Sesyncline”), Canary Creek, Mast Creek;
- South Hermann Creek (“Sesyncline”) catch: (adult) Brook Trout;
- Mast Creek catch: (juvenile) Bull Trout;
- Fish were not captured in Canary Creek.

2007 Section 10: Periphyton, Benthos and Fish Tissue Metals

- Aquatic biological baseline conditions in the Hermann Mine Project area, specifically periphyton biomass and community composition, benthos community composition, and tissue contaminant burdens in periphyton, benthos, and fish;
- Slimy Sculpin selected as a target fish species for selenium toxicity;
- Two sites sampled: M20 Creek and Sesyncline;
- Concentrations of selenium in three Sculpin samples from M20 Creek and one from the Murray River near the mouth of South Hermann Creek exceeded the MWLAP draft guideline;
- No Sculpin samples exceeded the USEPA draft criterion;
- No relationship between Sculpin age and selenium whole body tissue concentrations;
- Sculpin from M20 Creek accumulate higher tissue selenium concentrations than those from the Murray River downstream of the confluence with South Hermann Creek;
- The data for M20 Creek were similar to or lower than the results for fish collected from nearby areas such as the Wolverine River, Perry Creek, and Bullmoose Creek.

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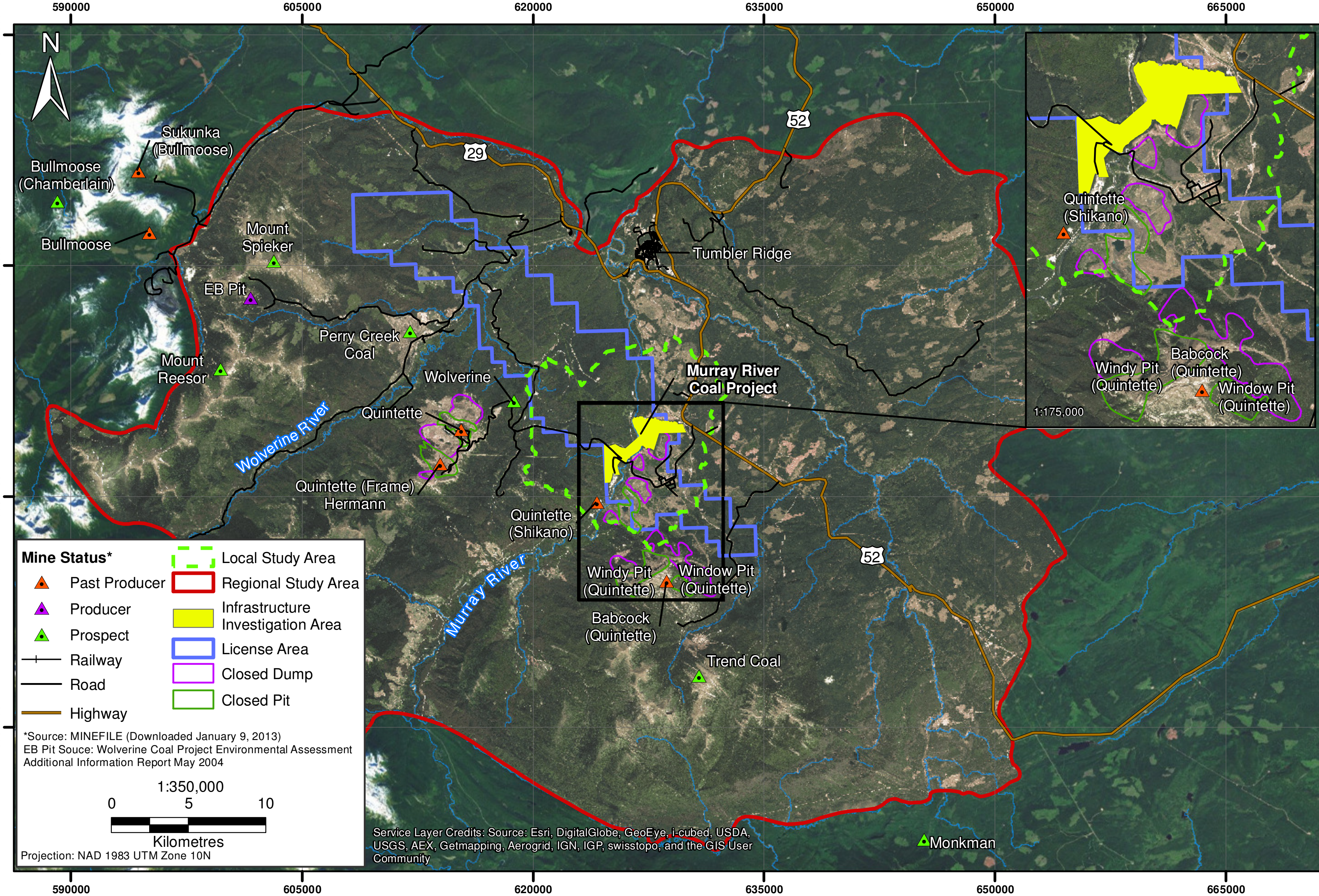

Figure 2.3-1

MURRAY RIVER COAL PROJECT

Figure 2.3-1

Current and Historical Mining Activity in the Regional Study Area

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2007 Fish Tissue Analysis

- Tissue metals analysis report from 2004;
- Slimy Sculpin sampled: Sesyncline (n=5), M20 Creek (n=5).

2007 EA Section 11: Fish

- Fish distribution and habitat use in waters potentially affected by the development of the Hermann Mine Project were investigated between summer 2004 and fall 2006;
- Objectives: confirm/document fish barriers; describe limits of fish distribution; confirm presence/absence of fish; confirm presence/sensitivity of habitat in M20 Creek;
- Five streams: M20 Creek, Mast Creek, M14 Creek, South Hermann Creek, and Canary Creek;
- M20 Creek catch: Arctic Grayling, Bull Trout, Burbot, Mountain Whitefish, Longnose Sucker, Rainbow Trout, Slimy Sculpin;
  - Fish distribution in M20 is restricted by a series of impassable barriers on the middle portion of the mainstem,
  - The fish-bearing portion of the M20 drainage is limited to the lower two mainstem reaches, which are accessible to fish from the Murray River,
  - Of the species recorded in M20, only Slimy Sculpin exist as a year-round resident population;
- Mast Creek is known to support Bull Trout and Slimy Sculpin populations;
- M14 Creek drainage is comparatively small and most reaches are ephemeral in nature;
  - Catch: Finescale Dace, Lake Chub, Longnose Sucker;
- South Hermann Creek lower reach contains marginal seasonal rearing potential for sport and non-sport species;
  - four Brook Trout in spawning condition were captured; resident Slimy Sculpin and rearing juveniles of other species were absent;
- Canary Creek: limited seasonal use of the lower reach, by juvenile sport and non-sport fish from the Murray River, is probably during periods of continuous channel connectivity and surface flow;
  - No resident fish populations.

<u>Quintette Project</u>

Fish and fish habitat studies within the Quintette Project were completed in the early 1980s. These studies focused on several sub-watersheds in and around the Murray River Project area including M20, M19, M17 and M15 creeks, and the Murray River. In addition, Stantec (2011) completed recent studies to support an application to re-start the Quintette Mine.

2011 Quintette Project: Murray River Fish and Fish Habitat Baseline Report

- A summary of the existing knowledge of fish and fish habitat conditions in the Murray River and its tributaries in the vicinity of the Quintette Project;
- Seven stream sites: Waterfall Creek, M5, M7, M9, M15, M17, and M19 Creeks (all on east side of the Murray River);
- Bull Trout caught in Waterfall Creek;

- No fish caught in other streams (M5, M7, M9, M15, M17, and M19 Creeks);
- Waterfall Creek appears to provide the most stable habitat accessible to fish species from the Murray River. However, a major waterfall located approximately 2 km upstream of the Waterfall/Murray confluence presents an impassable barrier to fish movement;
- The lower sections of Murray River tributaries near or within the Project area are generally accessible to fish; however, a number of factors limit the productive capacity of these tributaries:
  - The presence of impassable barriers which limit fish access to upper reaches,
  - Relatively high channel gradients,
  - High natural silt loading,
  - Low water levels or absence of flow due to seasonal/ephemeral nature of watercourses,
  - Occasionally elevated water temperatures.

2012 Quintette Mine Restart: Section 7: Fish Tissue

- The 2011 fish tissue sampling program was designed to:
  - Provide additional baseline metals information, specifically selenium concentrations, in fish from reference areas and areas potentially affected by the Quintette Project
  - Provide baseline data to inform assessments of potential project effects on fish (e.g., selenium toxicity), and on the health of fish consumers (i.e., wildlife and humans) in the Project area;
- Silmy Sculpin was targeted to monitor the potential for selenium toxicity;
- Streams sampled: Murray River, M5, M9, M15, M17, and Waterfall Creeks;
- Baseline selenium concentrations in fish from both the Murray and Babcock watersheds have exceeded the BC fish tissue guideline in the past and also in 2011 at three of four Murray locations sampled;
- These results indicate that baseline concentrations of selenium are elevated in the region and that concentrations have remained elevated due to discharge from closed mines and active mines.

2012 Quintette Mine Restart: Appendix E: Fish Data

- Fish community characteristics:
  - *Stantec 2011*: Murray River: 85 Slimy Sculpin; Waterfall Creek: 3 Brook Trout; M17 Creek: 2 Brook Trout,
  - *Historical Data*: Babcock system: Bull Trout, Slimy Sculpin; Murray system: Mountain Whitefish, Slimy Sculpin;
- Fish tissue data:
  - *Stantec 2011*: Murray Watershed and Babcock Watershed,
  - *Historical Data*: Murray Watershed.

<u>Murray River Project</u>

Fish and fish habitat fieldwork specific to the Murray River Project was conducted by Diversified Environmental Services (DES) in 2011.

2011 Fisheries Habitat Assessment

- Purpose: To delineate fish distribution and habitat use in aquatic habitats potentially affected by Project infrastructure;
- Objectives: confirm and update fish species and abundance data for previously assessed streams; collect species and habitat data for streams not previously assessed;
- Conducted within drainages of M19 Creek, M20 Creek, Twenty Creek and Wetland 00313;
- M19 Creek catch: Arctic Grayling, Brook Trout, Burbot, Longnose Sucker, Mountain Whitefish, Slimy Sculpin;
  - M19 contained high quality seasonal rearing habitat suitable for juvenile Arctic Grayling, with abundant rearing cover provided by pools, LWD, SWD and undercut bank;
- M20 Creek catch: Arctic Grayling, Brook Trout, Bull Trout, Burbot, Mountain Whitefish, Rainbow Trout, Slimy Sculpin;
- Twenty Creek catch: Brook Trout, Mountain Whitefish, Rainbow Trout; and
- Wetland 00313 catch: Lake Chub.

3. Methods

3. Methods

3.1 DEFINITIONS

Streams, lakes, and wetlands are important habitat components for fish. Fish species may use only one habitat component or move between components during various life-history stages. Stream and wetland habitat components were sampled during fish and fish habitat baseline studies within the Infrastructure Investigation Area and LSA. Streams are defined as areas of flowing water characterized by a continuous channel with evidence of scouring to the channel bed or deposits of mineral alluvium (RISC 2001). Wetlands are defined as shallow, open water bodies, or open water bodies in which more than 25% of the surface is covered in vegetation.

For the purposes of this program only stream and wetland habitat components were assessed. Lakes were not found within the Infrastructure Investigation Area, and lakes within the LSA and RSA are not anticipated to be impacted by the Project.

3.2 RECEIVING AND REFERENCE ENVIRONMENT SITES

3.2.1 Study Design

This study design follows a Before-After-Impact-Control (BACI) method consistent with guidance from the MMER (Environment Canada 2012) to assess potential future effects to the downstream 'receiving environment' from Project activity. Since the Project is currently not in development, data collected from 2010 through 2013 were used to characterize baseline ('Before') conditions for the purpose of comparison with post-development conditions (i.e., 'After') in a monitoring program.

Steam and wetland sites used for this baseline study were sub-divided into two categories: 'receiving environment' sites (i.e., 'Impact' in a BACI) and 'reference environment' sites (i.e., 'Control'). 'Receiving environment' includes sites and water bodies within the immediate Project area (e.g., Infrastructure Investigation Area) and downstream of the Project. 'Reference environment' includes sites on the Murray River and selected tributary stream sites upstream of the Project location. Receiving and reference environment site locations are shown in Figure 3.2-1. Receiving environment sites were further classified based upon distance from the Infrastructure Investigation Area. Those sites located within the Infrastructure Investigation Area were classified as near-field, sites outside of the Infrastructure Investigation Area and within the LSA were classified as mid-field, and sites that were outside of the LSA and within the RSA were classified as far-field. Site details and rationale are shown in Table 3.2-1.

3.2.2 Fish Habitat

The objective of the fish habitat surveys was to use a standardized approach to describe baseline conditions of fish habitat at receiving environment and reference environment sites. Detailed fish habitat assessments were completed in 2010, 2012, and 2013 (Figure 3.2-1; Table 3.2-2). Fish habitat assessments followed the Fish Habitat Assessment Protocol (FHAP; Johnston and Slaney 1996). A field data sheet template is shown in Appendix 1.

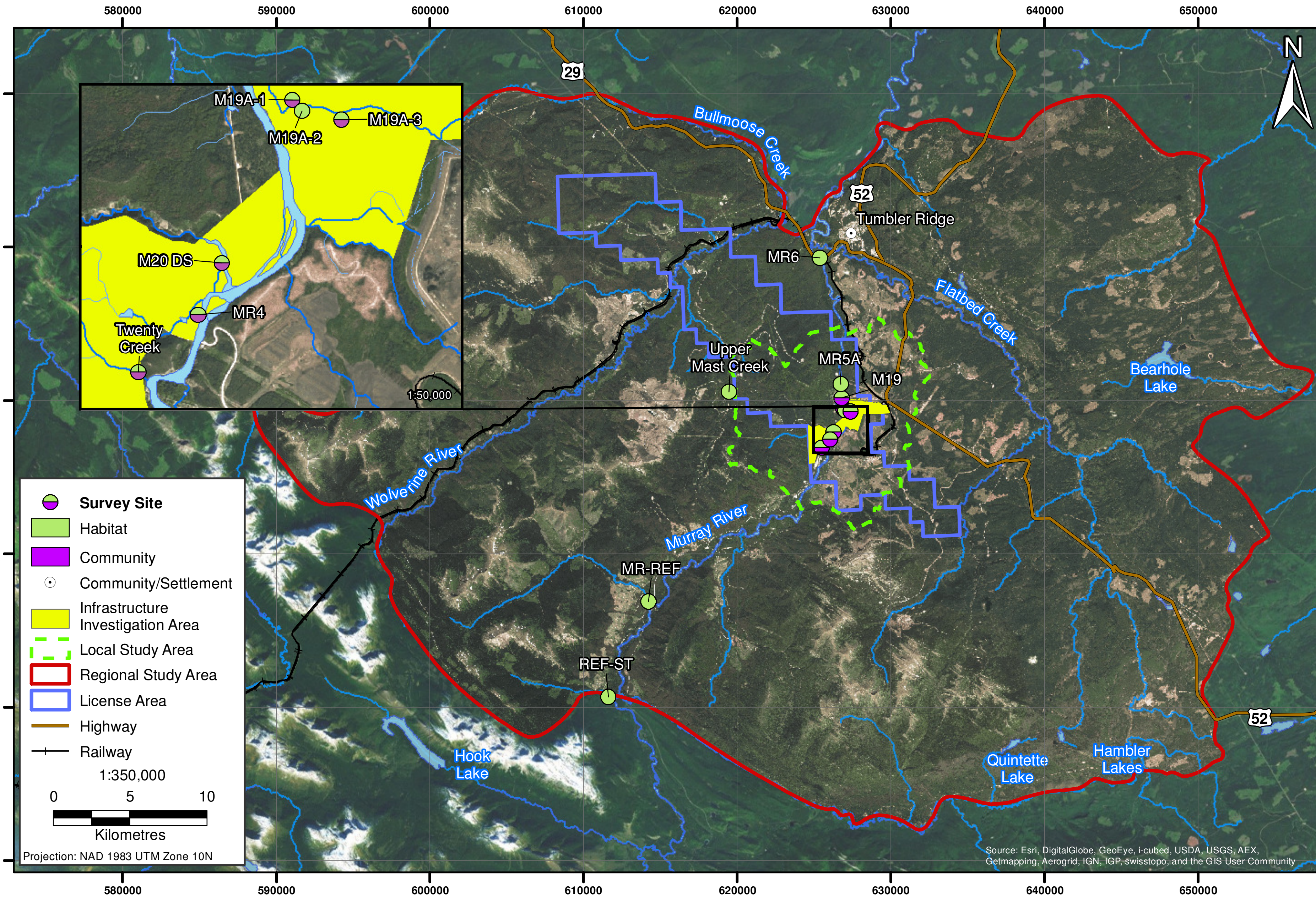

Figure 3.2-1

MURRAY RIVER COAL PROJECT

Fish Habitat and Community Survey Sites, 2010 to 2013

Figure 3.2-1

Table 3.2-1. Receiving and Reference Environment Site Rationale, 2010 and 2012

Year	Site Name	Waterbody Name	UTM Coordinates			Site Type	Receiving Environment Class	Rationale
			Zone	Easting	Northing	(Reference / Receiving)	(Near-, Mid-, or Far-field)	
2012	M20 US	M20 Creek	10 U	625300	6098442	Reference	–	Comparison of effects immediately upstream of Project infrastructure on M20 Creek
2012	M20 DS	M20 Creek	10 U	626248	6097956	Receiving	Near-field	To monitor effects of Project infrastructure (including proposed discharge) on west side of Murray River
2012	MR 3	Murray River	10 U	625221	6095745	Reference	–	Comparison of effects immediately upstream of Project infrastructure on Murray River
2012	MR 4	Murray River	10 U	626712	6097950	Receiving	Near-field	To monitor effects of all Project infrastructure on Murray River
2012	MR US	Murray River	10 U	618494	6090320	Reference	–	Comparison of effects far upstream of Project infrastructure
2012	MR DS	Murray River	10 U	626711	6100880	Receiving	Far-field	To monitor effects of all Project infrastructure on Murray River
2010	M20 DS	M20 (Camp) Creek	10 U	626195	6097960	Receiving	Near-field	To monitor effects of Project infrastructure (including proposed discharge) on west side of Murray River
2010	MR 4	Murray River	10 U	626029	6097474	Receiving	Near-field	Monitoring site, near-field exposure site downstream of potential discharge
2010	MR 5A	Murray River	10 U	626724	6101080	Receiving	Mid-field	Monitoring site, far-field exposure site downstream of potential discharge
2010	MR 6	Murray River	10 U	625364	6109309	Receiving	Far-field	Monitoring site, far-field exposure site downstream of potential discharge
2010	Twenty Creek	Twenty Creek	10 U	625500	6096907	Receiving	Near-field	Monitoring site, downstream of proposed Project site
2010	Upper Mast Creek	Mast Creek	10 U	619459	6100577	Receiving	Far-field	Possible impact due to Project infrastructure
2010	MR-REF	Murray River	10 U	614218	6086910	Reference	–	Monitoring site, upstream Murray River reference for comparison with downstream Murray River sites
2010	REF-ST (Club Cr.)	Club Creek	10 U	611594	6080686	Reference	–	Monitoring site, for comparison with Twenty Creek and M20 (Camp) Creek receiving environment sites

Table 3.2-2. Receiving and Reference Environment Fish Habitat Assessment Sites, 2010 to 2013

			UTM Coordinates		
Site ID	Location	Date	Zone	Easting	Northing
M19A-1	M19A Creek	14-Jun-13	10 U	626904	6099476
M19A-2	M19A Creek	14-Jun-13	10 U	626995	6099374
M19A-3	M19A Creek	25-Aug-13	10 U	627360	6099292
M20 DS	M20 Creek	23-Sep-12	10 U	626248	6097956
M19	M19 Creek	5-Aug-11	10 U	626778	6100178
Twenty Creek	Twenty Creek	5-Aug-11	10 U	625474	6096940
MR4	Murray River	3-Jun-10	10 U	626029	6097474
MR5A	Murray River	3-Jun-10	10 U	626724	6101080
MR6	Murray River	4-Jun-10	10 U	625364	6109309
M20 DS	M20 Creek	3-Jun-10	10 U	626195	6097960
Twenty Creek	Twenty Creek	4-Jun-10	10 U	625500	6096907
Upper Mast Creek	Mast Creek	4-Jun-10	10 U	619459	6100577
MR-REF	Murray River	3-Jun-10	10 U	614218	6086910
REF-ST	Club Creek	4-Jun-10	10 U	611594	6080686

FHAP assessments involved differentiating the stream into separate habitat units such as riffles, cascades, glides and pools, and then measuring an array of physical attributes for each habitat unit (Table 3.2-3). These attributes included data on mean depth, mean width, substrate composition, observations on flow conditions, fish cover, potential barriers, bank stability, and bank height. Data were collected with a measuring tape, metre stick, and range finder. At each site, UTM coordinates (NAD 87) were recorded with a handheld Garmin 60CSx GPS unit. A minimum of two photographs (e.g., upstream and downstream) were taken to document each stream site. Additional photographs were taken of stream features (e.g., barriers or falls) and UTM coordinates were recorded using a hand-held GPS unit.

Table 3.2-3. Fish Habitat Assessment Variables

Substrate Types	Physical Measurements	Habitat	Cover
• % Sand	• Length (m)	• Habitat Type	• % Deep Pool
• % Gravel	• Mean Depth (m)	• Pool Type	• % Boulder
• % Cobble	• Bankfull Depth (m)	• Pool Residual Depth	• % Instream Vegetation
• % Boulder	• Wetted Width (m)	• Bank Stability	• % Undercut
• % Bedrock	• Bankfull Width (m)	• Confinement	• % Large Woody Debris
• Bank Texture	• Gradient (%)	• Hill-slope Coupling	• % Small Woody Debris
	• Bank Height (m)	• Stream Pattern	• % Canopy Closure
		• Islands/Bars	• % Riparian Cover
		• Fish Passage Barriers	• % Overhanging Vegetation

Stream habitats within these sites were separated into the following habitat units:

- Pool – low velocity area with smooth, non-turbulent flow, low gradient (near 0%), and a concave bottom;

- Glide – an area of smooth, non-turbulent flowing water with moderate velocity and gradient less than 4%;
- Riffle – an area of turbulent, fast-flowing water with a gradient less than 4%; and
- Cascade – high gradient (> 4%) area of turbulent, fast-flowing water.

Data collected for each habitat variable were used to evaluate the overall quality of fish habitat. Professional knowledge and expertise was used to rank habitat suitability for each fish life history stage (i.e., spawning, rearing, and over-wintering) and overall habitat quality (categorized as none, poor, fair, or good; Table 3.2-4).

Table 3.2-4. Life History Habitat Suitability and Overall Habitat Quality Criteria

Life Stage Suitability Rank	Criteria
None	No habitat present for any life history stage
Poor	Most of the necessary physical/biological components of the habitat for this life history stage are missing or severely deficient
Fair	Some of the necessary physical/biological components of the habitat for this life history stage are present, but a key component is missing
Good	All of the necessary physical/biological components of the habitat for this life history stage are present
Overall Habitat Quality Rank	**Criteria**
None	No habitat present
Marginal	Low productive capacity
Important	Common habitat which supplies basic needs of fish (typically includes rearing habitat with some spawning habitat potential)
Critical	Rare or exceptionally productive or unusual habitat with very high habitat values which are of uncommon and/or highly valuable

Streams within the LSA were also surveyed using the *Reconnaissance 1:20,000 Fish and Fish Habitat Inventory Protocol* (RISC 2001) and the *Reconnaissance 1:20,000 Fish and Fish Habitat Inventory: Site Card Field Guide* (RISC 1999a) by DES (2011) and other consultants. This protocol involves characterizing fish habitat over a 100-m-long section of stream by measuring physical attributes (e.g., channel width, gradient, temperature), characterizing cover types and substrate (dominant and subdominant cover and substrate type, cover abundance and location), and describing stream morphology.

Streams were classified according to the *Forest Practices Code of British Columbia Fish-Stream Identification Guidebook* (MOF 1998). Under this procedure, streams are classified based on mean channel width (m) and fish-bearing status (Table 3.2-5). The guidebook provides criteria for classifying streams as either fish-bearing (i.e., Classes S1, S2, S3, and S4) or non-fish-bearing (i.e., S5 and S6). Streams are classified by this guidebook as non-fish-bearing if the mean gradient is greater than 20%. Additional habitat features were considered prior to classifying stream reaches as non-fish-bearing, including:

- stream channel was not defined;
- step-pool morphology was absent;
- pools were shallow and void of alluvial deposits (i.e., no over-wintering habitat);
- habitat was non-existent or marginal; and

- fish-bearing lakes were not present upstream.

Table 3.2-5. Stream Classification Criteria

Classification	Bankfull Width	Status
S1	>20 m	fish-bearing
S2	5 to 20 m	fish-bearing
S3	2.5 to 5 m	fish-bearing
S4	<2.5 m	fish-bearing
S5	> 5 m	non-fish-bearing
S6	< 5 m	non-fish-bearing
NCD	NA	non-classified drainage

3.2.3 Community

The study design for fish community sampling followed RISC Fish Collection Methods and Standards (RISC 1997), Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures (RISC 2001), and the Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Fish Collection Field Guide (RISC 1999b). The objectives of fish sampling were to confirm fish presence/absence and characterize fish community composition. Fish community sampling was conducted in the same locations as habitat surveys (Table 3.2-6).

Table 3.2-6. Receiving and Reference Environment Fish Community Assessment Sites, 2012 and 2013

			UTM Coordinates			
Site ID	Location	Date	Zone	Easting	Northing	Sampling Purpose
M19A-1	M19A Creek	13-Jun-13	10 U	627358	6099292	Fish Community
M19A-3	M19A Creek	25-Aug-13	10 U	627360	6099292	Fish Community
M20 DS	M20 Creek	23-Sep-12	10 U	626248	6097956	Fish Community
M20 US	M20 Creek	21-Sep-12	10 U	625300	6098442	Tissue Metals
MR DS	Murray River	20-Sep-12	10 U	626711	6100880	Tissue Metals
MR US	Murray River	21-Sep-12	10 U	618494	6090320	Tissue Metals
MR3	Murray River	20-Sep-12	10 U	625221	6095745	Tissue Metals
MR4	Murray River	20-Sep-12	10 U	626712	6097950	Tissue Metals
M19	M19 Creek	5-Aug-11	10 U	626778	6100178	Fish Community
Twenty Creek	Twenty Creek	5-Aug-11	10 U	625474	6096940	Fish Community

Electrofishing was conducted at sites where stream cover and water depth permitted. A systematic sweep was conducted across the entire wetted width from the downstream to the upstream site boundary (Stanfield 2005). Electrofishing effort was not pre-determined due to differences between site and available habitat. Electrofisher voltage (V), duty cycle (%) and frequency (Hz) settings remained consistent where possible.

Minnow traps consisted of two wire mesh cylinders (mesh size 0.63 cm) locked together using a clip attached to a rope and marker buoy. Each minnow trap was baited with an equal amount of commercial crab bait. Minnow traps were set for overnight for approximately 24 hours, and retrieved the following day. All traps were marked with contact information and the fish collection permit number.

3.2.4 Biology

Fish were sampled for biological data during the 2011, 2012, and 2013 field programs. Following capture, fish were identified to species and given a unique sample number. Length was measured to the nearest 1 mm with a measuring board. Species with a forked tail (e.g., Bull Trout) were measured from the nose to the tail notch for fork length (FL). Species without a forked tail (e.g., Burbot and Slimy Sculpin) were measured from the nose to the end of the tail for total length (TL). Wet weight was collected (to the nearest 0.01 g) with an Ohaus 200 g scale. Observations were recorded on the general condition of fish, noting the presence of deformities, erosions, lesions, and tumours (DELTs), and age (through the collection of scale and fin ray samples from a subsample of fish). Scales were collected with tweezers below the posterior margin of the dorsal fin on the left side of the sampled fish. Two to three rays of the left pelvic fin were also collected with scissors or pliers. Aging structures were placed in envelopes labelled with the site, date, species, and sample number.

3.2.5 Environmental Effects Monitoring and Tissue Metals

<u>Sentinel Species Selection</u>

Biological endpoint responses and effect indicators specified by Environment Canada (2012), and fish tissue metals will be used as principle biological endpoints for effects monitoring for the Project. Endpoint data and fish tissue metals were assembled from 2004 to 2012 from sites within the RSA and LSA.

Numerous studies emphasize the importance of including sentinel species in order to detect biological effects following environmental impact. Martinez-Gomez et al. (2010) provide multiple criteria for the selection and sampling of a sentinel species to detect biological effects after oil spills. Sentinel species should be representative of the environment, and, where possible, it should be a species for which biological-effects techniques are well documented. Sample sizes as small as eight individuals of each sex per study area may be appropriate when effects occur at low prevalence rates, but that larger sample sizes would be necessary at higher prevalence rates. Slimy Sculpin and Bull Trout were selected because they most closely fulfil the sentinel species criteria, and they are common within the Project area.

Spencer et al. (2008) and Arciszewski et al. (2010) suggest that Slimy Sculpin are an ideal sentinel species for effects monitoring in Canada for the following reasons:

1. Higher abundances and greater geographical distributions than most other northern species, and therefore they are easily collected;
2. Typically sedentary and have limited home ranges due to territorial behaviour and restricted mobility. An important assumption regarding study design and sentinel species selection is that fish collected at a given site will exhibit responses and characteristics that reflect their local environments (Gibbons et al. 1998; Arciszewski et al. 2010). As such, the lack of movement between locations, especially between reference and exposure sites, is a key factor in the selection of Slimy Sculpin as a sentinel species;
3. Relatively short lifespan and sexual maturation at approximately 2 years. These biological characteristics foster alterations in reproduction and growth in response to environmental change at a faster rate than other longer-lived species (e.g., Bull Trout and Mountain Whitefish);
4. Easily aged using otoliths, which yield the most accurate growth estimates;
5. Fecundity between 100 and 1,400 eggs; and
6. Benthic position in the food web (Gray et al. 2004; Arciszewski et al. 2010). Benthivorous fish can be a good choice for fish population surveys because they are usually less mobile than

pelagic species and they feed at the water-sediment interface where metals can accumulate (Ribey et al. 2002).

Bull Trout within the RSA are present as stream resident and adfluvial forms. These forms vary greatly in terms of movement and dispersal within watersheds (Bryant et al. 2004; Ihlenfeldt 2005). Resident Bull Trout generally live from 8 to 9 years, their age and length to maturation is short (3 to 5 years; 130 to 162 mm), spawning is site-specific, and their diet is based primarily on aquatic macroinvertebrates (Ihlenfeldt 2005; McPhail 2007; Environment Canada 2011). Bull Trout are a 'Blue-listed' species in British Columbia, and lethal sampling for tissue metals sample collection is typically limited to three juvenile Bull Trout per site. Thus, Bull Trout were considered less desirable as a sentinel species.

Tissue Metals Collection and Processing

In 2012, Slimy Sculpin were collected from four sites (2 receiving environment and 2 reference environment sites, respectively) on the Murray River (Figure 3.2-2; Table 3.2-7). A sample size of eight sculpin and three Bull Trout from each sampling site was provided by the BC MOE (B. Carmichael, BC MOE, personal communication) for lethal sampling under BC Fish Collection Permit No. FJ12-81135. All fish used for tissue metals were collected as whole body samples.

Table 3.2-7. Summary of Fish Tissue Metals Sampling Sites and Species, 2004 to 2012

		UTM Coordinates						
Site	**Waterbody**	**Zone**	**Easting**	**Northing**	**2012**	**2011**	**2005**	**2004**
MR3	Murray River	10 U	625221	6095745	CCG	-	-	-
MR4	Murray River	10 U	626712	6097950	CCG	-	-	-
MR US-1	Murray River	10 U	618494	6090320	CCG	CCG	-	-
MR US-2	Murray River	10 U	621888	6092141	-	-	CCG, MW	-
MR DS-1	Murray River	10 U	626711	6100880	CCG	CCG	-	-
MR DS-2	Murray River	10 U	626418	6099744	-	-	CCG, MW	-
M20 US	M20 Creek	10 U	625300	6098442	CCG, BT	-	-	-
Murray RB	Murray River	10 U	626054	6097265	-	CCG	CCG	-
B2 Wetland	Wetland	10 U	622426	6091874	-	FDC	-	-
M20 Wetland	Wetland	10 U	625797	6097292	-	FDC	-	-
M14 Wetland	Wetland	10 U	623857	6093384	-	FDC	-	-
Barbour Wetland	Wetland	10 U	619763	6090816	-	FDC	-	-
Waterfall Creek	Waterfall Creek	10 U	622034	6091256	-	EB	-	-
M20 DS-1	M20 Creek	10 U	625746	6098250	-	BT, EB	-	-
M20 DS-2	M20 Creek	10 U	626242	6098112	-	CCG	-	-
FEL	Fellers Creek	10 U	634276	6067125	-	BT	-	-
Murray 11 / Wetland 00313	Wetland	10 U	625654	6097348	-	FDC	-	-
SS-FT	Murray River	10 U	620794	6090991	-	-	-	CCG
M20 DS	M20 Creek	10 U	626238	6097954	-	-	-	CCG

Notes:
Fish Species Codes: BT = Bull Trout, CCG = Slimy Sculpin, EB = Brook Trout, FDC = Finescale Dace, MW = Mountain Whitefish
Dashes (-) = data not collected

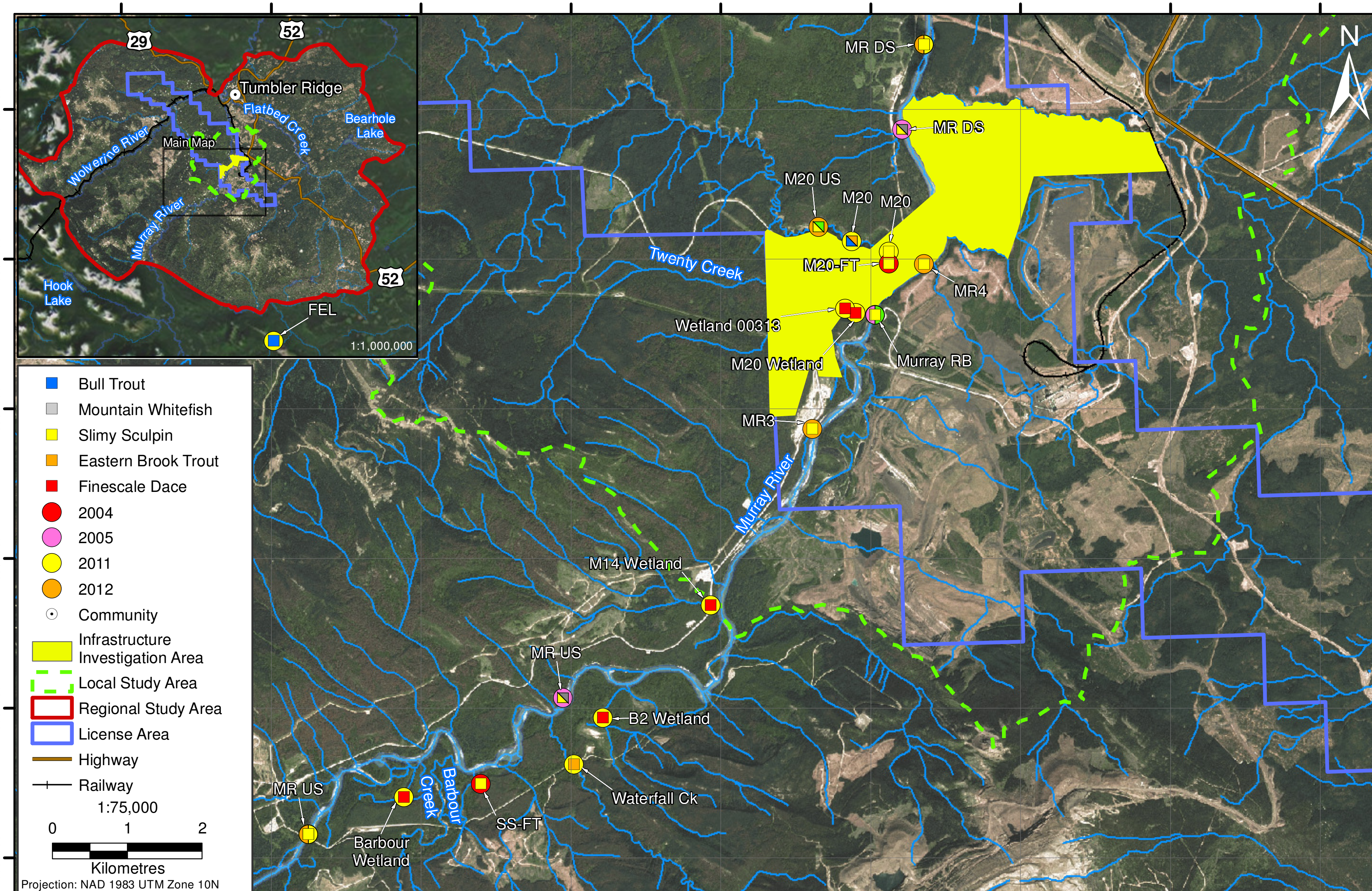

Figure 3.2-2

hd Mining

MURRAY RIVER COAL PROJECT

Fish Tissue Metals Sample Sites, 2004 to 2012

Figure 3.2-2

Rescan™ Engineers & Scientists

Fish were euthanized by a sharp blow to the head and severing of the gills prior to sampling. Fish were then measured for length (mm), weighed (to the nearest g), placed in a labeled Whirl-pac bag, and temporarily held in an ice-filled cooler. After each field day all tissue samples were stored in a -20°C freezer. Tissue samples were collected on September 21 and 22, 2012, stored frozen, then shipped to ALS Environmental (Burnaby, BC) for metals analyses on October 9, 2012. Therefore, the holding time for the samples was 16 days prior to analysis.

Tissue samples were analysed for metals concentrations according to procedures adapted from the United States Environmental Protection Agency (EPA) (US EPA 1995). Samples were divided into two parts: one part for measurement of metal concentrations (on a wet weight basis) and a second part for measurement of percent moisture to facilitate conversion to mg/kg dry weight.

Each sample was homogenized either mechanically or manually prior to digestion at ALS. The hotplate digestion method involved the use of nitric acid followed by repeated additions of hydrogen peroxide. Total concentrations of 25 metals were measured by Inductively Coupled Plasma – Mass Spectroscopy (or ICPMS). The 25 metals and their analytical detection limits are shown in Table 3.2-8. Iron, phosphorus, potassium, sodium, and titanium were not measured due to limited sample sizes.

Table 3.2-8. Metals and Detection Limits for Fish Tissue Analysis

Variable	Detection Limit	Unit
Aluminum (Al)	2	mg/kg ww
Antimony (Sb)	0.01	mg/kg ww
Arsenic (As)	0.01	mg/kg ww
Barium (Ba)	0.01	mg/kg ww
Beryllium (Be)	0.1	mg/kg ww
Bismuth (Bi)	0.03	mg/kg ww
Cadmium (Cd)	0.005	mg/kg ww
Calcium (Ca)	2	mg/kg ww
Chromium (Cr)	0.1	mg/kg ww
Cobalt (Co)	0.02	mg/kg ww
Copper (Cu)	0.01	mg/kg ww
Lead (Pb)	0.02	mg/kg ww
Lithium (Li)	0.1	mg/kg ww
Magnesium (Mg)	1	mg/kg ww
Manganese (Mn)	0.01	mg/kg ww
Mercury (Hg)	0.001	mg/kg ww
Molybdenum (Mo)	0.01	mg/kg ww
Nickel (Ni)	0.1	mg/kg ww
Selenium (Se)	0.2	mg/kg ww
Strontium (Sr)	0.01	mg/kg ww
Thallium (Tl)	0.01	mg/kg ww
Tin (Sn)	0.05	mg/kg ww
Uranium (U)	0.002	mg/kg ww
Vanadium (V)	0.1	mg/kg ww
Zinc (Zn)	0.1	mg/kg ww

Note: mg/kg ww = milligrams per kilogram of wet weight

3.3 HABITAT OFFSETTING

3.3.1 Regulatory Background

If serious harm to fish or fish habitat cannot be avoided or mitigated, any residual impact should be addressed by offsetting. Offset measures are those that are taken to replace or enhance fisheries productivity to compensate for unavoidable impacts with the goal of maintaining the productivity of commercial, recreational, or Aboriginal fisheries. The *Fisheries Productivity Investment Policy: A Proponent's Guide to Offsetting* (DFO 2013) describes four guiding principles for the consideration of fisheries offsetting projects:

- *Offsetting measures must support fisheries management objectives or local restoration priorities;*
- *Benefits from offsetting measures must balance project impacts;*
- *Offsetting measures must provide additional benefits to the fishery; and*
- *Offsetting measures must generate self-sustaining benefits over the long term.*

Offsetting may be accomplished through a variety of methods including habitat restoration or enhancement, habitat creation, chemical or biological manipulations, and complementary measures such as funding scientific research. Habitat restoration and creation are generally preferred over chemical and biological manipulations and complementary measures; however, the latter may be considered when enhancement or creation opportunities are particularly rare across a landscape.

3.3.2 Proposed Habitat Offsetting

The goal of the proposed Project offsetting program was to locate and characterize potential fish habitat sites for future offsetting planning. Sites were selected based upon their location relative to the Infrastructure Investigation Area, accessibility for Arctic Grayling and Bull Trout, current habitat complexity, future potential habitat complexity, site accessibility, and ease of potential habitat enhancement or creation work.

Five potential fish habitat offsetting sites were identified within a side-channel of the Murray River in 2012 (Figure 3.3-1 and Table 3.3-1). Sites were surveyed in September 2012 (low flow condition) and again in June 2013 (high flow condition). At each site, FHAP was conducted as described in Section 3.2-2. Existing habitat value, connectivity to the Murray River, flow conditions, bed load stability, site access, and fish presence were also detailed. Photographs and UTMs were recorded at each site. Potential enhancement concepts, such as increasing habitat complexity were also recorded in field notes.

Seven additional potential offsetting sites (Figure 3.3-1) were surveyed by a Fisheries Biologist and Habitat Restoration Engineer in 2013. These locations were initially selected during a desktop review of the LSA using Google Earth™ and other satellite imagery available online (e.g., Bing Maps™). Potential sites were selected based upon the location of historical off-channel habitat, and professional judgement of the Habitat Restoration Engineer and Fisheries Biologist. A field reconnaissance of each site was conducted in June 2013 to confirm desktop observations. Sites were prioritized based upon the feasibility of proposed habitat offsetting and scale of the potential habitat improvements. Sites that did not provide significant opportunities for habitat enhancement or creation were not assessed further.

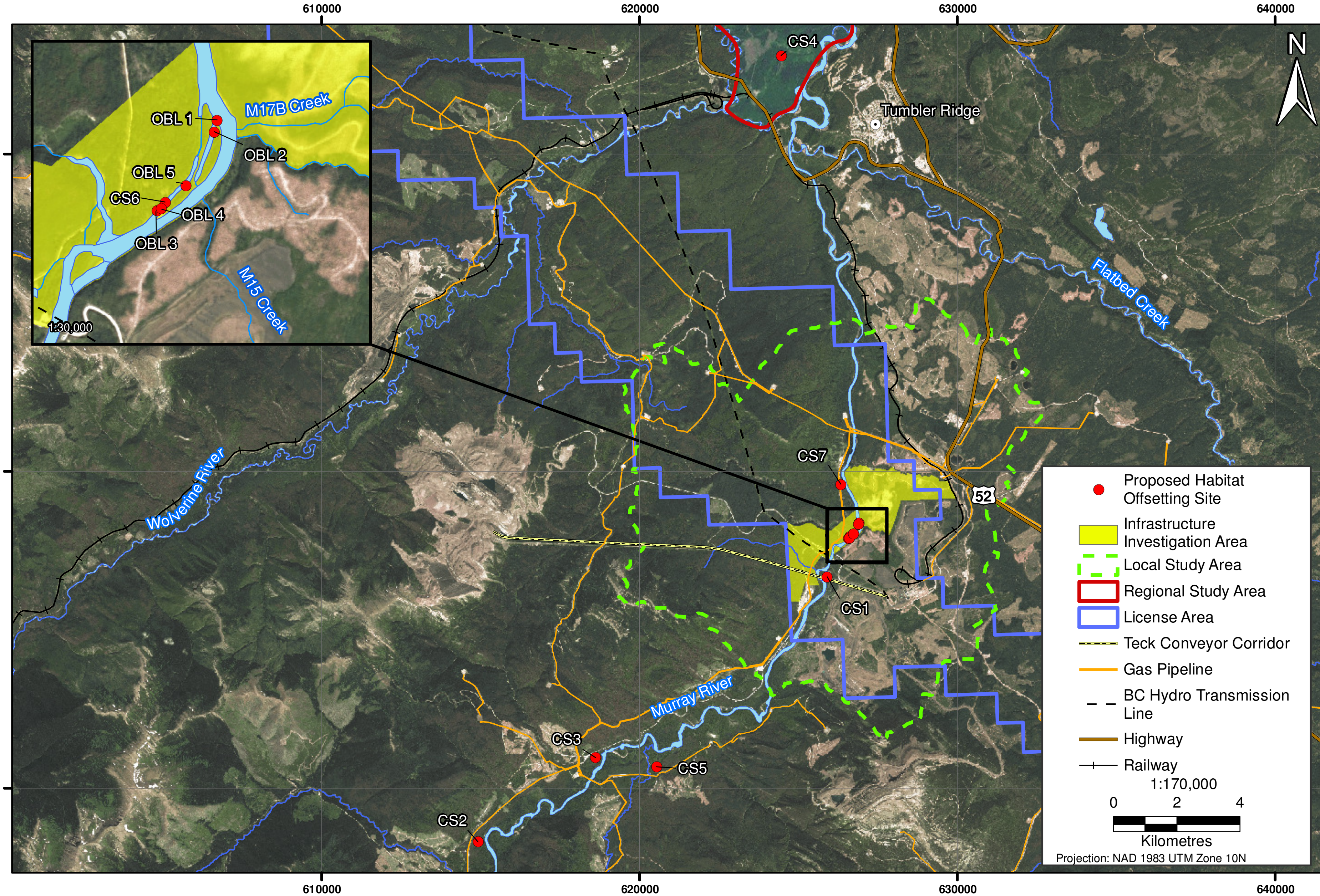

Figure 3.3-1

HD Mining

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Proposed Habitat Offsetting Sites, 2012 and 2013

Figure 3.3-1

Rescan an ERM company

Table 3.3-1. Proposed Fish Habitat Offsetting Sites, 2012 and 2013

			UTM Coordinates			Habitat			Community			
Site	Water Body	Date	Zone	Easting	Northing	Reconnaissance	Topographic Survey	FHAP	1-Pass EF	3-Pass EF	BS	MT
CS1	Side channel of Murray River	22-Aug-13	10 U	625897	6096674	X	X	X	X	-	X	X
CS2	Tributary of Murray River	21-Aug-13	10 U	614909	6088321	X	-	-	-	-	-	-
CS3	Tributary of Murray River	21-Aug-13	10 U	618607	6090967	X	-	-	-	-	-	-
CS4	Tributary of Murray River	21-Aug-13	10 U	624453	6113115	X	-	-	-	-	-	-
CS5	Tributary of Murray River	23-Aug-13	10 U	620530	6090686	X	-	X	X	-	-	X
CS6	Tributary of Murray River	21-Aug-13	10 U	626623	6097933	X	-	-	-	-	-	-
CS7	Tributary of Murray River	21-Aug-13	10 U	626335	6099601	X	-	-	-	-	-	-
OBL 1	Murray River	23-Sep-12	10 U	626910	6098392	X	-	X	X	-	-	X
OBL 2	Murray River	22-Sep-12	10 U	626894	6098325	X	-	X	X	-	-	X
OBL 3	Murray River	23-Sep-12	10 U	626562	6097863	X	-	X	X	X	-	X
OBL 4	Murray River	24-Sep-12	10 U	626577	6097888	X	-	X	X	X	-	X
OBL 5	Murray River	23-Sep-12	10 U	626562	6097863	X	-	X	X	-	-	X

Method codes:
FHAP = Fish Habitat Assessment Protocol, BS = beach seine, EF = backpack electrofisher, MT = minnow trap
X = method was conducted, Dashes (-) = method was not conducted

Two sites (CS1 and CS5) were further ground-truthed for habitat offsetting by a Fisheries Biologist and Restoration Engineer in August 2013. A detailed topographic survey was conducted at CS1 using a Nikon Nivo 3M (Model A151438) Total Station. At CS1 fish habitat offsetting was designed to a 'technically feasible' level for inclusion in the Fish Habitat Offsetting Plan of the Environmental Assessment (EA). CS5 was selected as a secondary site for habitat offsetting. A detailed topographic survey using a Total Station was not conducted at CS5, and habitat offsetting works were evaluated on a 'conceptual' level. Additional observations on existing habitat value, connectivity to the Murray River, site access, and fish presence were also recorded at CS1 and CS5. Numerous photographs and UTMs were recorded at each site. Both offsetting sites were also surveyed for fish community and CPUE for comparison with post-compensation monitoring.

3.4 QUALITY ASSURANCE AND CONTROL

To ensure consistency and accuracy of collected data, a QA/QC program was established at the outset of the field program. For all fish habitat and community surveys, data sheets were reviewed at the end of each field day to ensure data were complete and collected properly. Field notes were transcribed onto electronic spreadsheets once in the office and all transcriptions were checked visually against the field forms and any errors corrected.

The data were plotted (e.g., weight-length plots) to identify outliers that may have resulted from transcription errors. If transcription errors could not be amended, then those data were excluded from further analysis.

To assess the accuracy of the fish tissue metal analyses, ALS conducted two measures of quality control: method blanks (or MB) and comparison with reference material (or CRM). A method blank is a test in which no tissue was added. Five method blanks were run with 30 metals measured for each blank, resulting in a total of 150 comparisons between measurements and targets. A total of 4 measurements (or 2.7%) were above the method detection limit (or MDL) and were classified by ALS as "MB-LOR" (Appendix 2a). This result was well within the Data Quality Objectives (DQO) set by ALS (Elle Diniz, ALS Environmental, pers. comm.). All results of the QA/QC program for tissue metals are presented in Appendices 2 and 3.

To further assess the accuracy of the metal analyses, samples of a reference material, VA-NRC-TORT2 or lobster hepatopancreas, certified by the National Research Council of Canada, were subjected to the same analytical procedures as the tissue samples. The measured concentrations of each metal were then compared to the known metal concentrations in the certified material to determine if they fell within the 95% confidence limits expected for each metal. Of the 34 comparisons performed, all 34 fell within the 95% confidence limits around the target (Appendix 2a).

To assess the variability of fish tissue metal analysis, and hence the homogeneity of the samples, three of the 43 samples (or ~7% of the total number of samples) were each split into two replicates and the relative percent difference (RPD) between replicate metal concentrations (and percent moisture) was calculated as:

$$RPD = 100((sample - duplicate)/((sample + duplicate)/2)))$$

Because 31 variables were measured for each of the three samples (percent moisture and concentrations of 30 metals), this gave a total of 93 potential RPD (Appendix 3a; Table 3.4-1). However, 26% of those potential RPD were not calculated because one or both of the values were less than the MDL. In general, analytical variability is much higher near the MDL than is considered acceptable. Therefore, those RPD were classified as "RPD-not available" or RPD-NA.

Table 3.4-1. Tests of Variability of Fish Tissue Metal Concentrations, Murray River Project, 2012

Qualifier	Number of Potential RPD	Percent
RPD-NA	24	26
RPD	69	74
Total	**93**	**100**

Notes: RPD = Relative Percent Different, RPD-NA = RPD not available due to result(s) being less than detection limit.

The remaining 69 comparisons were considered to be valid RPD. They ranged from 0.2 to 15% with a median of 4%. None of the values exceeded the RPD limits established by ALS (20% for percent moisture and 30 to 50% for metals, depending on the analysis; Elle Diniz, ALS Environmental, pers. comm.).

3.5 DATA ANALYSIS

The variables used to assess fish community and biological data included: relative species abundance, length, weight, condition, and catch-per-unit-effort (CPUE). Data analysis and interpretation for these variables followed Guy and Brown (2007). Several of these variables required calculation. A description of the calculations is presented below.

The CPUE statistic is used as an estimate of relative abundance of fish (Hubert and Fabrizio 2007). A key factor that allows comparison of CPUE data is the standardization (type of trap, mesh size, etc.) of sampling devices. Fishing gear and methods (e.g., electrofisher duty cycle, type and size of minnow traps, and a consistent amount of bait) were applied consistently at all sites to facilitate comparison of CPUE data.

For electrofishing, CPUE was calculated as the number of fish caught per 100 s of electrofishing:

$$CPUE = \text{number of fish caught} / 100\ s$$

For minnow traps, CPUE was calculated from the number of fish caught per trap per day:

$$CPUE = \text{number of fish} \times [\text{set time (h)} / 24\ h\ \text{(day)}]$$

Condition and weight-length regressions are indicators of the relative health of fish within a lake. Condition factor was based on the following formula from Ricker (1975):

$$Condition = \text{weight (g)} \times 10^5 / \text{length}^3\ \text{(mm)}$$

Weight was multiplied by 10^5 to avoid fractional values, and a length-weight exponent of exactly 3 was assumed to apply to all species of fish.

All tissue metals data were reported in units of mg/kg ww. Tissue metals concentration data were summarized in descriptive statistics tables for each fish species, sampling site, and year. Mean metals concentrations (mg/kg ww), standard error (SE), and minimum and maximum values were calculated. Metals data were excluded from analyses if 90% of concentrations were below the MDL. For the included metals, values below the MDL were assigned values of one-half the MDL.

Selenium data for whole-body Slimy Sculpin were converted from mg/kg ww to mg/kg dw for direct comparison with draft selenium guidelines for British Columbia (Beatty and Russo 2012), using the following formula:

$$[Se]\ mg/kg\ dw = [Se]\ mg/kg\ ww\ / ((100 - \%\ moisture)/100)$$

Adjusted r^2 values are provided for all linear regressions shown in this report. R^2 was adjusted to account for sample size and the number of regressors within each dataset. Linear regressions were reported with the appropriate sample size (n) and P value and met the assumptions of normality and equal variance. When graphing, regression lines were presented only where significant relationships were found. For fish, the slope of the linear regression of log transformed weight on log transformed length is expected to be approximately equal to three, based on allometric scaling. Deviation below a slope of three may indicate a population with low condition.

All data were managed using Microsoft Excel 2010. All statistics were conducted according to Zar (1984). R software (R Development Core Team 2012) and SigmaPlot 12.0 software (Systat Software 2012) were used for statistical analyses and graphing.

4. Results and Discussion

4. Results and Discussion

4.1 SPECIES DISTRIBUTION

Fish habitat use, species presence/absence, and distribution have been surveyed extensively within the RSA since the early 1980s (BC Research 1982; McCart et al. 1985; DES 2006; WCC 2007; DES 2011; Stantec 2011).

Fish presence within the Murray River (Plate 4.1-1) is limited by Kinuseo Falls (Plate 4.1-2). This 60 m waterfall is located approximately 160 km upstream of the confluence of the Murray and Pine rivers, and approximately 38 km upstream from the Project. Kinuseo Falls is a permanent barrier to fish movement, and represents the upper limit of distribution for most fish species.

Plate 4.1-1. Murray River looking northeast to the proposed Infrastructure Investigation Area and LSA, September 2012.

The Murray River contains relatively high fisheries values and supports regionally important Arctic Grayling (Plate 4.1-3) and Bull Trout (Plate 4.1-4) populations. Bull Trout are a fish species of special concern ('blue-listed') in British Columbia. Arctic Grayling are currently not at risk in British Columbia, and are included on the provincial 'yellow-list'. In addition to Arctic Grayling and Bull Trout, native fish species commonly present downstream of Kinuseo Falls include Burbot (Plate 4.1-5), Finescale Dace, Lake Chub, Longnose Dace, Longnose Sucker, Mountain Whitefish, Northern Pike (*Esox lucius*; Plate 4.1-6), and Slimy Sculpin (Plate 4.1-7). Tables 4.1-1 and 4.1-2 present summaries of known fish species occurrence in the Murray River, tributary streams, and wetlands sampled within the RSA and LSA.

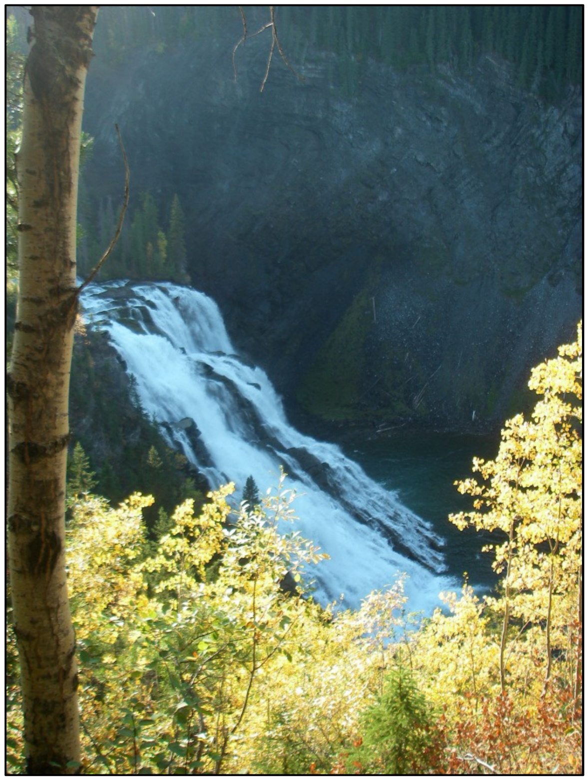

Plate 4.1-2. Kinuseo Falls, September 2012.

*Plate 4.1-3. Arctic Grayling (*Thymallus arcticus*), 2011.*

*Plate 4.1-4. Bull Trout (*Salvelinus confluentus*), 2012.*

*Plate 4.1-5. Burbot (*Lota lota*), 2013.*

Table 4.1-1. Summary of Known Fish Species Occurrence in the Murray River and Tributary Streams

Species Comon Name	Species Scientific Name	Species Code	Murray River	M14	M15	M17	M19	M19A	M20	Twenty Creek	Barbour Creek	Fellers Creek	Mast Creek	South Hermann Creek	Waterfall Creek
Arctic Grayling[+]	*Thymallus arcticus*	GR	X			X[a]	X[a]		X[a]		X				
Brassy Minnow	*Hybognathus hankinsoni*	BMC	O												
Brook Stickleback	*Culaea inconstans*	BSB	O												
Brook Trout	*Salvelinus fontinalis*	EB	X			X[a]	X[a]		X[a]	X[a]	X			X	X
Bull Trout*	*Salvelinus confluentus*	BT	X			X[a]	X[a]		X[a]			X	X		
Burbot	*Lota lota*	BB	X			X[a]	X[a]		X[a]		X				
Finescale Dace	*Phoxinus neogaeus*	FDC	X	X											
Lake Chub	*Couesius plumbeus*	LKC		X											
Longnose Dace	*Rhinichthys cataractae*	LNC	O												
Longnose Sucker	*Catostomus catostomus*	LSU	O	X		X[a]	X[a]		X[a]						
Mountain Whitefish	*Prosopium williamsoni*	MW	X		X	X[a]	X[a]		X[a]	X[a]	X				X
Northern Pike	*Esox lucius*	NP	X												
Rainbow Trout	*Oncorhynchus mykiss*	RB	O						X[a]	X[a]					
Redside Shiner	*Richardsonius balteatus*	RSC	O												
Slimy Sculpin	*Cottus cognatus*	CCG	X		X[a]	X[a]	X[a]		X[a]		X		X		
Westslope Cutthroat Trout*	*Oncorhynchus clarkii lewisi*	WCT	O												

** Blue-listed species*

[+] Yellow-listed species

X = indicates that Project-specific sampling was utilized to confirm fish species presence in the Project LSA.

O = indicates that other sources of existing inventory data (e.g., historical literature, Habitat Wizard) were utilized to confirm fish species presence within the Murray River Watershed.

[a] Present below permanent barrier to fish migration (e.g., waterfall).

Empty cells indicate not present

Table 4.1-2. Summary of Known Fish Species Occurrence in Wetlands within the LSA and RSA

Species Common Name	Species Scientific Name	Species Code	B2 Wetland	Barbour Wetland	M14 Wetland	M20 Wetland	Murray Wetland 11	Wetland 00313
Arctic Grayling+	*Thymallus arcticus*	GR						
Brassy Minnow	*Hybognathus hankinsoni*	BMC						
Brook Stickleback	*Culaea inconstans*	BSB						
Brook Trout	*Salvelinus fontinalis*	EB						
Bull Trout*	*Salvelinus confluentus*	BT						
Burbot	*Lota lota*	BB						
Finescale Dace	*Phoxinus neogaeus*	FDC	X	X	X	X	X	
Lake Chub	*Couesius plumbeus*	LKC						X
Longnose Dace	*Rhinichthys cataractae*	LNC						
Longnose Sucker	*Catostomus catostomus*	LSU						
Mountain Whitefish	*Prosopium williamsoni*	MW						
Northern Pike	*Esox lucius*	NP						
Rainbow Trout	*Oncorhynchus mykiss*	RB						
Redside Shiner	*Richardsonius balteatus*	RSC						
Slimy Sculpin	*Cottus cognatus*	CCG						
Westslope Cutthroat Trout*	*Oncorhynchus clarkii lewisi*	WCT						

** Blue-listed species*
+ Yellow-listed species
X = indicates that Project-specific sampling was utilized to confirm fish species presence in the Project LSA.
= indicates that other sources of existing inventory data (e.g., historical literature; Habitat Wizard) were utilized to confirm fish species presence within the Murray River Watershed.
Empty cells indicate not present

*Plate 4.1-6. Northern Pike (*Esox lucius*), 2013.*

*Plate 4.1-7. Slimy Sculpin (*Cottus cognatus*), 2012.*

Three non-native sport-fish species have been introduced to the Murray River system in recent decades, including Brook Trout (Plate 4.1-8), Rainbow Trout, and Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*). Although Rainbow Trout are currently present at very low densities, sampling records indicate the species has failed to establish significant self-sustaining populations in the Murray River and its tributaries. Brook Trout were stocked in several lakes until the early 1990s, and have since spread beyond stocked lakes to establish populations in the Murray River. Brook Trout are now commonly found in several Murray River tributaries in the vicinity of the Project. Westslope Cutthroat Trout were stocked in Upper Blue Lake in 1983. This species is now abundant in the Upper and Lower Blue lakes system, but have not been found in portions of the Murray River drainage near the Project. Westslope Cutthroat Trout are protected as a Schedule 1 (Special Concern) species under the *Species at Risk Act* (SARA; S.C. 2002), considered of "Special Concern" under COSEWIC, and are provincially 'blue-listed'.

*Plate 4.1-8. Brook Trout (*Salvelinus fontinalis*), 2012.*

The primary fish species found in the LSA are Arctic Grayling, Bull Trout, Mountain Whitefish, and Slimy Sculpin (DES 2011). Table 4.1-3 presents a summary of species-specific life history periodicity and habitat distribution within the LSA. Arctic Grayling migration and spawning within the LSA is poorly understood; however, catches of young-of-the-year (YOY) indicate that spawning and rearing occurs within M19 Creek and possibly within other tributary streams. Bull Trout primarily spawn in upstream tributaries, including Fellers Creek, and utilize the reach of the Murray River within the Infrastructure Investigation Area for rearing, migration, and overwintering. Mountain Whitefish spawn in the Murray River adjacent to the Project area in the fall over gravel and cobble beds. Slimy Sculpin are the most abundant species in the LSA throughout the year and utilize various habitats for all life stages (DES 2011).

Fish distribution in tributary streams within the Infrastructure Investigation Area and LSA is heavily influenced by the presence of permanent barriers to fish migration (i.e., water falls). Figure 4.1-1 shows the geographical distribution of fish-bearing reaches and location of barriers to fish migration in the Infrastructure Investigation Area. Barriers which delineate upper and lower stream reaches, and habitat use by fish, are present in M17, M19, M20, and Twenty creeks. The fish community of M17, M19, and M20 creeks is similar, and includes Arctic Grayling, Bull Trout, Burbot, Longnose Sucker, Mountain Whitefish, and Slimy Sculpin (Table 4.1-1). Only Brook Trout, Mountain Whitefish, and Rainbow Trout have been documented in Twenty Creek. Lake Chub represent the fish community of Wetland 00313.

4.2 HABITAT

4.2.1 Overview

Appendix 4 presents FHAP data for 2013 (Appendix 4a), 2012 (Appendix 4b), and 2010 (Appendix 4c). Appendix 5 presents a summary of FHAP data and site photographs. FHAP sites are shown on Figure 3.2-1. Additional habitat data and stream reach-break analyses are presented in DES (2011).

Table 4.1-3. Summary of Species-specific Life History Periodicity and Habitat Distribution within the LSA

Species	Life stage	Habitat Distribution	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			Month											
Arctic Grayling	Spawning	M19, Murray River				■	■							
	Hatching	M19, Murray River						■						
	Fry rearing/migration	M19, Murray River						■	■	■	■	■		
	Rearing/overwintering	Murray River	■	■	■	■	■	■	■	■	■	■	■	■
	Adult migration	Murray River			■	■	■	■	■	■	■	■		
Bull Trout	Spawning	Tributary Streams									■	■		
	Hatching	Tributary Streams					■	■						
	Fry rearing/migration	Tributary Streams						■	■	■	■	■		
	Rearing/overwintering	Murray River	■	■	■	■	■	■	■	■	■	■	■	■
	Adult migration	Murray River				■	■	■	■	■	■	■		
Mountain Whitefish	Spawning	Tributary Streams									■	■	■	
	Hatching	Tributary Streams				■	■	■						
	Fry emergence/migration	Tributary Streams					■	■	■					
	Rearing/overwintering	Murray River	■	■	■	■	■	■	■	■	■	■	■	■
Slimy Sculpin	Spawning	Streams/Lakes				■	■							
	Hatching	Streams/Lakes					■	■						
	Rearing/overwintering	Streams/Lakes	■	■	■	■	■	■	■	■	■	■	■	■

Source: Scott and Crossman (1973)

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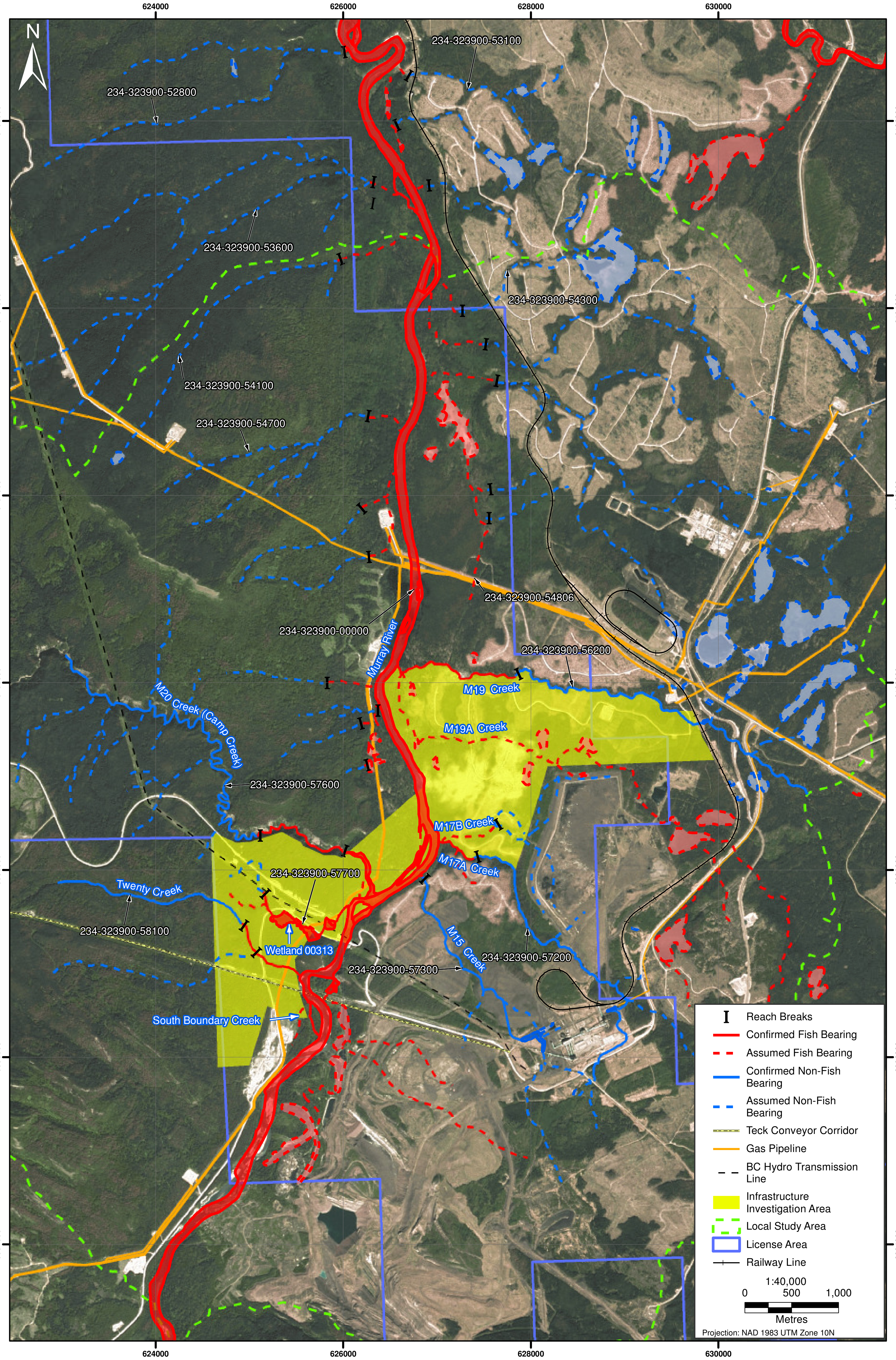


Figure 4.1-1

MURRAY RIVER COAL PROJECT

Spatial Distribution of Fish-bearing Reaches and Barriers to Fish Migration in the Infrastructure Investigation Area, 2013

Figure 4.1-1

4.2.2 Murray River

The Murray River is a low-turbidity, moderate-gradient system stretching 200 km from its origin at Upper Blue Lake, in the Hart Ranges of the Rocky Mountains, to its confluence with the Pine River on the Peace Lowlands to the northeast. The Murray River flows north into the Pine River, 40 km downstream from the Village of Chetwynd, BC. Both the Pine and Murray rivers belong to the greater Peace River drainage system, which flows into the Slave River, a tributary of the greater the Mackenzie River Watershed (Rescan 2013). The Murray River has a drainage area of 5,550 km^2 upstream of its outlet into the Pine River (Rescan 2013).

Table 4.2-1 summarizes habitat value ratings at each Murray River site. Overall, the Murray River sites provide poor spawning habitat; however, good juvenile rearing and adult feeding habitat was present. LWD was present at all sites, which provides good rearing habitat for juveniles. No fish passage barriers were present at any of these sites. In 2010 a total of four Murray River sites (including one reference site) were sampled for fish habitat (Figure 3.2-1). Five habitat units were observed, with four glide habitat units and one pool habitat unit. All of the receiving environment sites consisted of glide habitat with 2% slope (Figure 4.2-1). MR-REF was classified as a glide with 2% slope, with a 20 m-long pool at the downstream end on the right bank.

Mean width was lowest at MR-REF, where the wetted width was 60 m and the bankfull width was 70 m (Figure 4.2-2). Mean width was greatest at MR4, which had a wetted width of 96 m and a bankfull width of 112 m. Wetted depths ranged from 1 m at MR4 to 2 m at MR5A and MR6 (Figure 4.2-3). Bankfull depth was lowest at MR4 (1 m deep) and greatest at MR-REF (3.5 m deep).

Instream cover was sampled at MR4, MR5A, and MR-REF, but could not be sampled at MR6 due to poor instream visibility (Figure 4.2-4). Large woody debris (LWD) was the most common type of cover at MR4 and boulders were the most common at MR5A. A large, 20 m-long pool supplied cover for fish at MR-REF.

Bed material composition was observed at MR-REF and MR4; however, due to poor visibility substrate was not observed at MR5A and MR6 (Figure 4.2-5). Fines and gravel were the dominant substrate at MR4 (each was 45% and cobble represented the remaining 10%), while cobble was the most abundant substrate type at MR-REF (cobble represented 60% of the substrate).

4.2.3 Tributary Streams

<u>Overview</u>

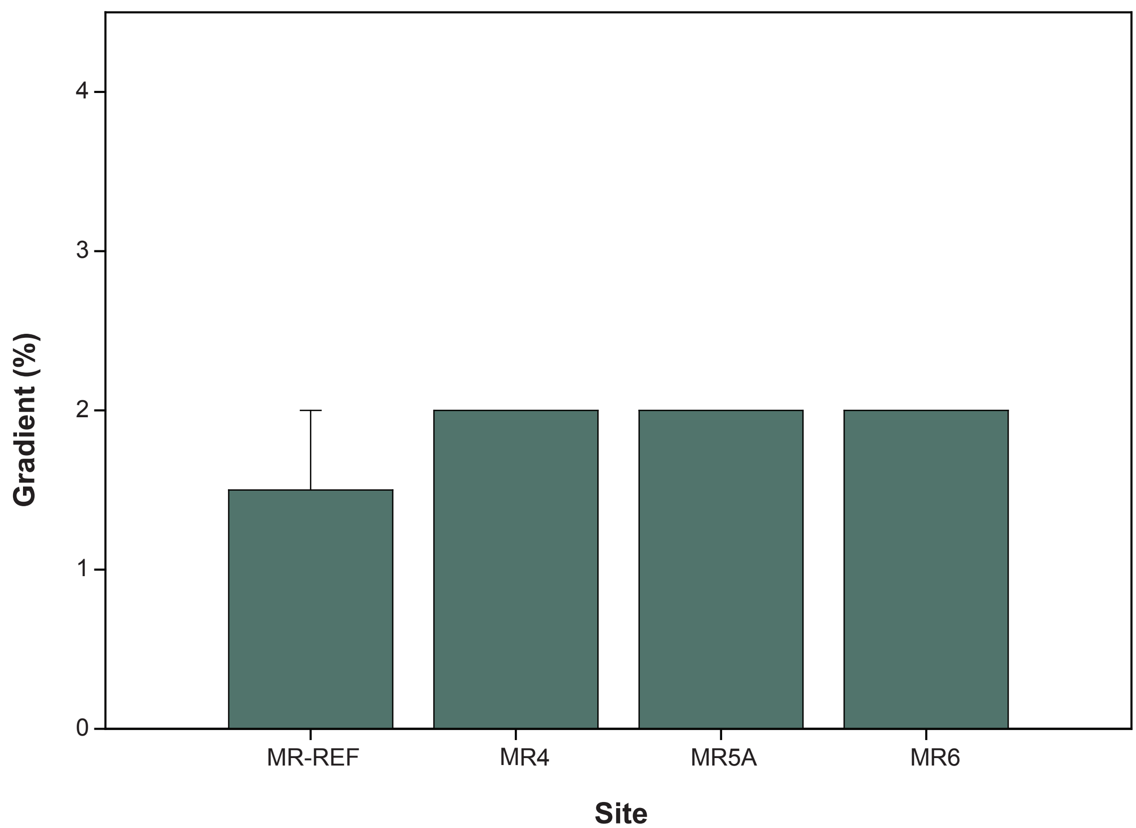
Habitat assessments for Twenty Creek, M20-FT, REF-ST (Club Creek) and Mast Creek sites were completed in 2010 during spring freshet conditions. M20-den (DS) was surveyed in low, summer flow conditions in 2012. Twenty Creek and South Boundary Creek were dry, and therefore not assessed in 2012. Fish habitat in M19A Creek was surveyed in both freshet and low-flow conditions in 2013. M17A and M17B creeks were surveyed by Stantec (2013) during mid-summer flow conditions in 2013.

Table 4.2-2 summarizes the overall habitat value rating at each tributary stream site. Riffle was the most abundant habitat type (47%), followed by pool (29%), and cascade (24%). Mean gradient was highest at M20-FT and lowest at Twenty Creek (Figure 4.2-6). Mean wetted with was highest at M20-FT (8.3 m) and mean bankfull width was greatest at REF-ST (30 m; Figure 4.2-7). Mean wetted and bankfull widths were lowest at Twenty Creek (2.3 m and 3.1 m respectively; Figure 4.2-8). Mean wetted and bankfull depths were lowest at Twenty Creek (0.2 m and 0.7 m) and highest at REF-ST (0.4 m and 1.3 m).

Table 4.2-1. Habitat Rating and Stream Classification for Murray River Sites, 2010

Site	Water Body	Environment Type	Spawning	Rearing	Adult Feeding	Overwintering	Migration	Fish-bearing	Stream Classification	Comments
MR-REF	Murray River	Reference	Poor	Good	Good	Poor	Good	Yes	S1- large river	Some LWD and pool habitat
MR4	Murray River	Receiving	Poor	Good	Good	Poor	Good	Yes	S1- large river	Abundant LWD but no deep pool habitat
MR5A	Murray River	Receiving	Poor	Good	Good	Good	Good	Yes	S1- large river	Some side channel, pool and LWD habitat
MR6	Murray River	Receiving	Poor	Poor	Good	Good	Good	Yes	S1- large river	No side channels or pool habitat for juvenile rearing but some LWD

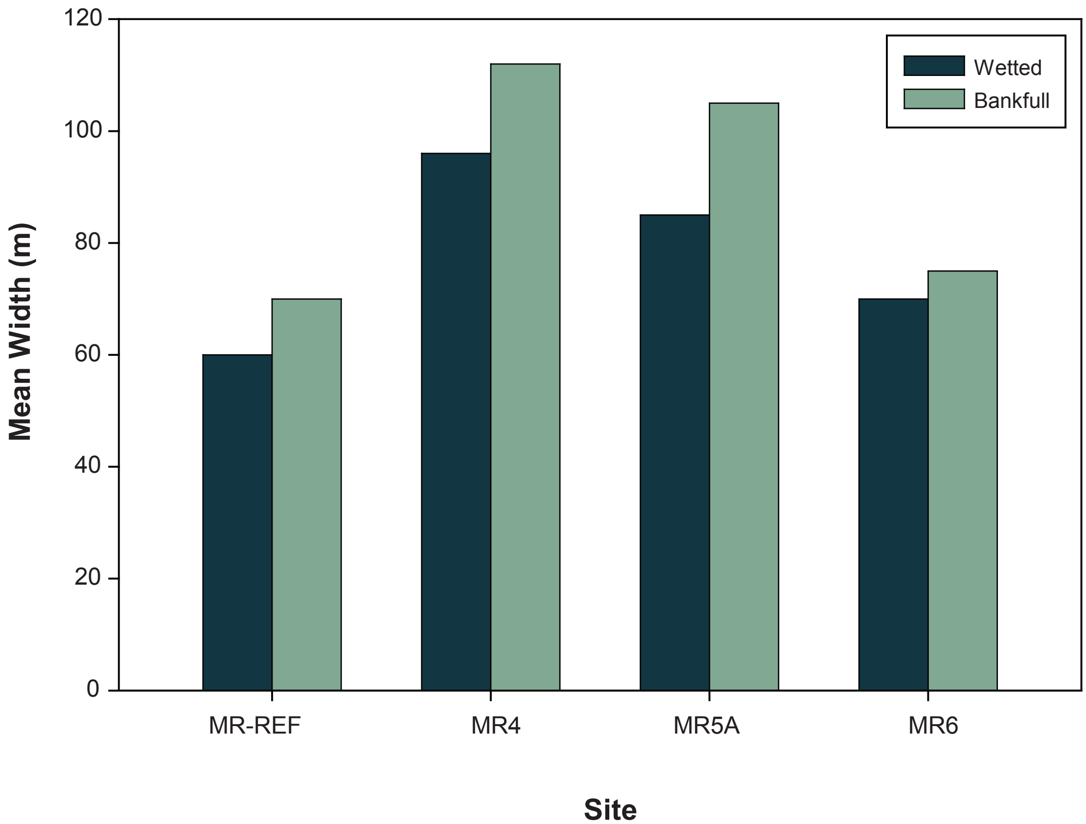
LWD = large woody debris



Note: Where no error bars exist, only one measure of gradient was taken for the entire lenght of stream sampled.

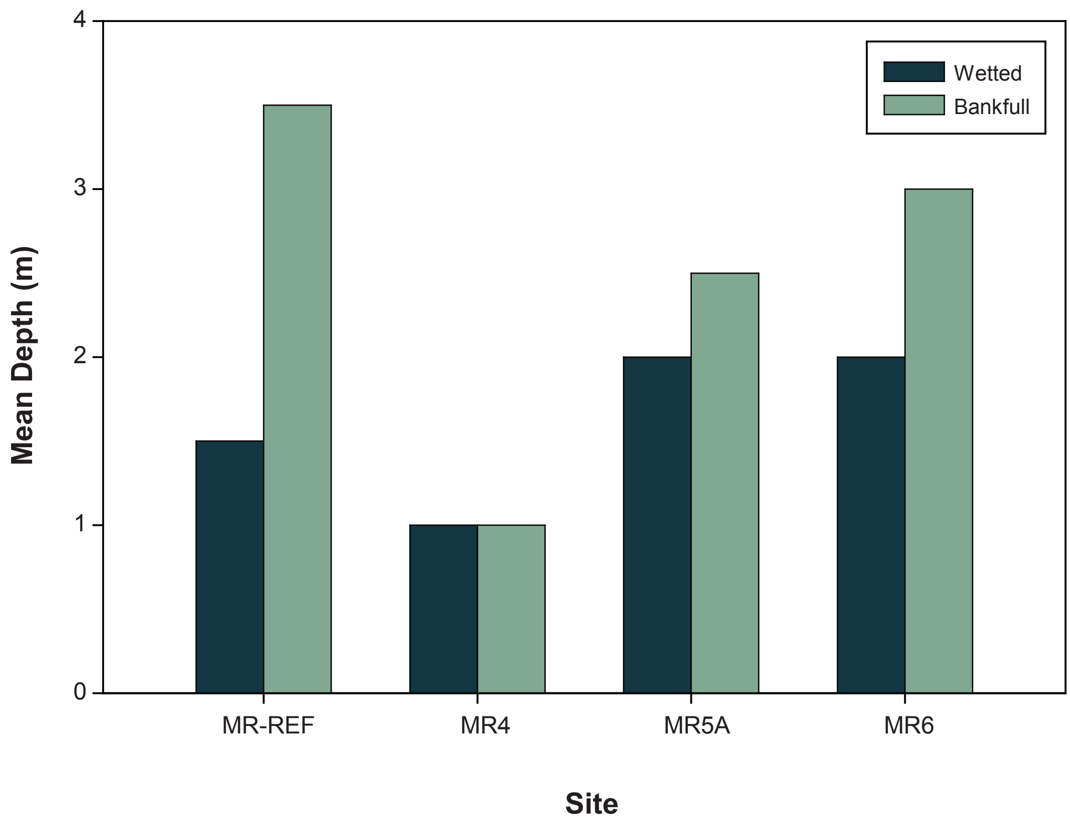
Figure 4.2-1

Mean Gradient at Murray River Sites, 2010



Mean Wetted and Bankfull Widths at Murray River Sites, 2010

Figure 4.2-2



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Mean Wetted and Bankfull Depths at Murray River Sites, 2010

Figure 4.2-3

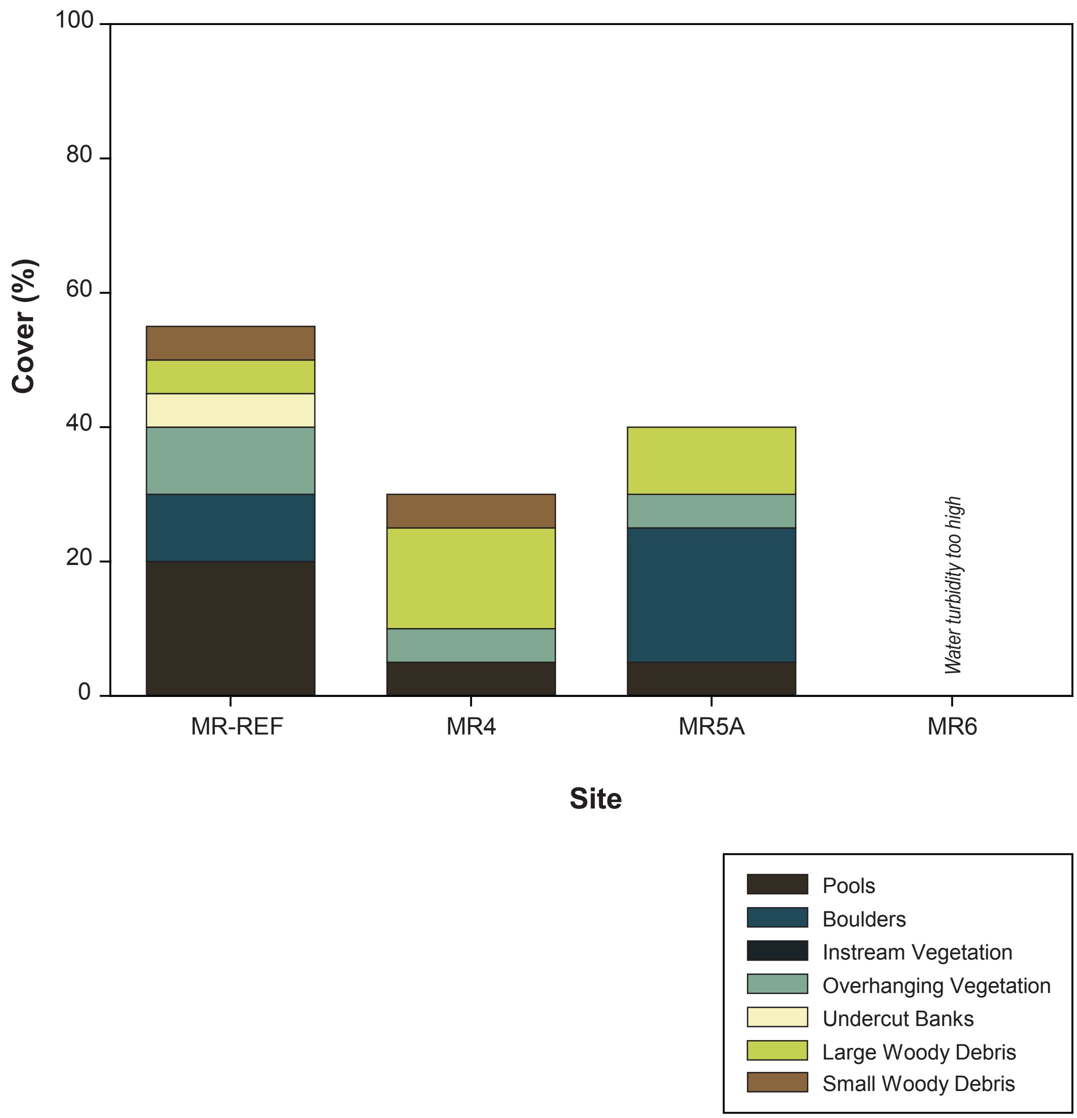
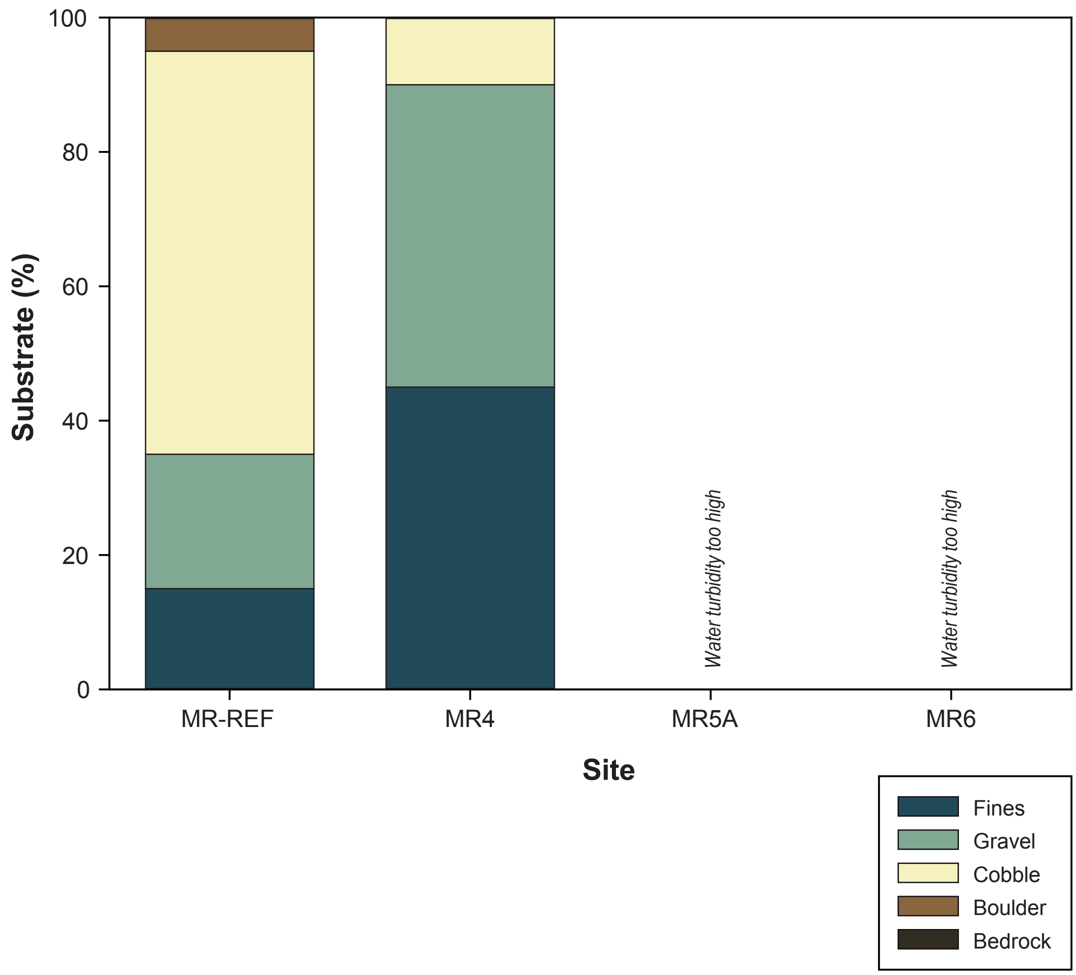


Figure 4.2-4

Fish Cover at Murray River Sites, 2010



Substrate Composition at Murray River Sites, 2010

Figure 4.2-5

Table 4.2-2. Habitat Rating and Stream Classification for Tributary Streams, 2010 to 2013

Site	Water Body	Year	Environment Type	Spawning	Rearing	Adult Feeding	Over-wintering	Migration	Fish-bearing	Stream Classification	Comments
REF-ST	Club Creek	2010	Reference	Good	Good	Good	Poor	Good	Yes	S3	
Upper Mast Creek	Mast Creek	2010	Reference	Poor	Good	Poor	None	Good	n/a	n/a	
M17A	M17A Creek	2013	Receiving	Fair	Fair	Fair	Fair	Poor	Yes*	S3	Source: Stantec (2013)
M17B	M17B Creek	2013	Receiving	Fair	None	None	None	None	Yes	S4 (default)	Source: Stantec (2013); No fish captured.
M19A-1	M19A Creek	2013	Receiving	Poor	Fair	Fair	Fair	Poor	No	S5	No fish captured
M19A-2	M19A Creek	2013	Receiving	Good	Fair	Good	Good	Fair	No	S5	No fish captured
M19A-3	M19A Creek	2013	Receiving	Poor	Fair	None	None	Poor	No	S5	No fish captured
M20 DS	M20 Creek	2012	Receiving	Poor	Good	Poor	None	Good	Yes*	S3	
M20 DS	M20 Creek	2010	Receiving	Poor	Fair	Poor	Poor	Good	Yes*	S3	
Twenty Creek	Twenty Creek	2010	Receiving	Poor	Good	Poor	Poor	Good	Yes*	S4 (default)	No fish captured

**Fish-bearing downstream of permanent fish migration barrier.*

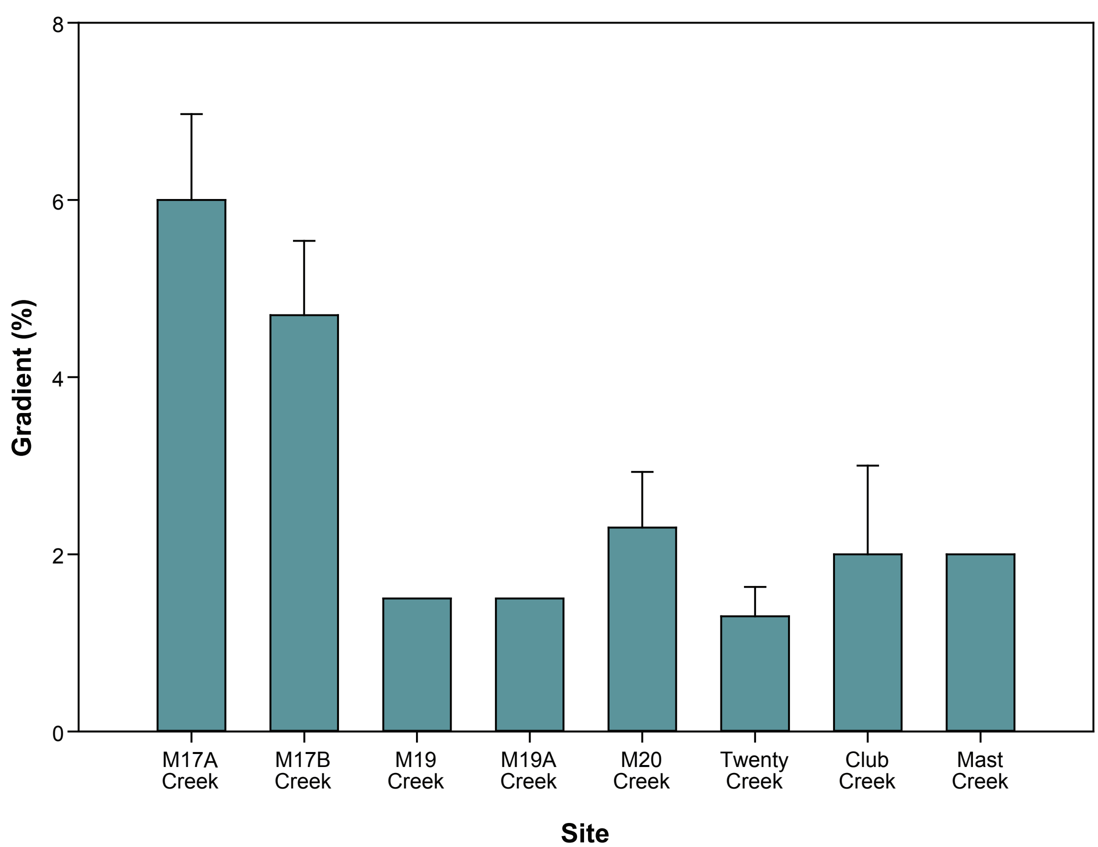


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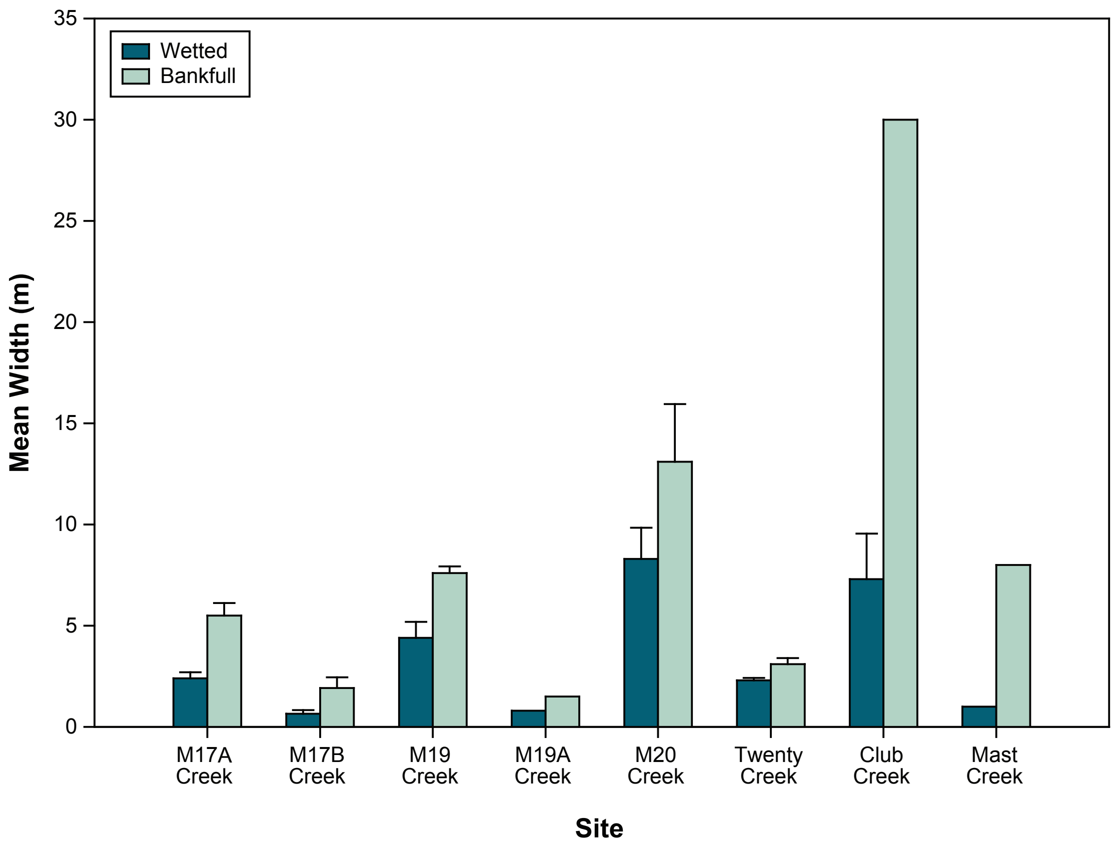
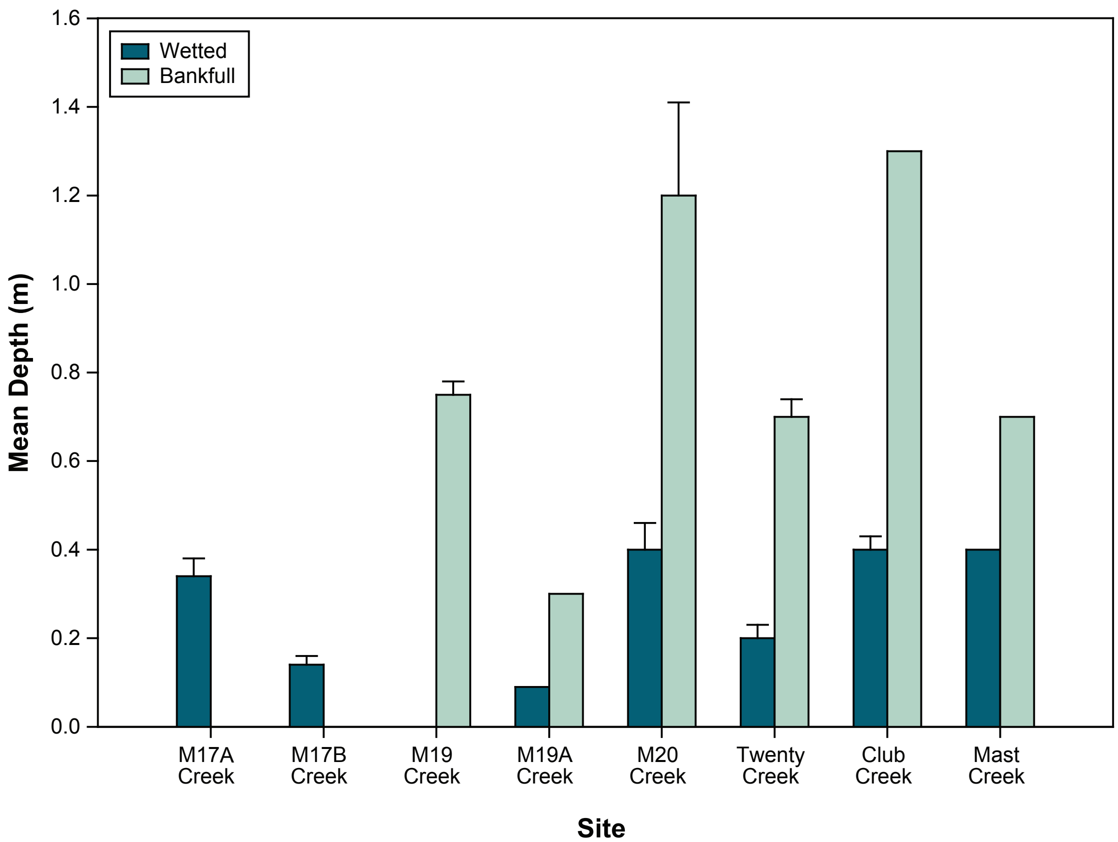
Figure 4.2-6

Mean Gradient at Tributary Stream Sites, 2010 to 2013

Rescan Engineers & Scientists



Note: Error bars represent the standard error of the mean. Where no error bars are presented only one measure of gradient was taken for the entire length of stream sampled.



Note: Error bars represent the standard error of the mean. Where no error bars are presented only one measure of wetted or bankfull width was taken for the entire length of stream sampled.

Total cover ranged 45% in Mast Creek to 59% in Twenty Creek (Figure 4.2-9). LWD was on average the most abundant type of cover (13%) and instream vegetation was not present at any site. Substrate composition varied among sites (Figure 4.2-10). Cobble was the most abundant substrate type (42%), followed by gravel (25%) then fines (24%). Boulder was least common substrate type (9%) and bedrock was not present at any site.

Club Creek

Club Creek was selected as a reference environment for comparison with tributary streams in the Infrastructure Investigation Area and LSA. A single site was surveyed immediately upstream of the creek's confluence with the Murray River in June 2010. Mean wetted width was 7.3 m and mean gradient was 2%. Channel morphology was predominantly cascade and riffle. Bed material was composed of cobble (45%), gravel (20%), fines (20%), and boulder (15%). Instream cover for fish was provided by boulder, and large and small woody debris.

Spawning, rearing, adult feeding, and migration habitat were all rated as good. Overwintering habitat was rated as poor, due to the lack of deep (>1 m) pools. Overall, Club Creek was classified as important habitat to support juvenile Bull Trout rearing. Club Creek was classified as a fish-bearing, S3 stream.

M17 Creek

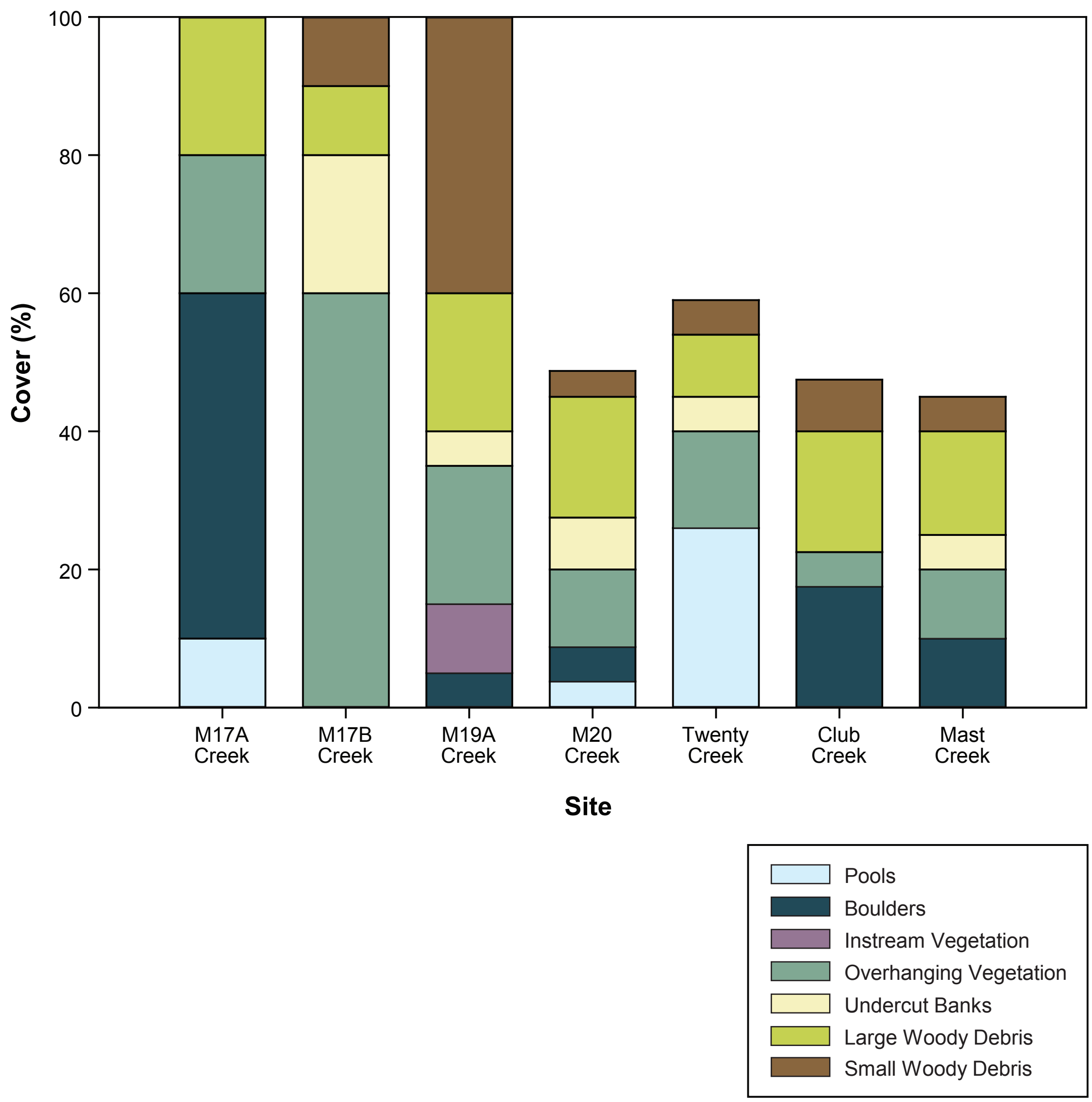
M17 Creek was sampled from 1982 to 1984 as part of the baseline studies for the Quintette Mine. During those surveys, M17 Creek was found to support Arctic Grayling, Bull Trout, Burbot, Longnose Sucker, Mountain Whitefish, and Slimy Sculpin. Brook Trout were also captured in fish community studies conducted in 2011.

Fish habitat data for M17A and M17B creeks was supplied by Stantec (unpublished data). Two sites were surveyed along M17A Creek on July 24, 2013. Mean gradient was 6%, while mean channel width was 5.5 m and mean channel depth was 0.3 m. Channel morphology was classified as riffle-pool. Cobble and gravel were observed as the dominant and sub-dominant substrate type, respectively. The dominant cover-type for fish was boulder (40%). Habitat for spawning, rearing, overwintering were rated as fair. Migration habitat was rated as poor. Overall, this reach of M17A Creek was fish-bearing, and classified as S3.

M17B Creek was surveyed on July 26, 2013. Mean channel width was 1.9 m, mean channel depth was 0.1 m, and mean gradient was 4.7%. Channel morphology was predominantly riffle-pool. Fines and gravel were the dominant and sub-dominant substrate types, respectively. Overhanging vegetation was the dominant form of cover for fish. Habitat for all fish life-history stages were not present due to lack of flow and depth. Barriers to fish migration were not observed between the site and the Murray River. Although electrofishing was not possible in summer low-flow conditions, fish may have access to M17B Creek in spring, freshet conditions. Fish habitat use is likely ephemeral, and restricted to the months of May and June. Therefore, M17B Creek was classified as S4-default and fish-bearing.

M19 Creek

The lower reach of M19 Creek was sampled in 1981, 1982, 1983, and 1984 during baseline fisheries investigations conducted for the Quintette Coal Mine (BC Research 1982, McCart et al. 1985). Two impassible barriers, consisting of 3 m and 4 m waterfalls, are present within a 50 m section of M19 Creek (DES 2011). The waterfalls are located approximately 1.5 km upstream of the confluence of M19 Creek and the Murray River. The lower waterfall represents the upstream limit of fish distribution within M19 Creek.



Fish Cover at Tributary Stream Sites, 2010 to 2013

Figure 4.2-9

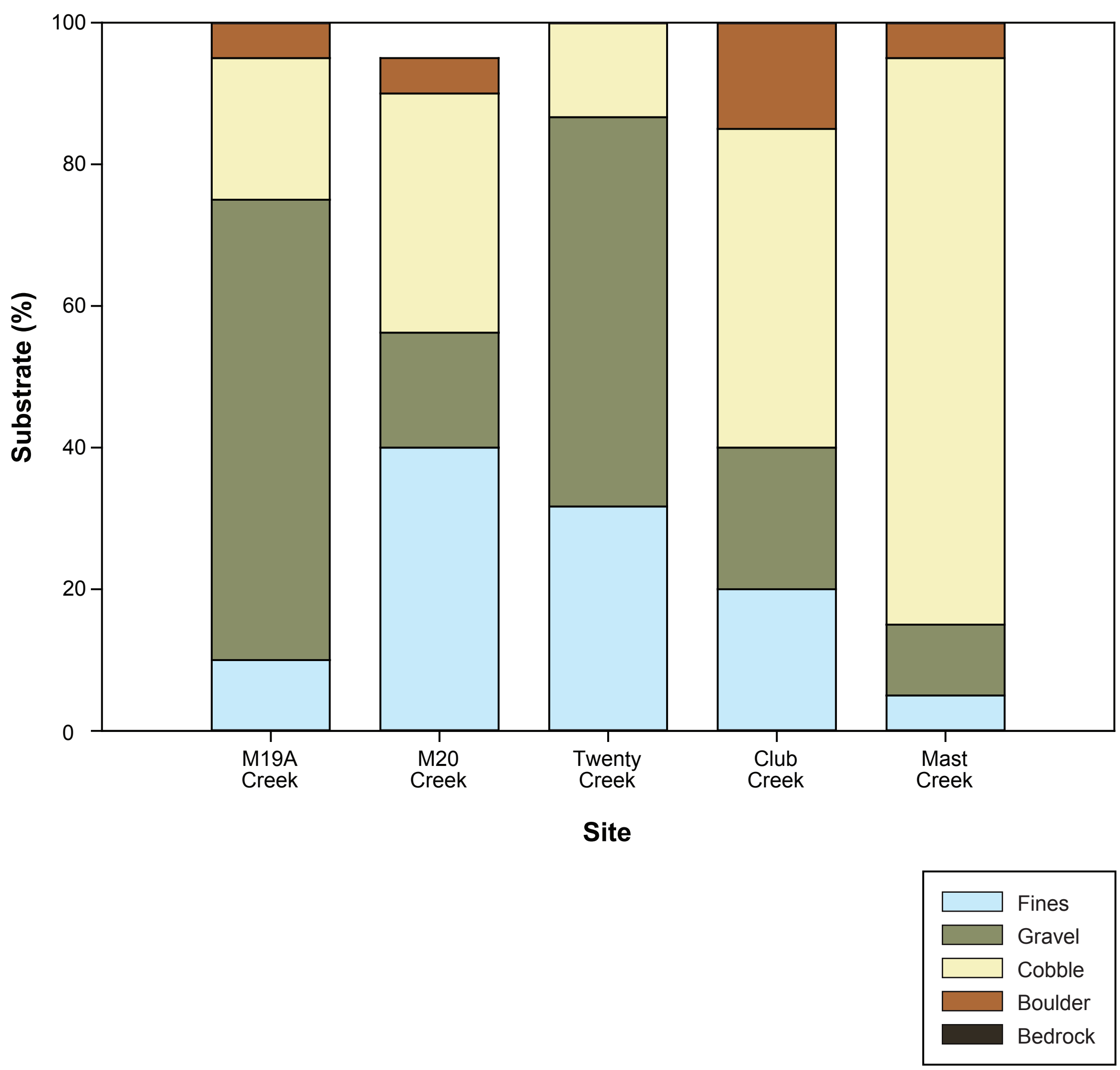


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Figure 4.2-10

Substrate Composition at Tributary Stream Sites, 2010 to 2013

Rescan Engineers & Scientists

Lower M19 Creek was sampled for fish habitat on August 5, 2011 (DES 2011). Flow levels were low; however, continuous surface flow was present to the confluence with the Murray River. M19 Creek contained high quality seasonal rearing habitat suitable for juvenile Arctic Grayling, with abundant rearing cover provided by pools, large and small woody debris, and undercut banks. YOY Arctic Grayling have been captured in 1981, 1983, and 2011, indicating that M19 Creek provides annual spawning and rearing habitat, which may be a limiting habitat type for Arctic Grayling in the LSA. Overall, the lower reach of M19 Creek was rated as important habitat and classified as S2, fish-bearing.

Spawning habitat for fall-spawning species (e.g., Bull Trout and Mountain Whitefish) may be constrained by low seasonal flow. Habitat surveys conducted in late-August to October indicate that M19 Creek may become seasonally de-watered, causing natural stranding mortality for fish. Thus, habitat suitability for Bull Trout and Mountain Whitefish appears to be low.

M19A Creek

Fish habitat in M19A Creek was surveyed at two sites on July 14, 2013 and at one site on August 25, 2013. Mean wetted and channel width was 2.5 m and 2.6 m, respectively. Mean wetted depth varied with seasonal flow, ranging from 0.3 m in high flow to 0.1 m in low flow. Channel morphology was classified as riffle-pool. Large sections of M19A Creek were flooded by beaver dams creating wetland habitat. Gravel and fines were observed as dominant and sub-dominant substrate type, respectively. Overhanging vegetation and woody debris (both small and large) were equally abundant cover types. Crown closure ranged from 20% to 100%.

Habitat for ratings for each life-history stage varied between sites. Stream sections flooded by beaver dams were rated higher for overwintering and rearing habitat, while riffle-pool sections rated higher for spawning habitat. Migratory habitat was consistently rated as poor due to the presence of beaver dams, log jams, and insufficient depth in low flow. Permanent barriers (e.g., water fall >1 m high) to fish migration were not found within M19A Creek. Overall, habitat was rated as marginal, and M19A Creek was classified as S4, default fish-bearing.

M20 Creek

M20 Creek (also known as Camp Creek) is situated along the northern boundary of the Infrastructure Investigation Area and flows into the Murray River adjacent to the site. M20 Creek is divided into three reaches: the lower 700 m section that is accessible to fish from the Murray River, the canyon section that has three waterfalls 8 to 20 m in height, and the upper reach above the barriers. There are naturally high levels of sediment in M20 Creek, originating from a source upstream of the waterfalls. The presence and abundance of fine sediment may limit spawning capacity of the lower reaches (DES 2011).

Reach 1 extends from the Murray River to the lower end of the canyon. This reach is generally shallow and riffles are the dominate habitat type. Overwintering habitat is limited due to the lack of deep pools. Reach 2 is 1,200 m in length, starting at the downstream edge of the canyon to the base of the lowest fish barrier. This reach flows through a steep canyon, and substrate is comprised of bedrock and cobbles. There is a higher component of pool and overwintering habitat due to the presence of bedrock crevasses. The upper reach of M20 Creek can be further sub-divided into multiple reaches but past reports treated this section as one reach. This reach begins above the series of barriers and includes the remainder of the headwaters. The main stem of the upper reach is confined by steep canyons and numerous small tributaries feed into the upper reach.

Fish distribution is well documented in M20 Creek (Hatfield 1998; RAB 1977; McCart et al. 1985; Poulin 2006; Diversified Environmental Services 2006). Several impassable barriers are located between reach 2 and 3, including a 10 m waterfall located 1.9 km upstream from its confluence with the Murray

River (WCC 2007). Extensive fish sampling has been conducted over multiple years to confirm that fish are not present in the upper reaches of M20 Creek.

The lower reach of M20 Creek, below the falls, has been sampled on several occasions from the 1970s to the present (RAB 1977; McCart et al. 1985). DES(2011) provides a comprehensive review of fish distribution and habitat in the lower reaches of M20 Creek. The lower reach of M20 is occupied year-round by resident Slimy Sculpin and provides limited rearing habitat for juvenile Bull Trout and Mountain Whitefish. Arctic Grayling, Burbot, and Longnose Sucker have also been sampled in M20 Creek. These species are thought to move from the Murray River and utilize M20 Creek sporadically during suitable flow conditions.

Fish habitat was surveyed within the lower reach of M20 Creek in high flow (2010) and low flow (2012). Channel morphology was classified as riffle-pool. Mean wetted depth was 8.3 m in high flow and 3.5 m in low flow. Mean stream gradient was 2.5%. Fines, gravel, cobble, and boulder were uniformly represented as dominant substrate types. Cover for fish was also diverse, with large woody debris, overhanging vegetation, and boulders present.

Rearing habitat was rated as good due to the abundance of cover for juvenile fish. Migratory habitat within Reach 1 was also rated as good due to the absence of permanent barriers between survey sites and the Murray River. As noted previously, a series of large waterfalls are present upstream, which delineates the fish-bearing and non-fish-bearing reaches of M20 Creek. Spawning and adult feeding habitat were rated as poor due to high turbidity and sediment load. Deep pools were not observed within the site, thus overwintering habitat was not present. Overall, fish habitat within M20 Creek was rated as marginal. The fish-bearing reach (Reach 1) of M20 Creek was classified as S2.

Mast Creek

Fish habitat within Mast Creek was surveyed during the high flow period on June 4, 2010. Mast Creek was surveyed as a secondary reference site for fish habitat located upstream of the Infrastructure Investigation Area. One riffle habitat type was observed at the site, and overall stream morphology was classified as riffle-pool. Stream gradient was 2%, wetted width was 4 m, and channel width was 8 m. Wetted depth and bankfull depths were 0.4 m and 0.7 m, respectively. Cobble represented 80% of the bed material. Overall cover for fish was sparse, with large woody debris representing the dominant cover type.

Riffle habitat and large woody debris provided good rearing habitat for juvenile fish. Barriers or other impediments to fish migration were not observed, thus migratory habitat was rated as good. Spawning habitat was rated as poor, with gravel representing only 10% of bed material. Adult feeding habitat was rated as poor and overwintering habitat was rated as ‘none’ due to a lack of depth and deep pools. Overall, fish habitat in Mast Creek was rated as marginal. Fish community was not surveyed, thus the fish-bearing status and stream class for Mast Creek was not determined.

South Boundary Creek

South Boundary Creek is located in the southeast portion of the Infrastructure Investigation Area on the west side of the Murray River. A reconnaissance of South Boundary Creek was conducted in 2010. The stream bed was dry, and classified as ‘no fish habitat’. Barriers to fish migration; however, were not identified along the length of the creek. Thus, fish migration and ephemeral habitat use may be possible during freshet or years of high flow. Historical habitat mapping data indicate that South Boundary Creek was classified as default fish-bearing, S4 stream.

Twenty Creek

Diversified (2011) provides a detailed description of fish habitat and fish spatial distribution within Twenty Creek. Fish habitat was surveyed at Twenty Creek during high flow in 2010 and during low flow in 2012. Twenty Creek was dry during summer low flow in 2012, thus habitat data were not collected. In 2010, stream morphology was classified as riffle-pool, with a mean gradient of 1.3%. Mean wetted width was 2.3 m and mean channel width was 3.1 m. Mean depth was 0.2 m and mean bankfull depth was 0.7 m. Gravel and fines were the dominant and sub-dominant bed material, respectively. Cover for fish was provided in by overhanging vegetation, small woody debris, and large woody debris.

Rearing and migratory habitat were limited by shallow water depth and flow, and rated as fair. Habitat for other life-history stages (spawning, feeding, and overwintering) were rated as poor or none, due shallow depth. Overall habitat was rated as marginal. Permanent barriers to fish migration were not identified between the site location and the Murray River. Reach 1 of Twenty Creek was classified as a fish-bearing, S4 stream.

4.2.4 Proposed Habitat Offsetting Sites

Five potential fish habitat offsetting sites (OBL1 through OBL5) were identified within a side-channel of the Murray River in 2012. In 2013, two additional sites (CS1 and CS5) were selected for proposed habitat offsetting. Of these sites, CS1 was selected as the primary site for fish habitat offsetting for the Project. Appendices 4 and 5 present FHAP data collected at the proposed fish habitat offsetting sites. Table 4.2-3 summarizes the overall habitat ratings observed at each site.

Site CS1 was described as a historical side-channel of the Murray River, with wetland habitat features. The wetted side-channel component was 43 m-long, with a mean wetted width of 6.8 m and mean depth of 0.4 m. Fines represented 100% of the bed material. Cover for fish was supplied by instream vegetation (99%) and boulder (1%). The wetted side-channel component provided good spawning, rearing, and migration for Northern Pike and Burbot. Over-wintering habitat was not present due to shallow depth. The wetland feature was classified as ‘no fish habitat’ due to the absence of water. This wetland feature will be primary site for fish habitat offsetting.

Site CS5 was classified as an S4, fish-bearing stream, with juvenile Brook Trout, Finescale Dace, and Slimy Sculpin present. The site is a large network of inactive, open beaver dams. With the beaver dams open, a small tributary stream has established though the site to the Murray River. A 93 m section of stream was surveyed, and divided into three riffle, two glide, and one pool habitat types. The mean stream gradient was 1.3%, ranging from 0% to 3%. The mean wetted and bankfull width was 1.8 m and 3.3 m, respectively. The mean wetted and bankfull depth was 0.2 m and 0.5 m, respectively. The dominant bed material was fines (60%), while the subdominant material was gravel (38%). Cover for fish was supplied by instream vegetation (22%), small woody debris (17%), undercut bank (14%), and pool (12%). Cover was also supplied in trace amounts by large woody debris and overhanging vegetation. Rearing habitat for juvenile Brook Trout was rated as fair. Spawning and migration habitat was rated as poor. Due to a lack of depth and pool habitat, adult feeding and overwintering habitat were not present. Habitat offsetting options include the creation of berms to re-establish the large network of flooded pond habitat. This offsetting site is considered as a secondary option to site CS1.

Table 4.2-3. Habitat Ratings for Proposed Offsetting Sites, 2012 and 2013

Site	Water Body	Year	Envrionment Type	Spawning	Rearing	Adult Feeding	Over-wintering	Migration	Fish-bearing	Comments
CS1	Murra River side-channel	2013	Offsetting	Good	Good	Fair	None	Good	Yes	Wetland feature non-fish-bearing
CS5	Unnamed tributary stream	2013	Offsetting	Poor	Fair	None	None	Poor	Yes	
OBL1	Murray River	2012	Offsetting	Poor	Good	Poor	Poor	Poor	Yes	
OBL2	Murray River	2012	Offsetting	Poor	Good	Poor	Poor	Poor	Yes	
OBL3	Murray River	2012	Offsetting	Poor	Poor	Poor	Poor	Good	Yes	
OBL4	Murray River	2012	Offsetting	Poor	Poor	Poor	Poor	Poor	Yes	
OBL5	Murray River	2012	Offsetting	Poor	Poor	Poor	Poor	Poor	Yes	

A total of five potential offsetting sites were surveyed within a side-channel of the Murray River in 2012. Mean gradient at OBL 1, OBL 2, and OBL 3 was zero, and 1.5% and 0.6% at OBL 4 and OBL 5, respectively. Mean wetted width was greatest at OBL 2 (32 m) and mean bankfull width was greatest at OBL 1 (39 m). Mean wetted width was least at OBL 4 (5 m) and mean bankfull width was least at OBL 3 (14 m). Wetted depth was least at OBL 3 (0.2 m) and greatest at OBL 2 (1 m). Bankfull depth was least at OBL 4 (0.5 m) and greatest at OBL 2 (1.5 m). Total cover ranged from 10% at OBL 3 to 30% at OBL 2. Boulders were the most common type of cover (8%) followed by LWD and SWD (both 4%) then overhanging vegetation (2%). Pools, instream vegetation, and undercut banks were not present. Gravel was the dominant (69%) substrate at all OBL sites.

4.3 COMMUNITY

4.3.1 CPUE and Relative Abundance

Sampling effort and CPUE data from 2003 to 2013 are presented in Appendix 6. Tables 4.3-1 to 4.3-3 present a summary of sampling effort and CPUE data for sites sampled from 2011 to 2013 using backpack electrofisher, minnow traps, and beach seine, respectively. CPUE data were collected by various consultants over several years with varying methods (e.g., electrofisher frequency and pulse width) and objectives. Thus, CPUE data were interpreted with caution, and used to provide an indication of fish presence/absence and relative abundance.

Fish communities within the fish-bearing reaches of tributary streams in the Infrastructure Investigation Area were sampled by backpack electrofishing from 2011 to 2013. CPUE was highest at M19 Creek (4.38 fish/100 s). Arctic Grayling and Slimy Sculpin had the highest relative abundances abundant in the lower reach of M19 Creek. M19 Creek was the only tributary stream within the Infrastructure Investigation Area where Arctic Grayling were consistently captured in high abundance. In contrast, fish were not captured from M19A Creek despite intense fishing effort, including 2,604 s of electrofishing and 486 h of minnow trapping.

M20 Creek and Twenty Creek exhibited similar CPUE, with contrasting fish relative abundance. The overall CPUE for M20 Creek was 1.87 fish/100 s. Slimy Sculpin were most abundant in M20 Creek, with Bull Trout and Mountain Whitefish less abundant. The overall CPUE for Twenty Creek was 1.51 fish/100 s. Brook Trout were most abundant, with Mountain Whitefish and Rainbow Trout also present in Twenty Creek.

Electrofishing was conducted at M17A Creek by Stantec over two sampling events in 2013. CPUE ranged from 0.31 fish/100 s in May to 0.21 fish/100 s in late July. Burbot, Slimy Sculpin, and Mountain Whitefish were relatively equally abundant in M17A Creek.

Schools of adult and YOY Lake Chub were visually observed in Wetland 00313 and reported in DES (2011). Electrofishing sampling effort, CPUE, and fish biological data for Wetland 00313; however, were not available. South Boundary Creek was dry at the time of the 2011 and 2012 surveys, and therefore fish community, CPUE, and relative abundance data were not collected.

Fish habitat at proposed offsetting sites ranged from streams to wetlands, thus various combinations of backpack electrofishing, minnow trapping, and beach seining gear were utilized. Tables 4.3-2 to 4.3-4 show fish community, CPUE, and relative abundance, by gear type, for eight potential habitat offsetting sites. Data for secondary proposed offsetting sites (including CS2, CS3, CS4, CS6, and OBL sites) are presented in Tables 4.3-2 to 4.3-4 and not discussed further.

Proposed offsetting site CS1 was surveyed using minnow traps and a beach seine. The fish community consisted of Northern Pike and Burbot. Minnow trap CPUE of Northern Pike was 0.33 fish/trap/24 h, while beach seine CPUE ranged from 0.08 to 0.17 fish/seine/m^2. CPUE of Burbot at site CS1 also ranged from 0.08 to 0.17 fish/seine/m^2.

Table 4.3-1. Summary of Electrofishing Sampling Effort and CPUE for Receiving Environment Tributary Streams, 2011 to 2013

Site	Water Body	Date	Sampling Gear	Pass	Effort (s)	Catch	Total Catch (No. of fish)	CPUE (No. of fish/100 s)
M17A	M17A Creek	11-May-13	EF	1	954	1 BB, 1 CCG, 1 MW	3	0.31
		29-Jul-13	EF	1	470	1 unidentified salmonid	1	0.21
M19	M19 Creek	5-Aug-11	EF	1	662	15 GR, 8 CCG, 1 LNC, 2 EB, 1 BB, 2 MW	29	4.38
M19A-1	M19A Creek	13-Jun-13	EF	1	2,216	0	0	0.00
M19A-3	M19A Creek	25-Aug-13	EF	1	388	0	0	0.00
M20 DS	M20 Creek	24-Sep-12	EF	1	750	1 BT, 12 CCG, 1 MW	14	1.87
			EF	2	400	1 CCG	1	0.25
			EF	3	286	0	0	0.00
Twenty Creek	Twenty Creek	5-Aug-11	EF	1	331	1 RB, 1 MW, 3 EB	5	1.51

Sampling Gear: EF = backpack electrofisher
Fish Species Codes: BB = Burbot, BT = Bull Trout, CCG = Slimy Sculpin, EB = Brook Trout, FDC = Finescale Dace, GR = Arctic Grayling, LNC = Longnose Dace, MW = Mountain Whitefish

Table 4.3-2. Summary of Electrofishing Sampling Effort and CPUE for Proposed Offsetting Sites, 2012 to 2013

Site	Water Body	Date	Sampling Gear	Pass	Effort (s)	Catch	Total Catch (No. of fish)	CPUE (No. of fish/100 s)
CS 2	CS 2	13-Jun-13	EF	1	344	0	0	0.00
CS 3	CS 3	13-Jun-13	EF	1	512	0	0	0.00
CS 5	CS 5	15-Jun-13	EF	1	624	0	0	0.00
		23-Aug-13	EF	1	698	1 CCG; 3 EB; 4 FDC	8	1.15
CS 6	CS 6	15-Jun-13	EF	1	611	0	0	0.00
OBL 1	OBL 1	22-Sep-12	EF	1	1,068	8 CCG, 3 DC	11	1.03
OBL 2	OBL 2	22-Sep-12	EF	1	857	2 BB, 23 CCG	25	2.92
OBL 3	OBL 3	23-Sep-12	EF	1	1,038	1 BB, 6 CCG	7	0.67
		23-Sep-12	EF	2	714	1 CCG	1	0.14
		23-Sep-12	EF	3	404	0	0	0.00
OBL 4	OBL 4	23-Sep-12	EF	1	674	1 CCG	1	0.15
		23-Sep-12	EF	2	423	0	0	0.00
		23-Sep-12	EF	3	266	0	0	0.00

Sampling Gear: EF = backpack electrofisher
Fish Species Codes: BB = Burbot, BT = Bull Trout, CCG = Slimy Sculpin, EB = Brook Trout, FDC = Finescale Dace, GR = Arctic Grayling, LNC = Longnose Dace, MW = Mountain Whitefish

Table 4.3-3. Summary of Minnow Trap Sampling Effort and CPUE for Receiving Environment Tributary Streams and Proposed Offsetting Sites, 2013

Site	Water Body	Date	Sampling Gear	No. of MT	Effort (h)	Catch	Total Catch (No. of fish)	CPUE (No. of fish/trap/24 h)
M19A-1	M19A Creek	14-Jun-13	MT	20	486	0	0	0.00
CS 1	CS 1	23-Aug-13	MT	10	293	4 NP	4	0.33
CS 3	CS 3	13-Jun-13	MT	10	258	0	0	0.00
CS 5	CS 5	16-Jun-13	MT	10	251	1 FDC	1	0.10
		22-Aug-13	MT	5	99	8 FDC, 4 EB	12	2.92
CS 6	CS 6	15-Jun-13	MT	10	261	0	0	0.00

Sampling Gear: MT = Gee minnow trap
Fish Species Codes: EB = Brook Trout, FDC = Finescale Dace, NP = Northern Pike

Table 4.3-4. Summary of Beach Seine Sampling Effort and CPUE at Proposed Offsetting Sites, 2013

Site	Water Body	Date	Sampling Gear	Haul No.	Area (m^2)	Catch	Total Catch (No. of fish)	CPUE (No. of fish/seine/m^2)
CS 1	CS 1	23-Aug-13	BS	1	12	1 NP	1	0.08
				2	12	2 NP	2	0.17
				3	12	2 BB	2	0.17
				4	12	1 BB	1	0.08
				5	9	1 BB	1	0.11

Sampling Gear: BS = Beach Seine
Fish Species Codes: BB = Burbot, NP = Northern Pike

Site CS5 was surveyed using a backpack electrofisher and minnow traps. A total of 1,322 s of electrofishing over two sampling events resulted in the capture of 3 Brook Trout, 4 Finescale Dace, and 1 Slimy Sculpin. Electrofishing CPUE at site CS5 ranged from 0 to 1.15 fish/100 s. A total of 350 h of minnow trap effort was also exerted at site CS5 during two sampling events. Finescale Dace and Brook Trout were captured. Minnow trap CPUE ranged from 0.1 to 2.92 fish/trap/24 h.

4.3.2 Biology

Fish biological data were collected from the Infrastructure Investigation Area, LSA and RSA in 2004, 2005, 2011, 2012, and 2013. Appendix 7 presents individual fish biological data for each year. Tables 4.3-5 to 4.3-9 present a summary of mean fork length, weight, and condition per species, site, and year. Only datasets with sufficient sample sizes for each species and sampling site were reported. Biological datasets with sufficient sample sizes included data for Slimy Sculpin (2004, 2005, 2011, and 2012) and Finescale Dace (2011). These datasets correspond with fish tissue metals sampling, where a minimum sample size of eight individuals was required per site, including measurements of fish length and weight. Mean length, length-frequency distributions, and weight-length regressions were developed for each biological dataset, and presented in Figures 4.3-1 through 4.3-12. Weight and condition data were not available for individual Slimy Sculpin sampled in 2004, thus weight-length regressions were not developed for that year.

Slimy Sculpin mean total length was consistent between sites and among sampling years (Figures 4.3-1, 4.3-3, 4.3-7, and 4.3-11), ranging from 61 mm to 67 mm. Length-frequency histograms developed for Slimy Sculpin generally showed a bi-modal distribution (Figures 4.3-4 4.3-8, and 4.3-12). Total length categories ranging from 40 to 50 mm had the highest proportion of Slimy Sculpin. A secondary mode (65 to 75 mm) was also present in Slimy Sculpin length-frequency distributions. All weight-length regressions calculated for Slimy Sculpin (Figures 4.3-2, 4.3-5, and 4.3-9) showed a significant ($P < 0.001$) relationship between weight and length, and adjusted r^2 values ranged from 0.72 to 0.99. The slope of weight-length regressions for Slimy Sculpin were also consistent among sampling sites and years.

Finescale Dace mean fork length was consistent between sites, ranging from 56 to 72 mm (Figure 4.3-3). Length-frequency histograms developed for Finescale Dace showed a uni-modal distribution (Figure 4.3-4). Length categories 65-70 mm and 70-75 mm had the highest proportion of Finescale Dace. As with Slimy Sculpin, all weight-length regressions calculated for Finescale Dace were significant ($P < 0.001$), with adjusted r2 values ranging from 0.79 to 0.97. The slope of weight-length regressions were also consistent among sampling sites.

Biological data was also collected from fish sampled at proposed habitat offsetting sites CS1 and CS5 in 2013 (Table 4.3-5). The mean total length of Burbot captured at CS1 using beach seine gear was 97 mm, and mean condition of 0.63 g/mm^3. Northern Pike were also captured at CS1 using beach seine and minnow trap gear. Mean fork length of Northern Pike ranged from 64 to 181 mm. Mean condition ranged from 0.66 to 0.70 g/mm^3. All sampled Burbot and Northern Pike appeared healthy and robust. Thus, condition values less than 1 are likely indicative of the species' long, cylindrical body form.

Brook Trout, Finescale Dace, and Slimy Sculpin were captured at CS5 using a backpack electrofisher and minnow traps. The mean fork length of Brook Trout and Finescale Dace was similar among methods. Brook Trout fork length ranged from 76 to 94 mm, and Finescale Dace fork length ranged from 56 to 76 mm. Condition of all species captured at CS5 was equal to and greater than the expected value of 1 g/mm^3.

Table 4.3-5. Fork Length, Weight, and Condition Summary Statistics, 2013

Site	Species	Sampling Gear	Length (mm)						Weight (g)						Condition (K)					
			n	Mean	SD	SE	Min	Max	n	Mean	SD	SE	Min	Max	n	Mean	SD	SE	Min	Max
CS1	BB	BS	4	97	7	4	62	65	4	1.6	0.1	0.0	1.5	1.8	4	0.63	0.03	0.01	0.59	0.64
	NP	BS	3	181	138	79	94	340	2	7.2	2.7	1.9	5.3	9.0	2	0.66	0.03	0.02	0.64	0.68
	NP	MT	4	64	2	1	90	105	4	6.5	1.8	0.9	4.9	8.3	4	0.70	0.04	0.02	0.65	0.75
CS5	CCG	EF	1	120	–	–	120	120	1	22.0	–	–	22.0	22.0	1	1.27	–	–	1.27	1.27
	EB	EF	3	81	4	2	78	85	3	6.1	1.3	0.7	5.2	7.7	3	1.13	0.08	0.05	1.07	1.23
	FDC	EF	4	67	8	4	56	76	4	3.3	1.1	0.5	2.3	4.7.	4	1.08	0.15	0.07	0.96	1.29
	EB	MT	4	82	8	4	76	94	4	5.8	1.7	0.8	4.2	8.1	4	1.06	0.12	0.06	0.95	1.21
	FDC	MT	8	61	7	2	56	73	8	2.8	0.8	0.3	2.3	4.5	8	1.23	0.10	0.03	1.09	1.36

Dashes indicate not applicable
Fish Species Codes: BB = Burbot, CCG = Slimy Sculpin, EB = Brook Trout, FDC = Finescale Dace, NP = Northern Pike
n = sample size
SD = standard deviation of the mean
SE = standard error of the mean
Dashes indicate not applicable

Table 4.3-6. Fork Length, Weight, and Condition Summary Statistics, 2012

Site	Waterbody	Species	Sampling Gear	Length (mm)						Weight (g)						Condition (K)					
				n	Mean	SD	SE	Min	Max	n	Mean	SD	SE	Min	Max	n	Mean	SD	SE	Min	Max
M20 DS	M20 Creek	BT	EF	1	193	–	–	193	193	1	41.2	–	–	41.2	41.2	1	0.57	–	–	0.57	0.57
		CCG	EF	13	62	21	6	32	98	13	3.7	3.4	0.9	0.5	10.8	13	1.23	0.18	0.05	1.05	1.74
		MW	EF	1	81	–	–	81	81	1	4.2	–	–	4.2	4.2	1	0.79	–	–	0.79	0.79
M20 US	M20 Creek	BT	EF	3	166	15	9	151	181	3	53.7	15.2	8.8	40.3	70.2	3	1.15	0.05	0.03	1.08	1.18
		CCG	EF	8	88	9.8	4	76	105	8	7.1	2.1	0.7	4.6	9.5	8	1.08	0.28	0.10	0.40	1.24
MR3	Murray River	CCG	EF	8	54	5.2	2	48	65	8	1.9	0.4	0.2	1.5	2.8	8	1.24	0.36	0.13	0.93	2.07
MR4	Murray River	CCG	EF	8	62	6.9	2	52	75	8	2.7	0.9	0.3	1.6	4.6	8	1.1	0.09	0.03	0.99	1.25
MR DS	Murray River	CCG	EF	8	66	10	4	55	81	8	2.6	1.2	0.4	1.4	4.6	8	0.87	0.06	0.02	0.75	0.93
MR US	Murray River	CCG	EF	8	66	7.1	3	58	78	8	2.9	0.9	0.3	1.9	4.4	8	0.99	0.12	0.04	0.86	1.21

Dashes indicate not applicable
Fish Species Codes: BT = Bull Trout, CCG = Slimy Sculpin, MW = mountain whitefish
n = sample size
SD = standard deviation of the mean
SE = standard error of the mean
Dashes indicate not applicable

Table 4.3-7. Fork Length, Weight, and Condition Summary Statistics, 2011

			Length (mm)						Weight (g)						Condition (K)					
Site	Waterbody	Species	n	Mean	SD	SE	Min	Max	n	Mean	SD	SE	Min	Max	n	Mean	SD	SE	Min	Max
B2 Wetland	B2 Wetland	FDC	75	56	8	1	45	77	75	1.6	0.8	0.1	0.8	4.7	75	0.85	0.07	0.01	0.66	1.03
Barbour Wetland	Barbour Wetland	FDC	24	72	9	2	59	88	24	3.3	1.3	0.3	1.2	5.7	24	0.82	0.07	0.02	0.57	0.96
Fellers Creek	Fellers Creek	BT	3	120	25	14	91	137	3	21.7	12.3	7.1	8.3	32.3	3	1.15	0.09	0.05	1.09	1.26
M14 Wetland	M14 Wetland	FDC	19	69	9	2	54	84	19	3.3	1.1	0.3	1.6	5.6	19	0.99	0.07	0.02	0.85	1.10
M17 Creek	M17 Creek	EBT	2	70	10	7	63	77	2	3.2	1.4	1.0	2.2	4.3	2	0.91	0.03	0.02	0.89	0.93
M20 Creek	M20 Creek	BT	3	192	16	9	179	210	3	68.3	16.0	9.3	51.2	83.0	3	0.95	0.10	0.06	0.89	1.07
		CCG	8	85	6	2	77	95	8	6.9	1.3	0.5	5.1	8.7	8	1.13	0.08	0.03	0.99	1.25
		EBT	3	154	5	3	150	160	3	40.5	5.9	3.4	33.8	45.1	3	1.10	0.10	0.06	1.00	1.21
M20 Wetland	M20 Wetland	FDC	19	72	7	2	63	98	19	3.7	1.4	0.3	2.6	9.1	19	0.96	0.06	0.01	0.82	1.08
Murray DS	Murray River	CCG	30	52	15	3	28	89	30	1.7	1.4	0.3	0.3	5.3	30	1.02	0.72	0.13	0.38	4.70
Murray RB	Murray River	CCG	33	51	11	2	35	75	33	1.3	1.0	0.2	0.4	4.4	33	0.86	0.13	0.02	0.61	1.13
Murray US	Murray River	CCG	22	62	16	3	39	98	22	1.9	1.5	0.3	0.4	6.0	22	0.65	0.17	0.04	0.42	1.01
Waterfall Creek	Waterfall Creek	EBT	3	180	25	14	160	208	3	69.6	38.8	22.4	47.0	114.4	3	1.12	0.17	0.10	0.93	1.27
Wetland 00313	Wetland 00313	FDC	17	63	6	1	47	69	17	2.9	0.7	0.2	1.2	3.7	17	1.13	0.15	0.04	0.76	1.43

Fish Species Codes: BT = Bull Trout, CCG = Slimy Sculpin, EB = Brook Trout, FDC = Finescale Dace
n = sample size
SD = standard deviation of the mean
SE = standard error of the mean

Table 4.3-8. Fork Length, Weight, and Condition Summary Statistics, 2005

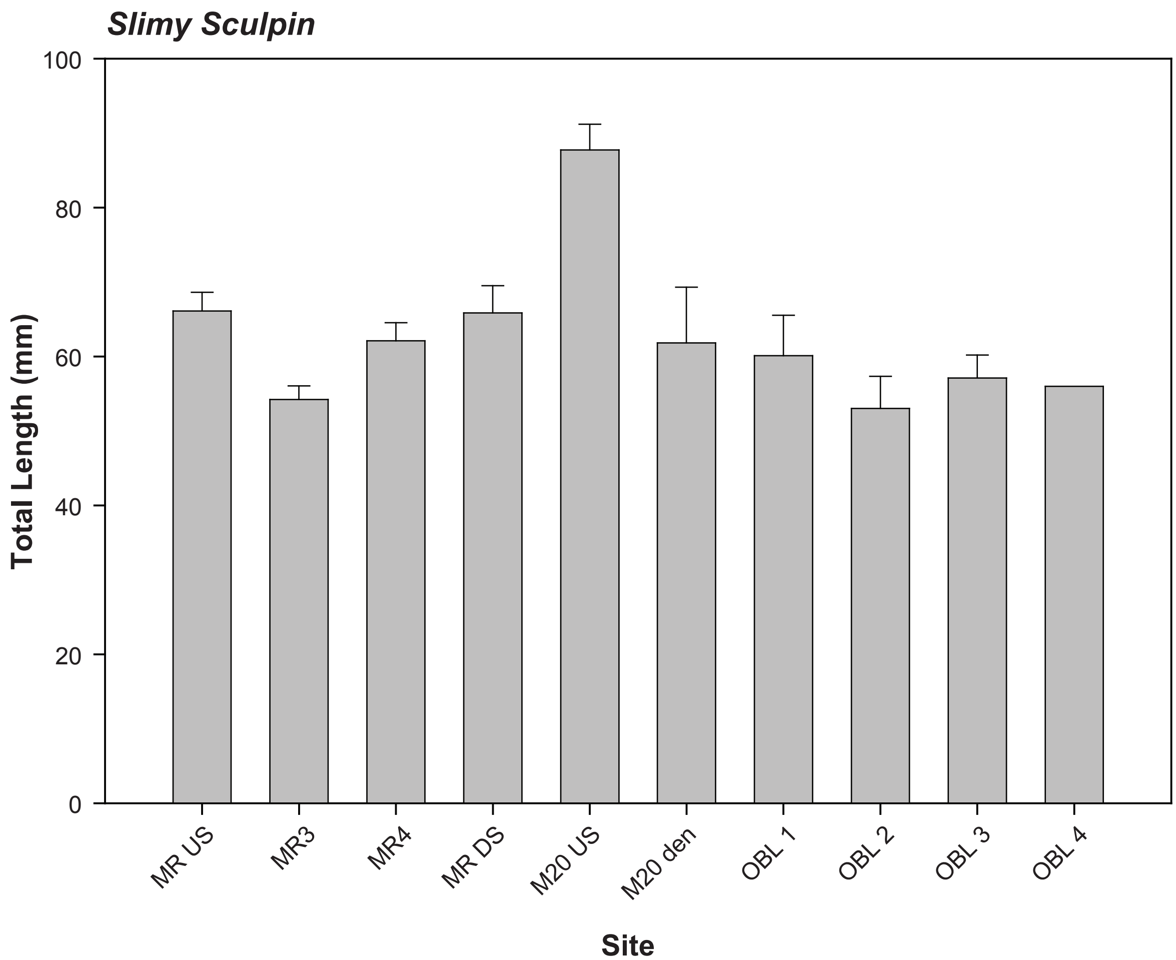
			Length (mm)						Weight (g)						Condition (K)					
Site	Waterbody	Species	n	Mean	SD	SE	Min	Max	n	Mean	SD	SE	Min	Max	n	Mean	SD	SE	Min	Max
Mast Creek	Mast Creek	CCG	9	74	7	2	66	83	9	5.7	1.8	0.6	3.7	8.4	9	1.34	0.17	0.06	1.08	1.62
Murray DS	Murray River	CCG	12	69	4	1	63	75	12	4.0	1.1	0.3	2	5.2	12	1.17	0.17	0.05	0.70	1.34
		MW	3	69	8	4	61	76	3	2.8	1.0	0.6	1.8	3.7	3	0.83	0.03	0.02	0.79	0.85
Murray RB	Murray River	CCG	18	58	10	2	43	74	18	2.2	1.2	0.3	0.8	4.5	18	1.06	0.11	0.03	0.92	1.36
Murray US	Murray River	CCG	18	65	6	2	55	80	18	3.0	1.2	0.3	1.9	6.4	18	1.06	0.11	0.03	0.88	1.26
		MW	8	66	3	1	60	72	8	2.8	0.6	0.2	2.1	3.8	8	0.94	0.07	0.03	0.84	1.03

Fish Species Codes: CCG = Slimy Sculpin, MW = Mountain Whitefish
n = sample size
SD = standard deviation of the mean
SE = standard error of the mean

Table 4.3-9. Fork Length, Weight, and Condition Summary Statistics, 2004

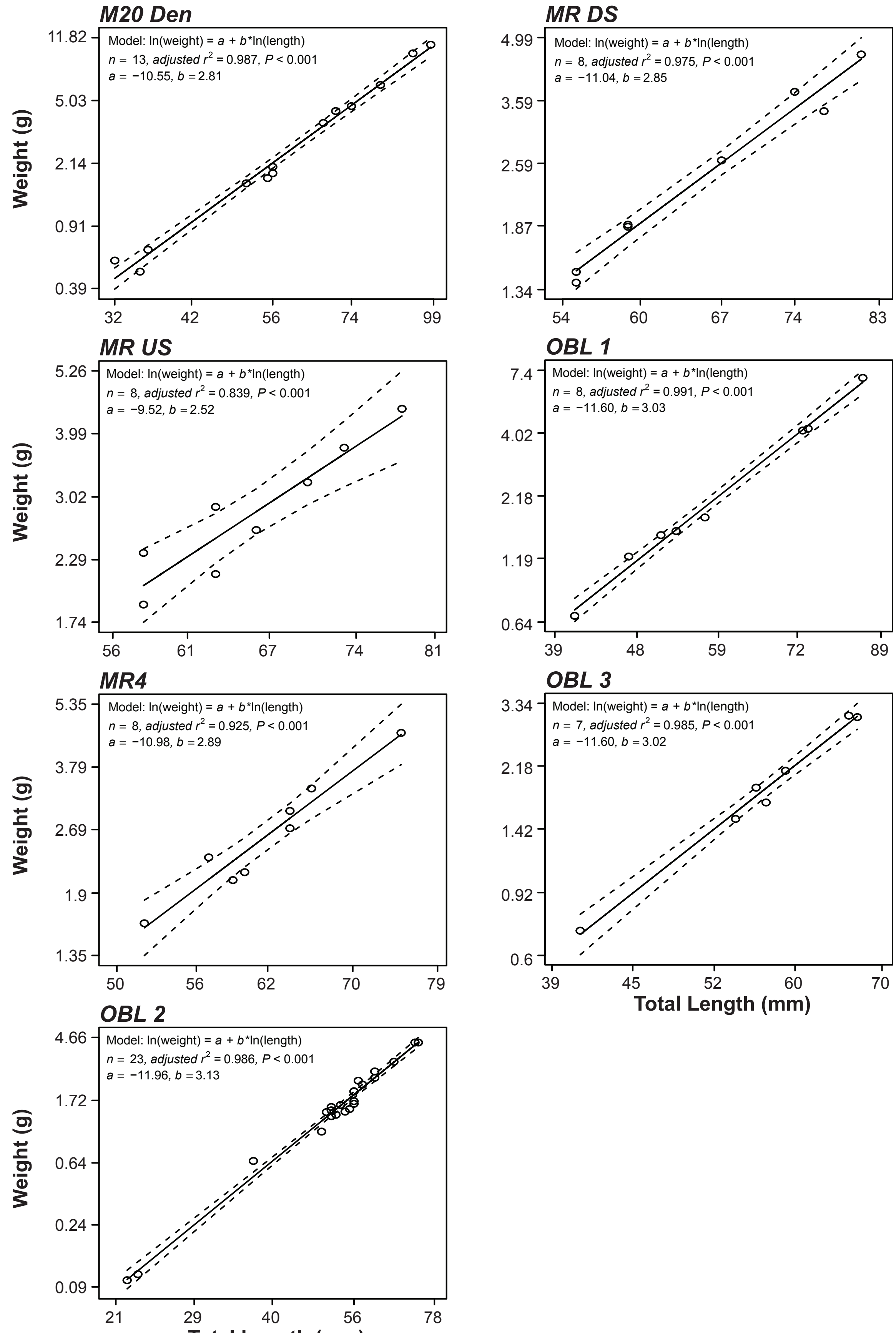
			Length (mm)						Weight (g)						Condition (K)					
Site	Waterbody	Species	n	Mean	SD	SE	Min	Max	n	Mean	SD	SE	Min	Max	n	Mean	SD	SE	Min	Max
M20-FT	Murray River	CCG	18	63	21	5	44	111	-	-	-	-	-	-	-	-	-	-	-	-
Sesyncline	Murray River	CCG	33	59	12	2	41	82	-	-	-	-	-	-	-	-	-	-	-	-

Fish Species Codes: CCG = Slimy Sculpin
Dashes indicate not applicable
n = sample size
SD = standard deviation of the mean
SE = standard error of the mean



Note: Errors bars indicate 1 standard error of the mean

Mean Length of Slimy Sculpin Captured by Electrofishing, 2012



Note: axis values have been backtransformed from the natural log (Ln)

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Weight-Length Regressions for Slimy Sculpin, 2012

Figure 4.3-2

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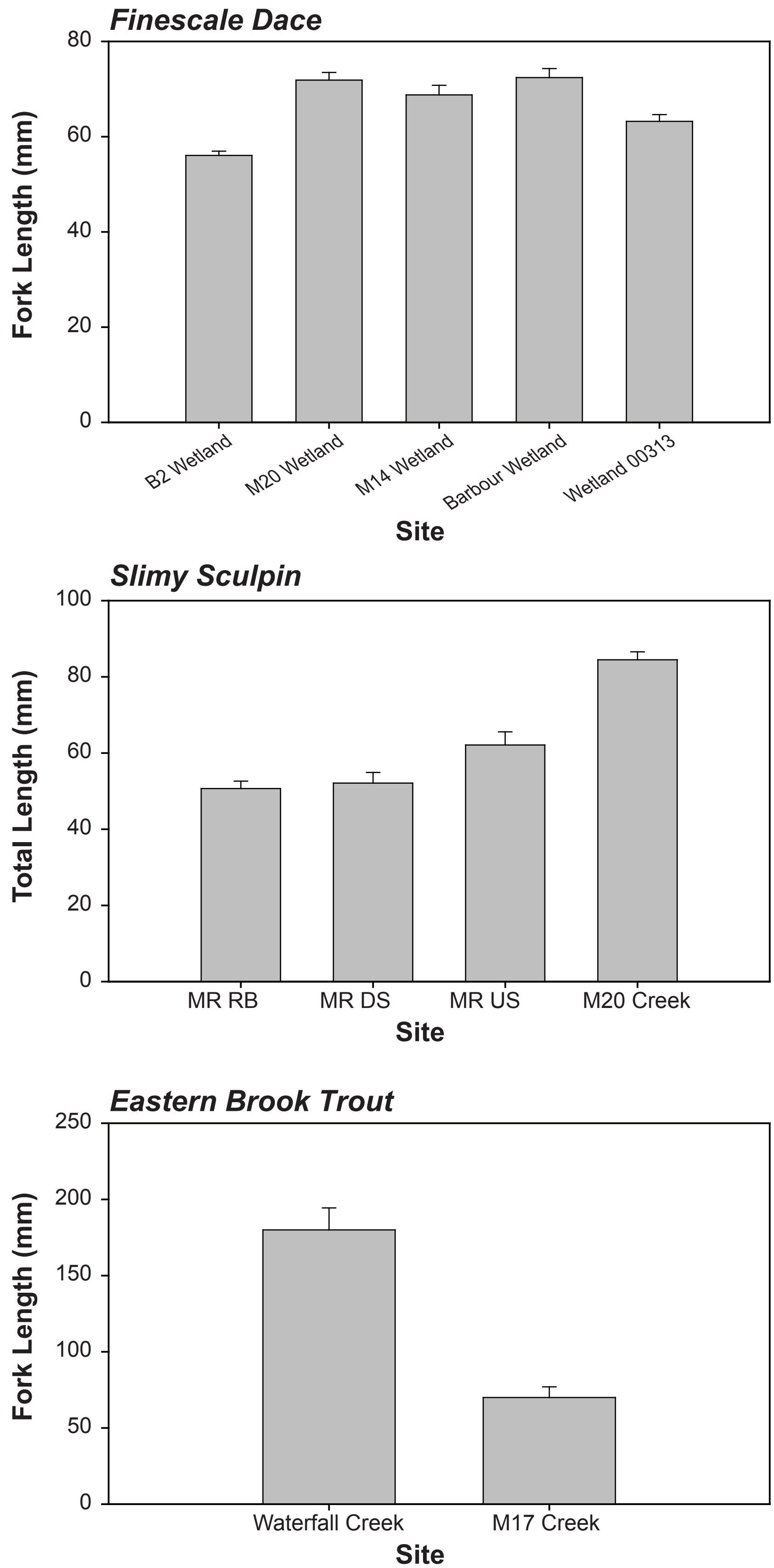

Note: Errors bars indicate 1 standard error of the mean

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Mean Length of Species Captured by Electrofishing, 2011

Figure 4.3-3

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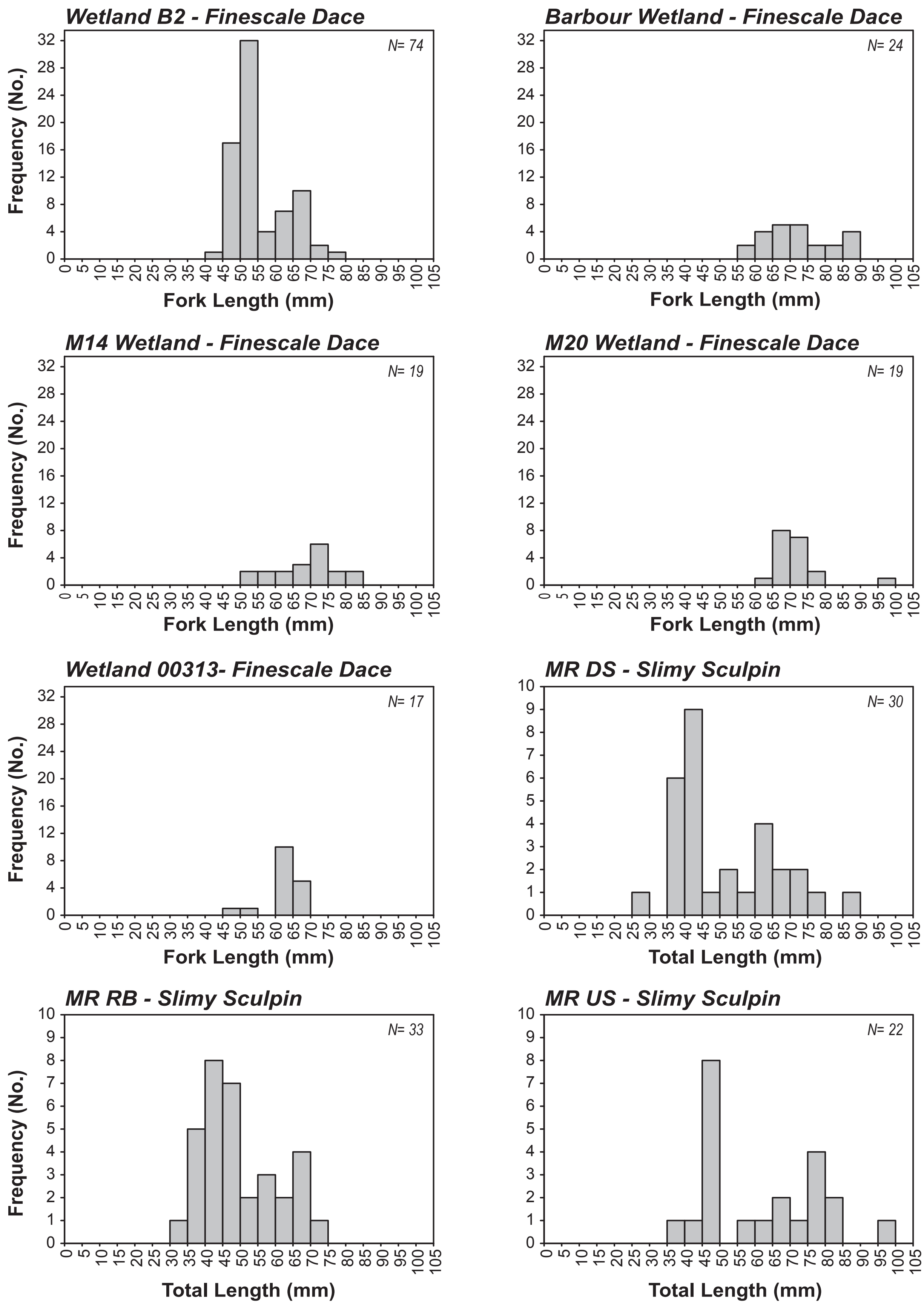

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Figure 4.3-4

Length-Frequency Distributions of Species Captured by Electrofishing, 2011

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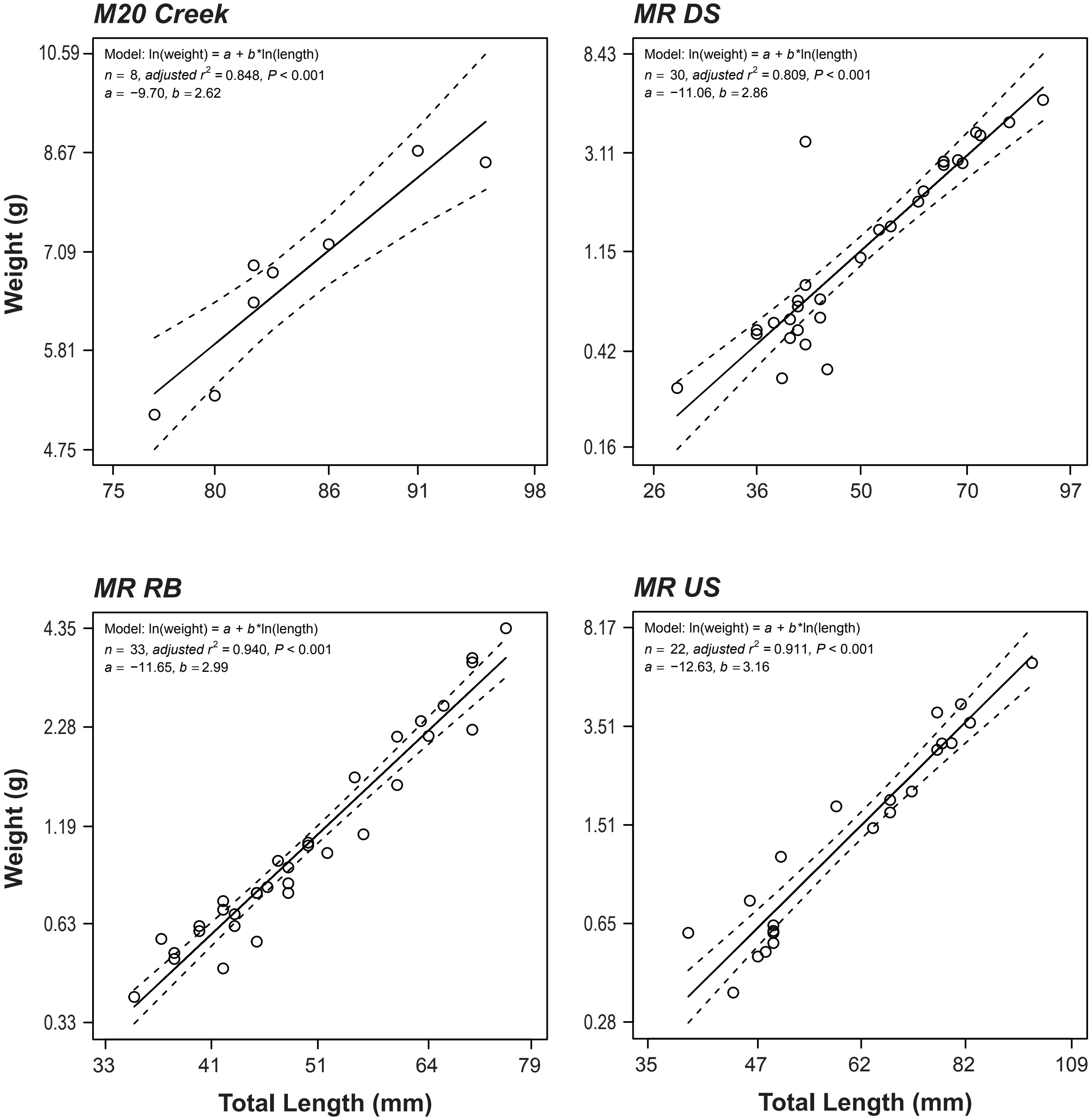
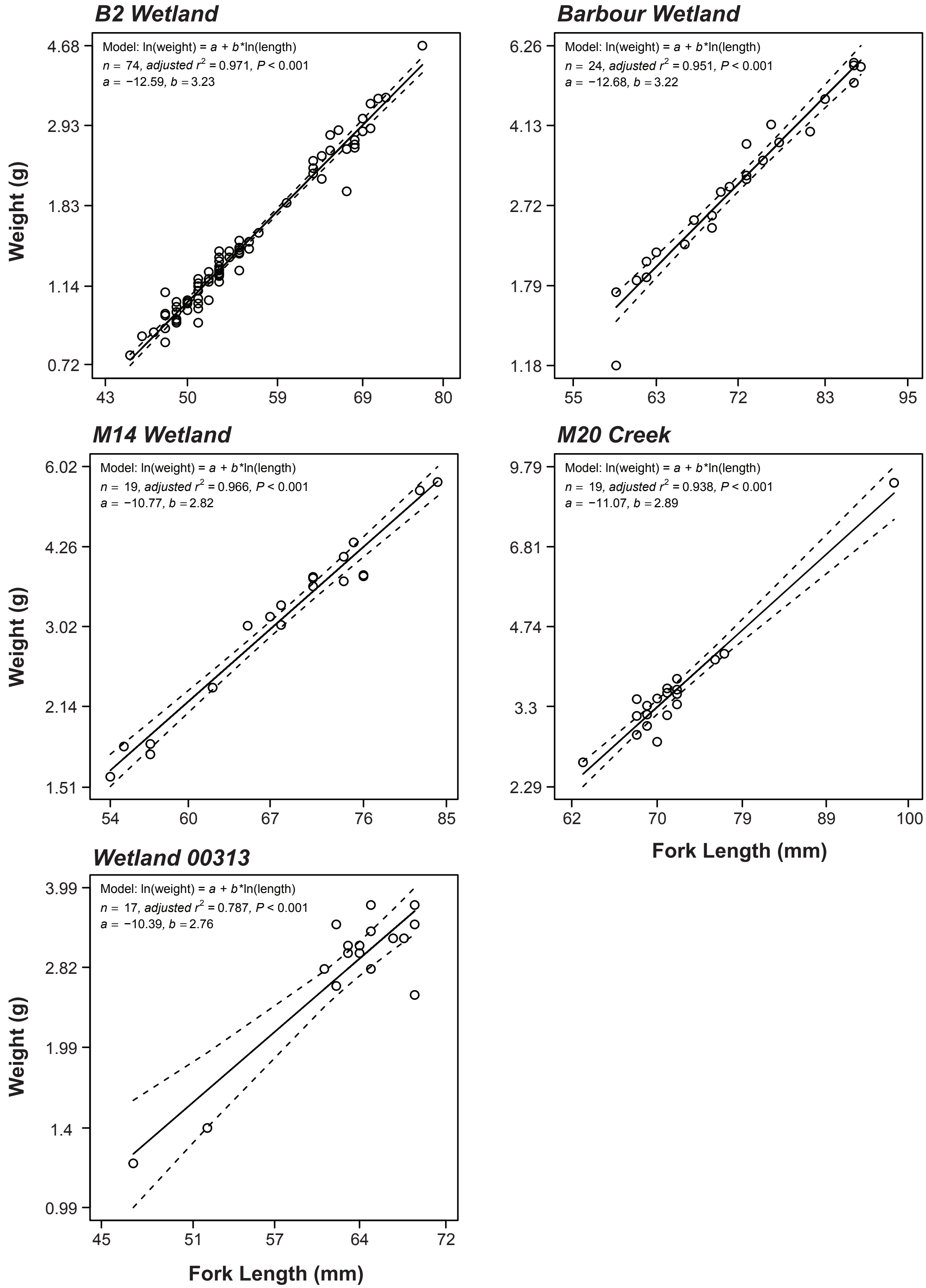


Note: axis values have been backtransformed from the natural log (Ln)

Figure 4.3-5

Weight-Length Regressions for Slimy Sculpin, 2011



Note: axis values have been backtransformed from the natural log (Ln)

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Weight-Length Regressions for Finescale Dace, 2011

Figure 4.3-6

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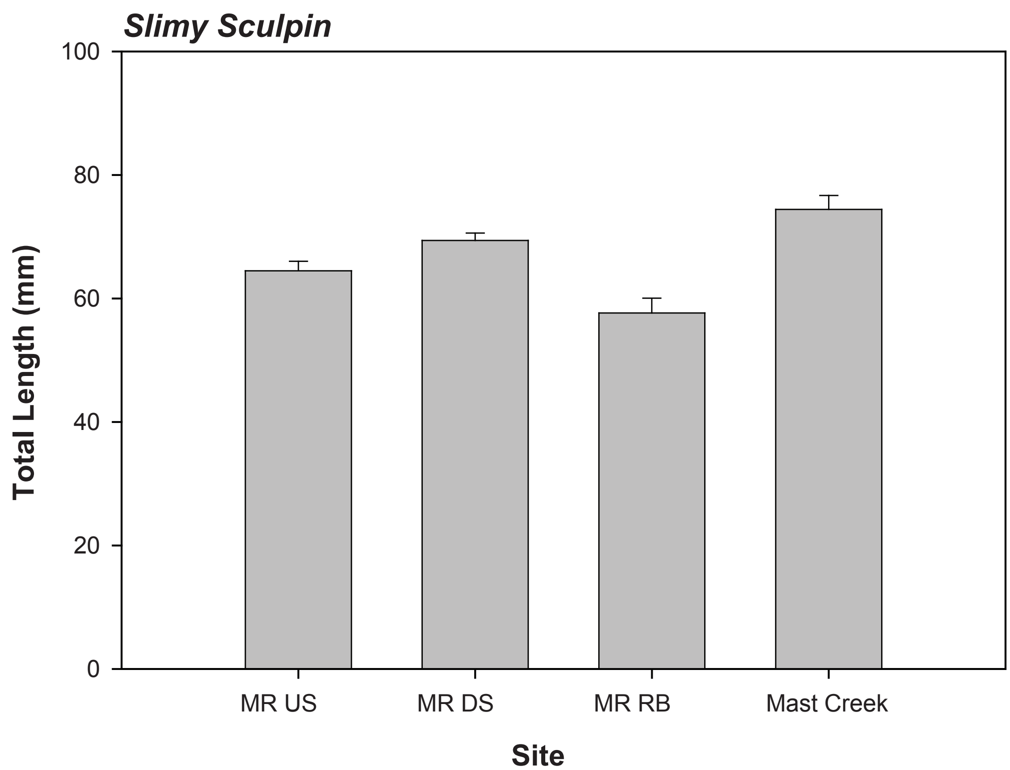
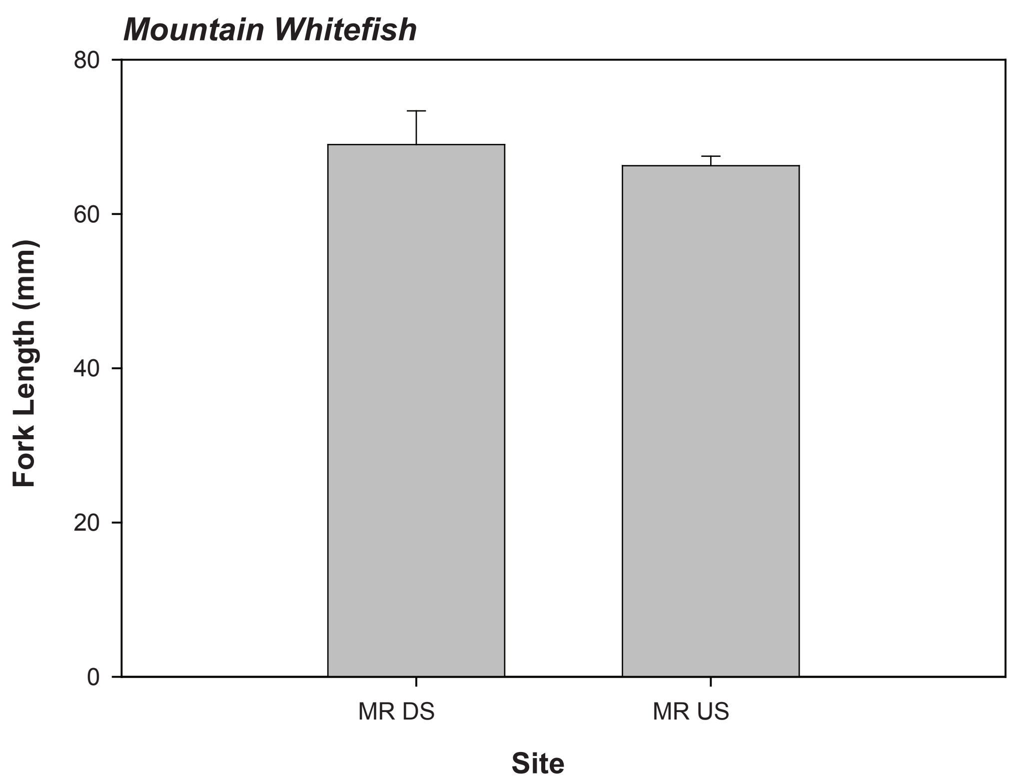




Note: Errors bars indicate 1 standard error of the mean

Figure 4.3-7

Mean Length of Species Captured by Electrofishing, 2005

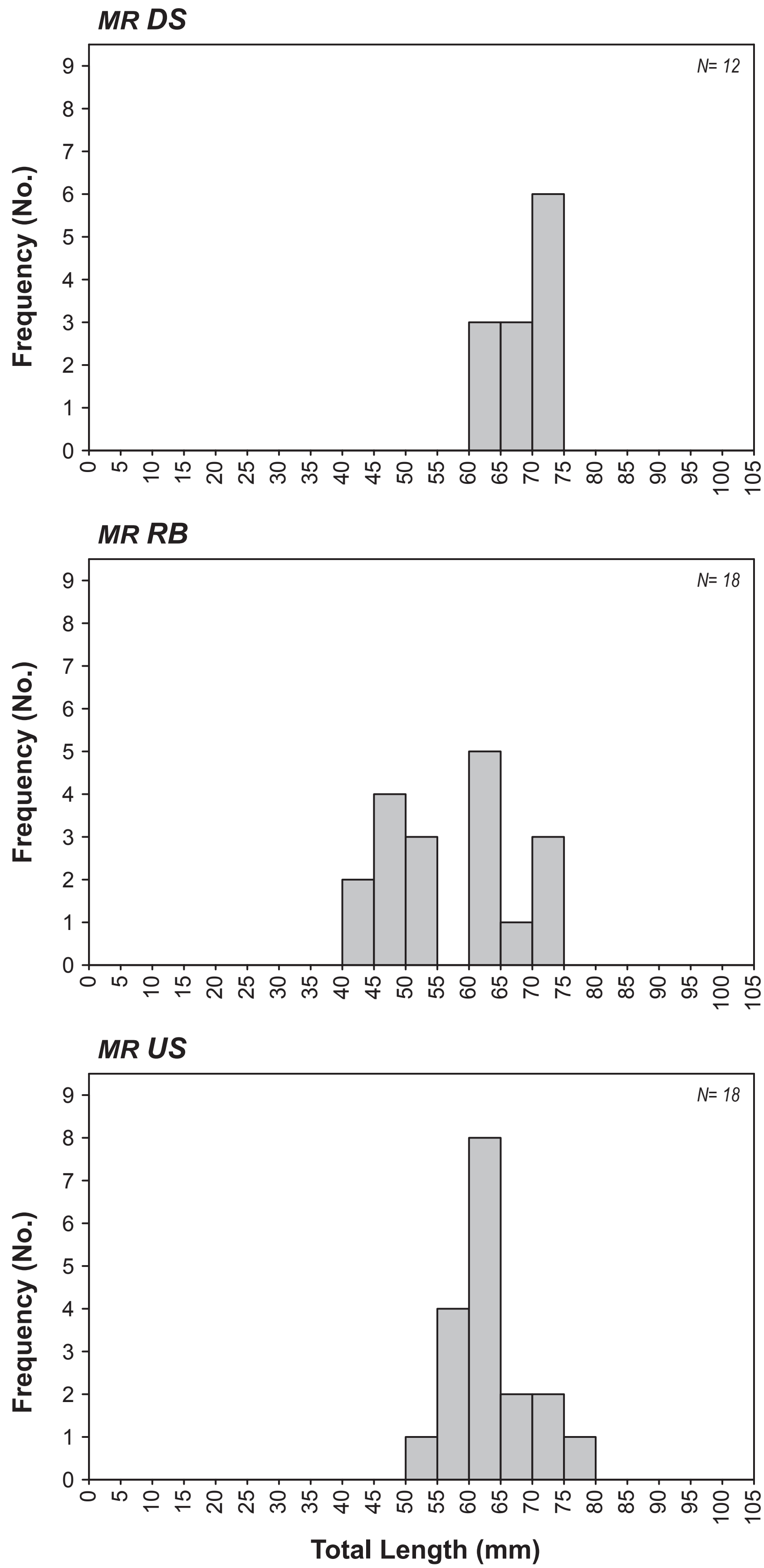
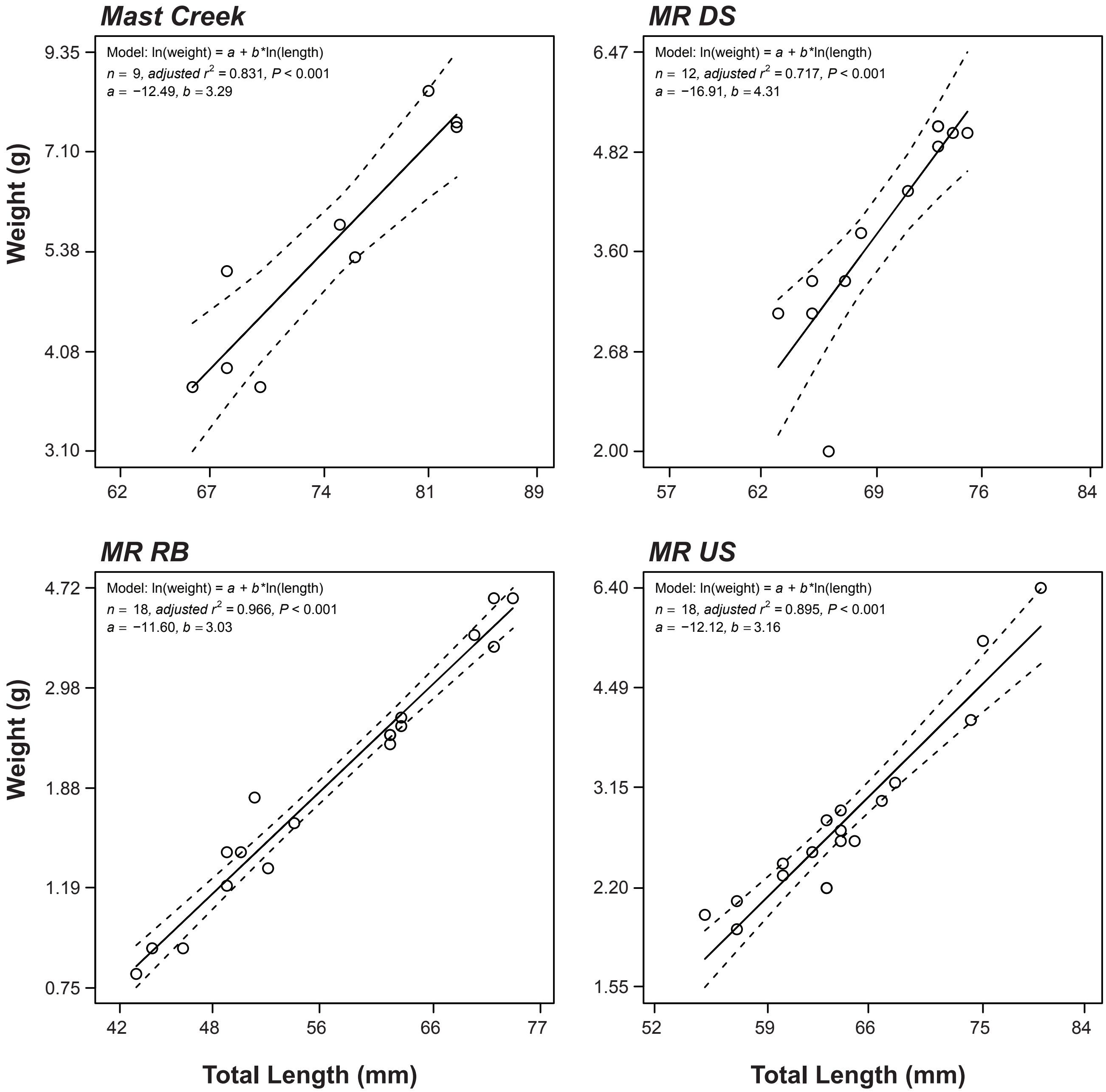


Figure 4.3-8

Length-Frequency Distributions of Slimy Sculpin, 2005



Note: axis values have been backtransformed from the natural log (Ln)

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Weight-Length Regressions for Slimy Sculpin, 2005

Figure 4.3-9

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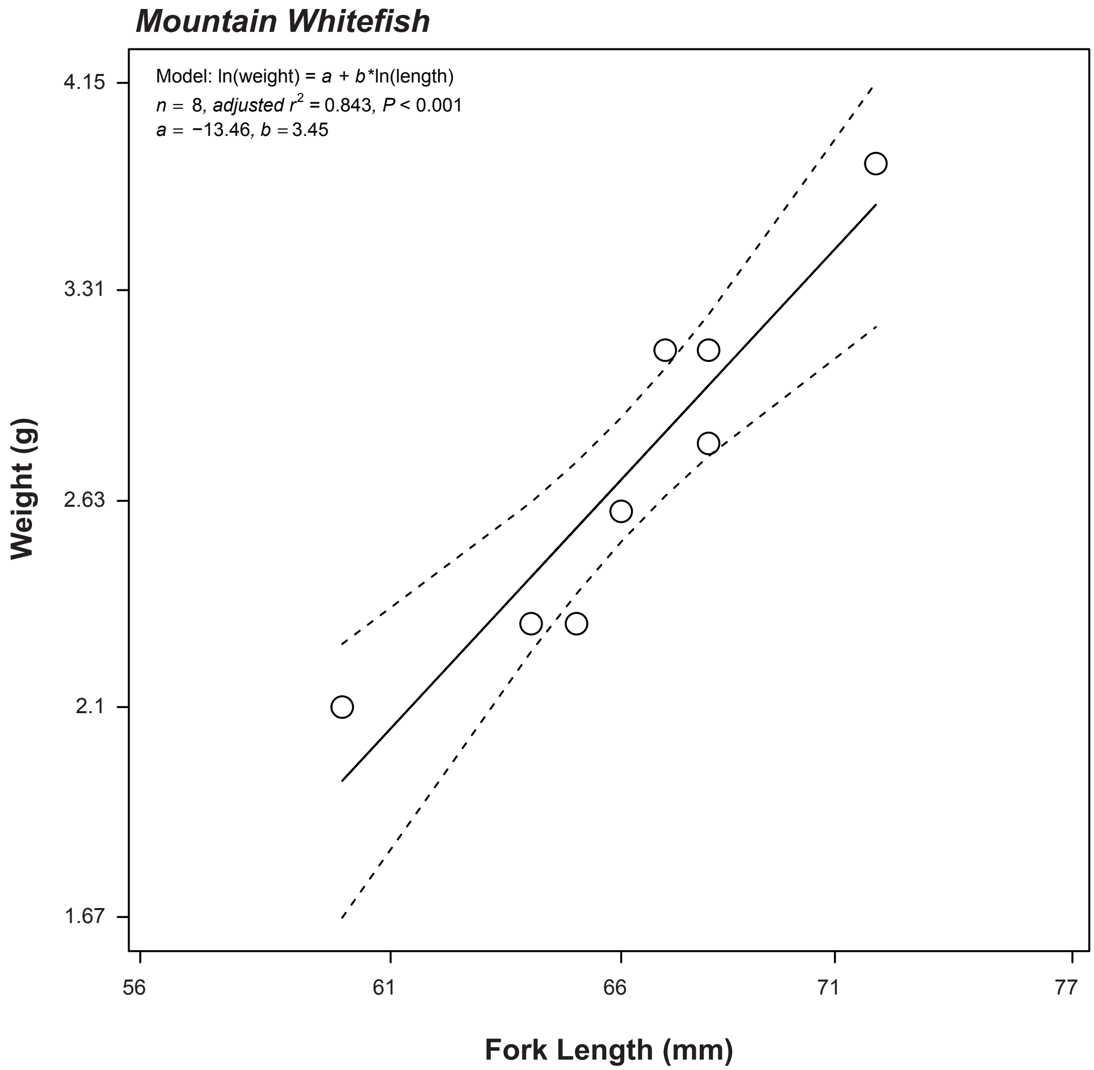
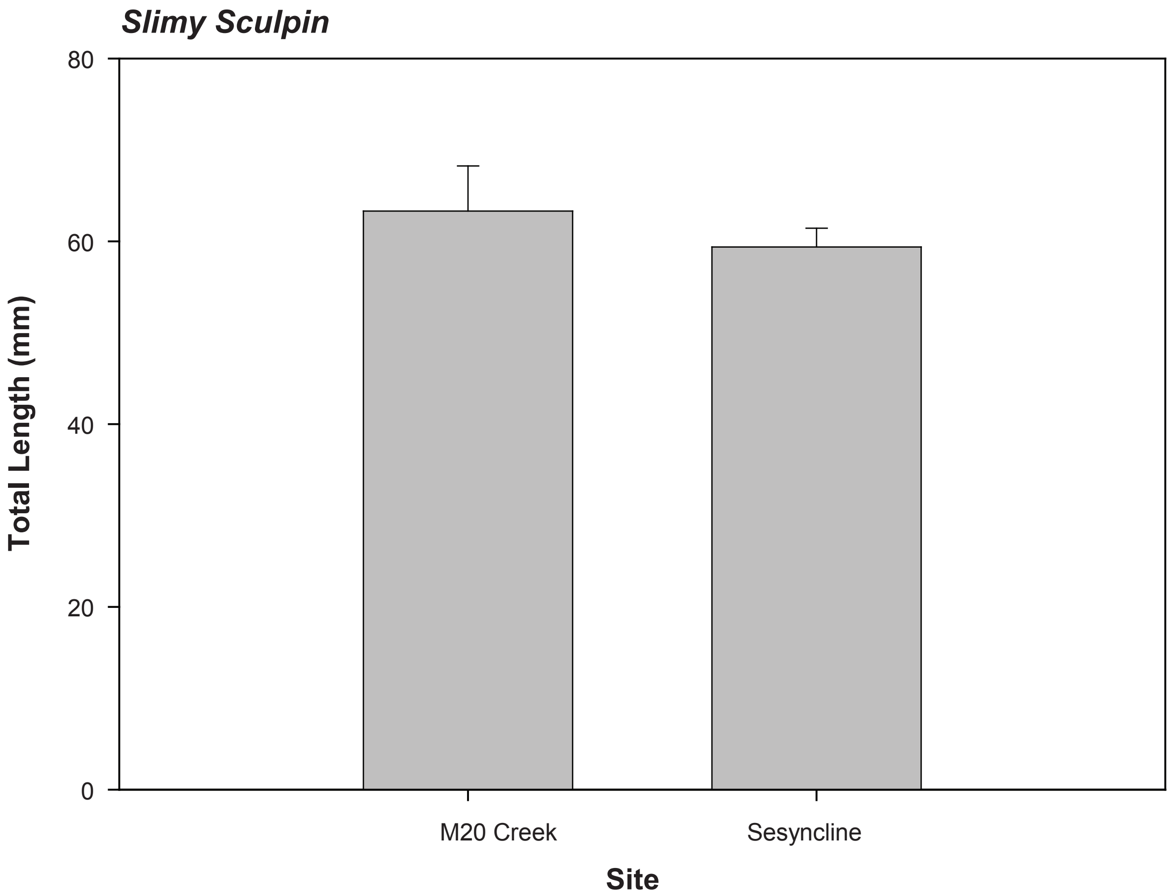


Note: axis values have been backtransformed from the natural log (Ln)

Weight-Length Regression for Mountain Whitefish at MR US, 2005



Note: Errors bars indicate 1 standard error of the mean

Length of Slimy Sculpin
Captured by Electrofishing, 2004

Figure 4.3-11

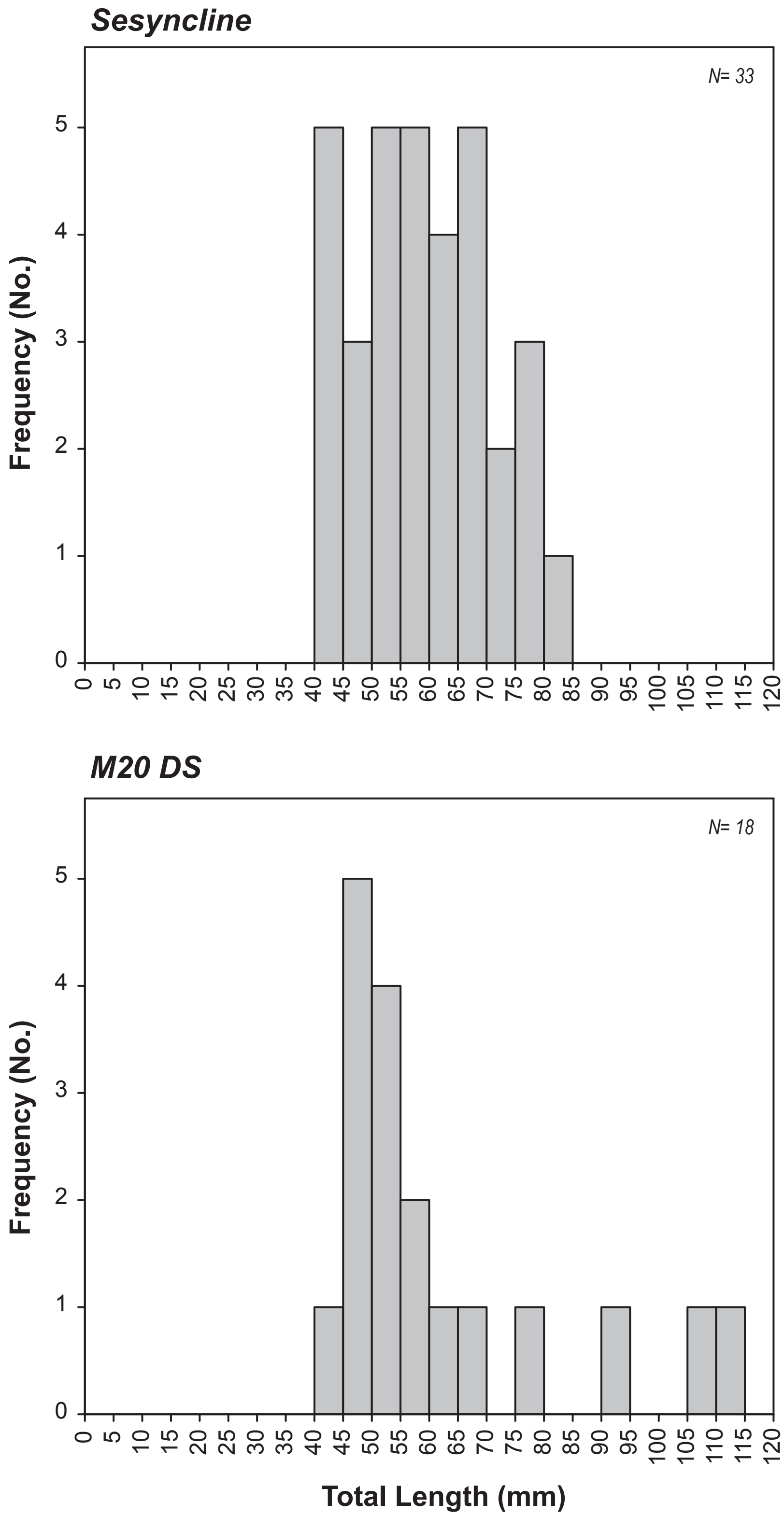


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Figure 4.3-12

Length-Frequency Distributions of Slimy Sculpin, 2004

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4.4 TISSUE METALS

Several fish species (Slimy Sculpin, Finescale Dace, Brook Trout, and Bull Trout) were sampled for fish tissue metals concentrations within the LSA and RSA from 2004 to 2012. Appendix 8 presents all tissue metals analytical data, and Tables 4.4-1 to 4.4-9 summarize mean tissue metal concentrations for each species sampled within the LSA and RSA to date. The concentration of 25 metals and tissue moisture were analysed for each year. Presently, mercury is the only metal for which Health Canada or CCME guidelines exist for fish tissue (CCME 1999; Health Canada 2011). An aquatic life guideline for selenium concentration in fish is currently in development for British Columbia (Beatty and Russo 2012). This guideline lists two thresholds for selenium: 1) 11 µg/g dry weight (equivalent to 11 mg/kg dw) in ovary or eggs, and 2) 4 µg/g dry weight (equivalent to 4 mg/kg dw) in muscle. Slimy Sculpin were selected as the sentinel species to examine changes in baseline tissue metals concentrations for the Project. Thus, concentrations of mercury and selenium from Slimy Sculpin are summarized and discussed below. Data pertaining to other fish species and tissue metals concentrations may be further presented, analysed, and discussed in future monitoring programs.

Mean mercury concentrations in Slimy Sculpin tissues were highest at Murray River mainstem sites and lowest at tributary stream sites. The highest mean concentration was recorded at MR US in 2011 and MR DS in 2012 (0.044 mg/kg ww at both sites), followed by MR US in 2012 (0.038 mg/kg ww). The lowest mean mercury concentrations were 0.018 mg/kg ww (M20, 2011) and 0.021 mg/kg ww (M20, 2004). Mercury concentrations in Slimy Sculpin from all sites sampled in all years were lower than the Health Canada guideline of 0.50 mg/kg ww for maximum total mercury in fish tissue (CCME 1999; Health Canada 2011).

Selenium showed opposite trends relative to mercury. Mean selenium concentrations measured in Slimy Sculpin were higher at tributary sites and lower at Murray River mainstem sites. The highest mean selenium concentrations were recorded at M20 Creek (2.4 mg/kg ww in 2012 and 2.3 mg/kg ww in 2011). The lowest mean selenium concentrations were recorded at MR DS (0.8 mg/kg ww in 2005 and 0.9 mg/kg ww in 2012).

Selenium data for whole-body Slimy Sculpin were converted from mg/kg ww to mg/kg dw for direct comparison with draft selenium guidelines for British Columbia (Beatty and Russo 2012). Table 4.4-10 shows mean selenium concentrations (mg/kg dw) in whole-body Slimy Sculpin sampled from 2004 to 2012 relative to the draft guideline of 4 mg/kg dw for fish muscle. Mean selenium concentrations exceeded the draft guideline at M20 Creek and Mast Creek during all sampling years. For Murray River sites, exceedances of the draft guideline occurred at MR US (2012, 2011), MR 3 (2012), MR 4 (2012), and MR RB (2011). Mean selenium concentrations for whole-body Slimy Sculpin sampled from MR DS were slightly below 4.0 mg/kg dw in 2005, 2011, and 2012.

Table 4.4-1. Summary of Mean Tissue Metal Concentrations in Slimy Sculpin, 2012

Variable	Units	Detection Limit	Murray River DS (n = 7)				MR 3 (n = 8)				MR 4 (n = 8)				Murray River US (n = 8)				M20 US (n = 8)			
			Mean	SE	Min	Max	Mean	SE	Min	Max	Mean	SE	Min	Max	Mean	SE	Min	Max	Mean	SE	Min	Max
Fork Length	mm	n/a	66	4	55	81	54	2	45	65	62	2	52	75	66	3	58	78	88	3	76	105
Moisture	%	0.1	75.5	0.5	73.4	77.2	73.0	0.4	71.2	74.7	74.2	0.7	70.7	76.5	73.9	0.5	70.9	74.9	74.8	0.7	71.9	77.7
Aluminum (Al)	mg/kg WW	2	33	11	6	88	25	9	5	81	80	21	18	191	24	6	4	62	44	16	6	149
Arsenic (As)	mg/kg WW	0.01	0.06	0.00	0.04	0.07	0.06	0.00	0.05	0.08	0.07	0.01	0.04	0.10	0.06	0.00	0.05	0.08	0.06	0.01	0.37	0.11
Barium (Ba)	mg/kg WW	0.01	4.44	0.30	3.26	5.53	3.66	0.28	2.53	4.96	3.78	0.49	2.00	5.57	3.55	0.60	1.07	6.49	5.09	0.68	1.47	7.08
Calcium (Ca)	mg/kg WW	2	14,929	933	11,300	17,700	15,563	952	11,900	19,700	10,419	1,332	6,560	18,400	14,368	1,896	5,130	21,400	10,701	1,752	4,660	18,100
Chromium (Cr)	mg/kg WW	0.1	0.1	0.0	0.1	0.2	0.1	0.0	0.1	0.1	0.2	0.1	0.1	0.5	0.1	0.0	0.1	0.2	0.1	0.0	0.1	0.3
Copper (Cu)	mg/kg WW	0.01	0.72	0.05	0.56	0.86	0.66	0.04	0.54	0.90	1.28	0.19	0.81	2.46	0.70	0.07	0.57	1.17	0.63	0.03	0.52	0.73
Lead (Pb)	mg/kg WW	0.02	0.05	0.00	0.04	0.06	0.03	0.00	0.01	0.05	0.05	0.01	0.02	0.09	0.02	0.00	0.01	0.04	0.03	0.01	0.01	0.09
Magnesium (Mg)	mg/kg WW	1	403	12	371	453	432	19	358	525	408	25	310	525	429	28	257	507	375	28	245	476
Manganese (Mn)	mg/kg WW	0.01	5.32	0.47	3.71	6.93	4.57	0.42	3.43	6.83	6.08	0.68	3.34	9.01	5.46	0.63	2.71	7.90	2.55	0.36	0.75	3.66
Mercury (Hg)	mg/kg WW	0.003	0.044	0.009	0.023	0.087	0.027	0.004	0.020	0.055	0.032	0.003	0.023	0.042	0.038	0.007	0.021	0.081	0.027	0.004	0.019	0.052
Molybdenum (Mo)	mg/kg WW	0.01	0.03	0.00	0.02	0.04	0.02	0.00	0.02	0.03	0.03	0.00	0.02	0.04	0.02	0.00	0.01	0.03	0.01	0.00	0.01	0.02
Selenium (Se)	mg/kg WW	0.2	0.9	0.1	0.6	1.2	1.3	0.1	0.8	1.6	1.4	0.1	1.1	1.9	1.2	0.1	0.8	1.4	2.4	0.1	2.0	2.8
Strontium (Sr)	mg/kg WW	0.01	10.67	0.89	7.89	13.60	10.44	0.69	7.77	13.10	7.57	1.15	4.46	14.30	9.64	1.42	3.08	16.20	9.37	1.55	4.25	17.30
Zinc (Zn)	mg/kg WW	0.1	26.8	2.4	18.0	38.2	23.5	0.9	19.6	27.0	22.5	0.8	20.4	27.4	26.7	2.7	18.5	41.8	22.5	1.5	15.8	28.0

Notes: n = number of samples, SE = standard error of the mean, min = minimum, max = maximum, WW = wet weight

Table 4.4-2. Summary of Mean Tissue Metal Concentrations in Bull Trout, 2012

Variable	Units	Detection Limit	M20 US (n = 3)			
			Mean	SE	Min	Max
Fork Length	mm	n/a	166	9	151	181
Moisture	%	0.1	76.7	0.7	75.5	77.8
Aluminum (Al)	mg/kg WW	2	14	5	4	21
Arsenic (As)	mg/kg WW	0.01	0.01	0	0.01	0.02
Barium (Ba)	mg/kg WW	0.01	1.33	0.32	0.73	1.85
Calcium (Ca)	mg/kg WW	2	3,597	906	2,540	5,400
Copper (Cu)	mg/kg WW	0.01	0.04	0	0.03	0.05
Magnesium (Mg)	mg/kg WW	1	307	18	285	344
Manganese (Mn)	mg/kg WW	0.01	0.98	0.13	0.72	1.17
Mercury (Hg)	mg/kg WW	0.003	0.017	0.002	0.014	0.018
Molybdenum (Mo)	mg/kg WW	0.01	0.01	0	0.01	0.02
Selenium (Se)	mg/kg WW	0.2	0.9	0.1	0.8	1
Strontium (Sr)	mg/kg WW	0.01	2.58	0.69	1.65	3.92
Zinc (Zn)	mg/kg WW	0.1	19.7	1.6	16.9	22.6

Notes: n = number of samples, SE = standard error of the mean, min = minimum, max = maximum, WW = wet weight

Table 4.4-3. Summary of Mean Tissue Metal Concentrations in Slimy Sculpin, 2011

Variable	Units	Detection Limit	M20 DS (n = 8)				Murray River RB (n = 8)				Murray River DS (n = 8)				Murray River US (n = 7)			
			Mean	SE	Min	Max	Mean	SE	Min	Max	Mean	SE	Min	Max	Mean	SE	Min	Max
Fork Length	mm	n/a	85	2	77	95	51	2	35	75	52	3	28	89	62	3	39	98
Moisture	%	0.1	71.0	0.4	69.2	72.8	73.2	0.5	71.9	75.8	74.1	0.6	71.9	76.3	74.7	0.6	72.9	78.0
Aluminum (Al)	mg/kg WW	2	37	11	9	95	93	14	35	140	99	22	38	193	57	23	10	162
Arsenic (As)	mg/kg WW	0.01	0.05	0.00	0.03	0.07	0.07	0.00	0.06	0.08	0.06	0.01	0.04	0.12	0.06	0.01	0.04	0.09
Barium (Ba)	mg/kg WW	0.01	5.53	0.30	4.74	6.82	4.32	0.26	3.21	5.08	5.07	0.44	3.86	7.80	4.24	0.58	2.39	6.85
Calcium (Ca)	mg/kg WW	2	15,650	1,035	10,700	19,100	15,388	1,105	11,000	19,800	17,150	1,470	11,100	23,500	17,300	2,317	9,500	25,200
Chromium (Cr)	mg/kg WW	0.1	0.1	0.0	0.1	0.2	0.4	0.1	0.1	0.8	0.3	0.1	0.1	0.5	0.3	0.0	0.1	0.4
Copper (Cu)	mg/kg WW	0.01	0.75	0.04	0.55	0.92	0.94	0.03	0.85	1.10	1.05	0.06	0.77	1.35	0.80	0.05	0.66	0.98
Lead (Pb)	mg/kg WW	0.02	0.03	0.00	0.01	0.05	0.04	0.00	0.02	0.05	0.05	0.01	0.03	0.08	0.03	0.01	0.01	0.07
Magnesium (Mg)	mg/kg WW	1	459	12	418	507	454	12	392	492	491	47	402	806	470	26	385	564
Manganese (Mn)	mg/kg WW	0.01	3.66	0.44	2.13	5.66	7.23	0.44	5.54	8.94	8.38	0.94	5.10	13.50	6.49	0.76	4.08	9.45
Mercury (Hg)	mg/kg WW	0.003	0.018	0.002	0.014	0.025	0.035	0.003	0.024	0.047	0.036	0.006	0.022	0.073	0.044	0.007	0.030	0.818
Molybdenum (Mo)	mg/kg WW	0.01	0.02	0.00	0.01	0.02	0.03	0.00	0.02	0.03	0.03	0.01	0.02	0.07	0.02	0.00	0.01	0.03
Selenium (Se)	mg/kg WW	0.2	2.3	0.2	1.3	2.8	1.5	0.1	1.3	1.7	1.0	0.0	0.9	1.1	1.1	0.1	0.8	1.4
Strontium (Sr)	mg/kg WW	0.01	12.25	0.99	7.28	15.40	10.36	0.71	7.88	13.60	11.25	0.90	7.47	15.30	10.66	1.54	5.36	16.80
Zinc (Zn)	mg/kg WW	0.1	24.4	1.0	19.4	28.9	25.5	0.7	23.4	29.1	27.5	1.4	22.2	32.8	29.6	2.5	22.0	41.8

Notes: n = number of samples, SE = standard error of the mean, min = minimum, max = maximum, WW = wet weight

Table 4.4-4. Summary of Mean Tissue Metal Concentrations in Bull Trout, 2011

Variable	Units	Detection Limit	M20 DS (n = 3)				Fellers Creek ('FEL'; n = 3)			
			Mean	SE	Min	Max	Mean	SE	Min	Max
Fork Length	mm	n/a	192	9	179	210	120	14	91	137
Moisture	%	0.1	77.6	0.6	76.6	78.8	75.7	1.1	73.5	76.9
Aluminum (Al)	mg/kg WW	2	12	7	5	25	5	2	2	9
Arsenic (As)	mg/kg WW	0.01	0.01	0.00	0.01	0.02	0.04	0.01	0.03	0.06
Barium (Ba)	mg/kg WW	0.01	0.98	0.14	0.72	1.18	0.40	0.01	0.38	0.42
Calcium (Ca)	mg/kg WW	2	5,443	2,889	2,140	11,200	5,167	372	4,780	5,910
Chromium (Cr)	mg/kg WW	0.1	0.1	0.0	0.1	0.2	0.0	0.0	0.0	0.1
Copper (Cu)	mg/kg WW	0.01	0.56	0.02	0.52	0.60	0.69	0.06	0.58	0.77
Magnesium (Mg)	mg/kg WW	1	312	46	254	402	319	7	307	331
Manganese (Mn)	mg/kg WW	0.01	0.92	0.29	0.56	1.50	0.88	0.22	0.45	1.13
Mercury (Hg)	mg/kg WW	0.003	0.030	0.008	0.019	0.046	0.021	0.001	0.018	0.022
Molybdenum (Mo)	mg/kg WW	0.01	0.01	0.00	0.01	0.02	0.02	0.00	0.01	0.02
Selenium (Se)	mg/kg WW	0.2	0.9	0.1	0.8	1.0	1.2	0.1	0.9	1.4
Strontium (Sr)	mg/kg WW	0.01	3.20	1.33	1.49	5.82	1.97	0.09	1.84	2.13
Zinc (Zn)	mg/kg WW	0.1	25.1	3.5	20.1	31.8	22.8	2.5	18.0	26.6

Notes: n = number of samples, SE = standard error of the mean, min = minimum, max = maximum, WW = wet weight

Table 4.4-5. Summary of Mean Tissue Metal Concentrations in Finescale Dace, 2011

		Detection Limit	Murray 11 (Wetland 00313) (n = 8)				B2 Wetland (n = 8)				M20 Wetland (n = 8)				M14 Wetland (n = 8)				Barbour Wetland (n = 8)			
Variable	Units		Mean	SE	Min	Max	Mean	SE	Min	Max	Mean	SE	Min	Max	Mean	SE	Min	Max	Mean	SE	Min	Max
Fork Length	mm	n/a	63	1	47	69	56	1	45	77	69	4	7	98	69	2	54	84	72	2	59	88
Moisture	%	0.1	75.4	0.9	73.0	79.3	75.9	0.5	73.6	77.9	73.7	0.3	72.0	74.7	74.8	0.2	73.8	75.6	74.7	0.3	73.6	76.0
Aluminum (Al)	mg/kg WW	2	1	0	1	3	33	9	11	79	2	0	1	5	11	3	1	28	3	1	2	6
Arsenic (As)	mg/kg WW	0.01	0.02	0.00	0.01	0.02	0.05	0.00	0.03	0.06	0.02	0.00	0.01	0.03	0.04	0.00	0.02	0.05	0.02	0.00	0.01	0.03
Barium (Ba)	mg/kg WW	0.01	11.70	0.74	10.00	16.20	11.76	1.59	7.58	20.10	8.01	0.50	6.78	10.60	7.34	0.33	6.32	8.57	10.59	0.59	7.18	13.10
Calcium (Ca)	mg/kg WW	2	12,263	852	9,360	15,900	9,785	787	7,220	12,800	9,000	714	6,090	11,200	10,314	837	7,200	14,200	9,225	522	6,300	10,800
Chromium (Cr)	mg/kg WW	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.1
Copper (Cu)	mg/kg WW	0.01	1.02	0.10	0.64	1.45	1.48	0.07	1.27	1.80	1.42	0.24	0.94	2.97	2.09	0.16	1.62	3.07	1.91	0.15	1.20	2.34
Lead (Pb)	mg/kg WW	0.02	-	-	-	-	0.01	0.00	0.01	0.03	0.01	0.00	0.00	0.04	0.01	0.00	0.01	0.02	0.01	0.00	0.01	0.01
Magnesium (Mg)	mg/kg WW	1	357	17	282	419	384	16	330	447	363	11	317	403	379	12	333	426	353	8	305	379
Manganese (Mn)	mg/kg WW	0.01	8.99	0.42	7.66	11.20	4.60	0.50	3.25	6.97	5.79	0.28	4.49	6.56	6.69	0.63	5.15	10.30	2.86	0.15	2.09	3.34
Mercury (Hg)	mg/kg WW	0.003	0.051	0.005	0.036	0.069	0.101	0.004	0.085	0.114	0.063	0.010	0.042	0.125	0.112	0.004	0.096	0.126	0.080	0.003	0.068	0.094
Molybdenum (Mo)	mg/kg WW	0.01	0.03	0.00	0.02	0.04	0.03	0.00	0.02	0.05	0.03	0.00	0.02	0.03	0.03	0.00	0.03	0.04	0.04	0.00	0.03	0.06
Selenium (Se)	mg/kg WW	0.2	0.4	0.0	0.3	0.5	0.6	0.0	0.5	0.7	0.6	0.0	0.5	0.8	0.9	0.0	0.8	1.1	1.9	0.1	1.7	2.2
Strontium (Sr)	mg/kg WW	0.01	9.32	0.60	7.64	12.80	9.94	0.79	7.47	13.50	5.67	0.41	4.07	7.28	12.70	1.05	9.42	16.80	6.69	0.48	4.17	8.93
Zinc (Zn)	mg/kg WW	0.1	47.3	1.5	41.8	54.1	62.7	2.8	54.6	78.5	47.6	2.6	30.2	54.4	52.6	1.8	46.5	60.7	67.7	3.3	50.9	79.6

Notes: n = number of samples, SE = standard error of the mean, min = minimum, max = maximum, WW = wet weight

Dashes = all samples were below detection limits

Table 4.4-6. Summary of Mean Tissue Metal Concentrations in Brook Trout, 2011

		Detection Limit	M20 DS (n = 3)				Waterfall (n = 3; muscle only)				Waterfall (n = 3; whole body)			
Variable	Units		Mean	SE	Min	Max	Mean	SE	Min	Max	Mean	SE	Min	Max
Fork Length	mm	n/a	154	3	150	160	180	14	160	208	180	14	160	208
Moisture	%	0.1	75.8	0.6	75.1	77.0	76.3	1.1	74.1	77.8	71.9	2.0	68.3	75.1
Aluminum (Al)	mg/kg WW	2	25	15	8	55	1	0	0	1	28	18	5	63
Arsenic (As)	mg/kg WW	0.01	0.02	0.00	0.01	0.02	0.01	0.00	0.01	0.02	0.03	0.01	0.02	0.04
Barium (Ba)	mg/kg WW	0.01	2.03	0.52	1.44	3.07	0.13	0.05	0.06	0.23	1.46	0.44	0.95	2.33
Calcium (Ca)	mg/kg WW	2	4,840	271	4,480	5,370	387	106	201	567	4,337	1,256	2,640	6,790
Chromium (Cr)	mg/kg WW	0.1	0.1	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2
Copper (Cu)	mg/kg WW	0.01	0.81	0.06	0.69	0.89	0.35	0.01	0.34	0.37	0.83	0.14	0.67	1.10
Lead (Pb)	mg/kg WW	0.02	0.17	0.01	0.00	0.04	-	-	-	-	0.01	0.00	0.01	0.02
Magnesium (Mg)	mg/kg WW	1	300	6	291	312	285	5	274	291	305	14	279	329
Manganese (Mn)	mg/kg WW	0.01	1.88	0.27	1.36	2.24	0.16	0.03	0.11	0.22	0.88	0.16	0.66	1.19
Mercury (Hg)	mg/kg WW	0.003	0.017	0.001	0.015	0.019	0.021	0.006	0.014	0.032	0.019	0.004	0.014	0.028
Molybdenum (Mo)	mg/kg WW	0.01	0.02	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.02
Selenium (Se)	mg/kg WW	0.2	0.7	0.1	0.5	0.8	1.1	0.0	1.0	1.2	1.6	0.1	1.4	1.7
Strontium (Sr)	mg/kg WW	0.01	4.09	0.25	3.76	4.58	0.30	0.10	0.14	0.48	3.32	0.95	1.88	5.10
Zinc (Zn)	mg/kg WW	0.1	21.9	1.1	20.2	23.9	6.9	0.4	6.1	7.5	21.5	1.6	19.8	24.6

Notes: n = number of samples, SE = standard error of the mean, min = minimum, max = maximum, WW = wet weight

Dashes = all samples were below detection limits

Table 4.4-7. Summary of Mean Tissue Metal Concentrations in Slimy Sculpin, 2005

		Detection	Murray River US E206322 (n = 5)				Murray River DS E206323 (n = 5)				Murray River RB E206972 (n = 5)			
Variable	Units	Limit	Mean	SE	Min	Max	Mean	SE	Min	Max	Mean	SE	Min	Max
Fork Length	mm	n/a	65	2	59	70	70	2	65	74	62	5	48	73
Moisture	%	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Aluminum (Al)	mg/kg WW	2	30	6	12	45	49	5	32	61	87	12	64	129
Arsenic (As)	mg/kg WW	0.01	0.07	0.01	0.05	0.09	0.05	0.00	0.05	0.06	0.07	0.01	0.06	0.10
Barium (Ba)	mg/kg WW	0.01	4.06	0.20	3.50	4.46	4.85	0.29	3.86	5.61	5.01	0.34	4.02	6.07
Calcium (Ca)	mg/kg WW	2	15,700	1,170	13,100	20,000	15,420	623	13,000	16,400	13,800	539	12,400	15,100
Chromium (Cr)	mg/kg WW	0.1	-	-	-	-	-	-	-	-	0.1	0.1	0.0	0.3
Copper (Cu)	mg/kg WW	0.01	0.82	0.04	0.72	0.94	0.67	0.03	0.59	0.73	0.95	0.04	0.86	1.06
Lead (Pb)	mg/kg WW	0.02	-	-	-	-	0.03	0.01	0.02	0.05	0.05	0.01	0.04	0.07
Magnesium (Mg)	mg/kg WW	1	415	16	376	462	410	15	366	458	432	9	407	456
Manganese (Mn)	mg/kg WW	0.01	6.08	0.54	5.14	8.17	5.01	0.36	4.01	6.04	6.57	0.37	5.65	7.30
Molybdenum (Mo)	mg/kg WW	0.01	0.02	0.00	0.01	0.03	0.02	0.00	0.01	0.02	0.03	0.00	0.02	0.03
Selenium (Se)	mg/kg WW	0.2	0.9	0.1	0.7	1.1	0.8	0.0	0.7	0.9	1.1	0.1	0.9	1.2
Strontium (Sr)	mg/kg WW	0.01	10.79	0.80	9.07	13.70	15.18	2.56	10.90	22.50	9.74	0.39	8.39	10.50
Zinc (Zn)	mg/kg WW	0.1	26.2	1.8	22.0	30.8	25.9	2.0	20.3	31.1	20.8	0.4	19.2	21.4

Notes: n = number of samples, SE = standard error of the mean, min = minimum, max = maximum, WW = wet weight
Dashes = all samples were below detection limits

Table 4.4-8. Summary of Mean Tissue Metal Concentrations in Mountain Whitefish, 2005

		Detection	Murray River DS E206323 (n = 1)				Murray River US E206322 (n = 3)			
Variable	Units	Limit	Mean	SE	Min	Max	Mean	SE	Min	Max
Fork Length	mm	n/a	-	-	-	-	-	-	-	-
Moisture	%	0.1	-	-	-	-	-	-	-	-
Aluminum (Al)	mg/kg WW	2	22	-	22	22	24	9	12	42
Arsenic (As)	mg/kg WW	0.01	0.03	-	0.03	0.03	0.05	0	0	0
Barium (Ba)	mg/kg WW	0.01	0.93	-	0.93	0.93	1.62	1	1	3
Calcium (Ca)	mg/kg WW	2	6100	-	6100	6100	7800	593	6710	8750
Copper (Cu)	mg/kg WW	0.01	0.79	-	0.79	0.79	0.77	0	1	1
Lead (Pb)	mg/kg WW	0.02	-	-	-	-	0.0233	0	0	0
Magnesium (Mg)	mg/kg WW	1	345	-	345	345	396	22	360	437
Manganese (Mn)	mg/kg WW	0.01	1.82	-	1.82	1.82	2.98	1	2	4
Molybdenum (Mo)	mg/kg WW	0.01	0.01	-	0.01	0.01	0.01	0	0	0
Selenium (Se)	mg/kg WW	0.2	1.1	-	1.1	1.1	1.3	0	1	1
Strontium (Sr)	mg/kg WW	0.01	25.70	-	25.70	25.70	4.06	0	4	4
Zinc (Zn)	mg/kg WW	0.1	25.7	-	25.7	25.7	31.5	2.3	26.8	33.9

Notes: n = number of samples, SE = standard error of the mean, min = minimum, max = maximum, WW = wet weight
Dashes = all samples were below detection limits

Table 4.4-9. Summary of Mean Tissue Metal Concentrations in Slimy Sculpin, 2004

Variable	Units	Detection Limit	SS-FT (n = 5)				M20 DS (n = 5)			
			Mean	SE	Min	Max	Mean	SE	Min	Max
Fork Length	mm	n/a	59	2	41	82	63	5	44	111
Moisture	%	0.1	76.6	0.3	75.6	77.5	77.0	0.6	76.1	79.2
Aluminum (Al)	mg/kg WW	10	21	3	14	28	36	10	11	68
Arsenic (As)	mg/kg WW	0.05	0.01	0.01	0.07	0.07	0.05	0.01	0.01	0.07
Barium (Ba)	mg/kg WW	0.05	3.02	0.18	2.51	3.51	6.14	0.47	5.43	7.98
Calcium (Ca)	mg/kg WW	10	12,136	594	10,857	14,220	16,079	2,171	10,997	23,541
Copper (Cu)	mg/kg WW	0.05	0.72	0.02	0.64	0.75	0.70	0.06	0.51	0.86
Magnesium (Mg)	mg/kg WW	3	383	9	373	422	422	22	389	509
Manganese (Mn)	mg/kg WW	0.05	3.65	0.11	3.46	3.94	3.17	0.42	2.08	4.02
Mercury (Hg)	mg/kg WW	0.00125	0.03250	0.00273	0.02660	0.04190	0.02110	0.00365	0.01480	0.03440
Selenium (Se)	mg/kg WW	0.025	0.898	0.049	0.725	1.017	1.164	0.088	0.934	1.336
Strontium (Sr)	mg/kg WW	0.05	8.44	0.39	7.49	9.65	11.79	0.98	9.42	15.01
Zinc (Zn)	mg/kg WW	0.5	22.8	0.7	20.0	23.8	26.5	1.2	23.1	30.4

Notes: n = number of samples, SE = standard error of the mean, min = minimum, max = maximum, WW = wet weight

Table 4.4-10. Mean Selenium Concentrations (mg/kg dw) in Whole-body Slimy Sculpin, 2004 to 2012

Site	Waterbody	Date	n	Mean Whole-body Selenium Concentration (mg/kg dw)	SD	SE
MR US	Murray River	2012	8	4.5	0.7	0.3
		2011	7	4.3	0.8	0.3
		2005	5	3.4	0.6	0.3
MR DS	Murray River	2012	8	3.7	0.8	0.3
		2011	8	3.9	0.2	0.1
		2005	5	3.5	0.4	0.2
MR 3	Murray River	2012	8	4.9	1.0	0.4
MR 4	Murray River	2012	8	5.4	1.1	0.4
MR RB	Murray River	2011	8	5.6	0.8	0.3
		2005	5	3.9	0.5	0.2
SS-FT	Murray River	2004	5	3.8	0.4	0.2
M20 US	M20 Creek	2012	8	9.4	1.2	0.4
		2011	8	7.9	1.7	0.6
M20 DS	M20 Creek	2004	5	5.1	0.8	0.3
Mast Creek	Mast Creek	2005	5	4.5	0.3	0.2

Notes:
n = number of tissue metals samples, SD = standard deviation of the mean, SE = standard error of the mean, dw = dry weight
Shaded cells indicate exceedance of draft guideline for selenium concentration in fish muscle of 4 mg/kg dw (Beatty and Russo 2012).

5. Summary

5. Summary

The purpose of this report is to present cumulative baseline fish and fish habitat data for the Murray River Project. Cumulative baseline data includes a review of existing information and Project-specific data collected from 2010 to 2013. Fish and fish habitat field programs were conducted in the open water season, both in high flow (May/June) and low flow (August/September).

A total of 16 fish species have been documented within the Murray River and connecting tributary streams. Arctic Grayling, Brook Trout, Bull Trout, Burbot, Finescale Dace, Lake Chub, Longnose Dace, Longnose Sucker, Mountain Whitefish, Northern Pike, Rainbow Trout, and Slimy Sculpin were captured between 2010 to 2013 from the Murray River and streams within the Infrastructure Investigation Area and LSA.

Fish distribution in tributary streams within the Infrastructure Investigation Area and LSA is heavily influenced by the presence of permanent barriers to fish migration (i.e., water falls). Barriers delineate upper and lower stream reaches, and habitat use by fish in M17, M19, M20, and Twenty creeks. The fish community of M17, M19, and M20 creeks is similar, and includes Arctic Grayling, Bull Trout, Burbot, Longnose Sucker, Mountain Whitefish, and Slimy Sculpin. Twenty Creek provides ephemeral habitat for Brook Trout, Mountain Whitefish, and Rainbow Trout. Lake Chub were most often associated with wetlands and lotic environments.

The Murray River was classified as an S1-large river. Sites within the Murray River generally provide good juvenile rearing and adult feeding habitat. LWD was the predominant cover-type for fish and provides good juvenile rearing habitat. Barriers to fish migration are not present along the Murray River within the Infrastructure Investigation Area and LSA.

The lower reaches of tributary streams within the Infrastructure Investigation Area were classified as S-2 to S-4. Tributary streams generally provide good juvenile rearing habitat; however, overwinter habitat and high quality spawning habitat were limited. The lower reach of M19 Creek may provide important annual spawning and rearing habitat, which may be a limiting habitat type for Arctic Grayling in the LSA. M19A Creek was classified as S4 (default) and rated as marginal fish habitat. Fish were not captured in M19A Creek despite significant fishing effort. The ability of M19A Creek to support fish may be limited by the presence of numerous beaver dams and ephemeral impediments to fish migration.

The fish-bearing and non-fish-bearing reaches of M20 Creek are delineated by a series of chutes and large waterfalls. The fish-bearing reach of M20 Creek was classified as S2. Spawning and adult feeding habitat within M20 Creek were rated as poor due to high turbidity and sediment load, and overall habitat was rated as marginal. Twenty Creek and M17 Creek contained marginal fish habitat. Habitat for most fish life-history stages were limited by shallow water depth and ephemeral flow.

Potential fish habitat offsetting sites were surveyed in the Murray River LSA in 2012 and 2013. A total of seven potential sites were surveyed for fish and fish habitat. Site CS1 was selected as the primary site for fish habitat offsetting for the Project.

Community, relative abundance, and fish biological data were collected in 2004, 2005, 2011, 2012, and 2013. Slimy Sculpin, Arctic Grayling, Mountain Whitefish, and Bull Trout were most abundant within the Infrastructure Investigation Area and LSA. Burbot and Northern Pike were most abundant at site CS1.

Biological datasets were developed and analysed for Slimy Sculpin and Finescale Dace. For both species, mean fish length was consistent between sites and among sampling years. Length-frequency histograms developed for Slimy Sculpin generally showed a bi-modal distribution, while Finescale Dace histograms were uni-modal. Weight-length regressions calculated for Slimy Sculpin and Finescale Dace showed a significant relationship between weight and length, with adjusted r^2 values ranging from 0.72 to 0.99. Condition (as the slope of weight-length regressions) for Slimy Sculpin and Finescale Dace were also consistent among sampling sites and years.

Fish tissue metals data were collected from the Project area in four years from 2004 to 2012. In 2012, Slimy Sculpin and Bull Trout were sampled for tissue metal concentrations to expand upon existing baseline data. Mercury concentrations in Slimy Sculpin from all sites sampled in all years were lower than the Health Canada guideline of 0.50 mg/kg ww for maximum total mercury in fish tissue (CCME 1999; Health Canada 2011). Mercury concentrations in Slimy Sculpin tissues were highest at sites located on the main stem of the Murray River and lowest in tributary stream sites. Slimy Sculpin Selenium showed opposite trends relative to mercury. Mean selenium concentrations in Slimy Sculpin were highest at tributary sites and lowest at Murray River mainstem sites. Mean selenium concentrations for whole-body Slimy Sculpin exceeded the provincial draft guideline of 4 mg/kg dw at several sites along the Murray River and at tributary streams within the LSA.

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Appendix 1
FHAP Survey Form

ERM

Murray River Project
FHAP Survey Form

Station ID: ____________ Survey Date (d/m/y): ______________________________ Coordinates: D/S ____ gps ____ Coordinates: U/S ____ gps ____

____________ Survey Crew: ______________________________

Survey Distance (m) ____________

Temperature (°C): ____________ Transparency: ____________ Comments

Channel Velocity (m/s): ____________ Conductivity (uS/cm): ____________

Current Flow Conditions: ____________ pH: ____________ Weather:

Discharge estimate (m^3/s) ____________

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m)		Width (m)		Bed Material					Pool Info			Fish Passage Barriers	
					Mean	Bank-full	Mean	Bank-full	Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Type	Depth (m) Max	Depth (m) Crest	Type	T/P
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow

Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2

Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden

Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed

Pool Type S = scour, D = dammed, U = unknown

Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)

Fish Passage Barriers IF = Impassible waterfall
BF = Boulder Field, passage through the boulder arrangement is not possible for fish
D = dry channel, no stream flow
NC = no distinct channel, water drains over land
N = no barrier to fish passage through the habitat unit

T/P T = temporary, portion of open water season
P = Permanent, all year round

Overall Rating

Spawning: ________ Rearing: ________ Adult Feeding: ________ Over-wintering: ________ Migration: ________

Murray River Project
FHAP Survey Form

Station ID: ____________________

Hab Unit No.	Banks of Channel				Instream Cover							Photos (Role #) (Photo #)	Comments	Riparian Cover		
	L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %			Canopy %	LB %	RB %
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Appendix 2
Quality Control Results

Appendix 2a. Quality Control Results, 2012

Appendix 2b. Quality Control Results, 2011

Appendix 2c. Quality Control Results, 2004 (Quintette Project)

Appendix 2d. Quality Control Results, 2004 (Hermann Project)

ERM

Appendix 2a. Quality Control Results 2012

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	CRM	Arsenic (As)-Total	WG1585172-6	VA-NRC-TORT2	21.8	21.6	mg/kg wwt	100.8	70-130	
Tissue	CRM	Arsenic (As)-Total	WG1585172-7	VA-NRC-DOLT4	9.99	9.66	mg/kg wwt	103.4	70-130	
Tissue	CRM	Arsenic (As)-Total	WG1585173-4	VA-NRC-TORT2	22.1	21.6	mg/kg wwt	102.5	70-130	
Tissue	CRM	Arsenic (As)-Total	WG1585173-5	VA-NRC-DOLT4	9.70	9.66	mg/kg wwt	100.4	70-130	
Tissue	CRM	Cadmium (Cd)-Total	WG1585172-6	VA-NRC-TORT2	28.5	26.7	mg/kg wwt	106.9	70-130	
Tissue	CRM	Cadmium (Cd)-Total	WG1585172-7	VA-NRC-DOLT4	26.3	24.3	mg/kg wwt	108.3	70-130	
Tissue	CRM	Cadmium (Cd)-Total	WG1585173-4	VA-NRC-TORT2	28.4	26.7	mg/kg wwt	106.4	70-130	
Tissue	CRM	Cadmium (Cd)-Total	WG1585173-5	VA-NRC-DOLT4	25.5	24.3	mg/kg wwt	105.0	70-130	
Tissue	CRM	Calcium (Ca)-Total	WG1585172-7	VA-NRC-DOLT4	684	680	mg/kg wwt	100.7	70-130	
Tissue	CRM	Calcium (Ca)-Total	WG1585173-5	VA-NRC-DOLT4	640	680	mg/kg wwt	94.1	70-130	
Tissue	CRM	Chromium (Cr)-Total	WG1585172-6	VA-NRC-TORT2	0.60	0.77	mg/kg wwt	77.3	70-130	
Tissue	CRM	Chromium (Cr)-Total	WG1585172-7	VA-NRC-DOLT4	1.10	1.40	mg/kg wwt	1.10	.9-1.9	
Tissue	CRM	Chromium (Cr)-Total	WG1585173-4	VA-NRC-TORT2	0.57	0.77	mg/kg wwt	74.3	70-130	
Tissue	CRM	Chromium (Cr)-Total	WG1585173-5	VA-NRC-DOLT4	1.23	1.40	mg/kg wwt	1.23	.9-1.9	
Tissue	CRM	Cobalt (Co)-Total	WG1585172-6	VA-NRC-TORT2	0.541	0.510	mg/kg wwt	106.1	70-130	
Tissue	CRM	Cobalt (Co)-Total	WG1585172-7	VA-NRC-DOLT4	0.250	0.250	mg/kg wwt	0.250	.15-.35	
Tissue	CRM	Cobalt (Co)-Total	WG1585173-4	VA-NRC-TORT2	0.523	0.510	mg/kg wwt	102.5	70-130	
Tissue	CRM	Cobalt (Co)-Total	WG1585173-5	VA-NRC-DOLT4	0.239	0.250	mg/kg wwt	0.239	.15-.35	
Tissue	CRM	Copper (Cu)-Total	WG1585172-6	VA-NRC-TORT2	106	106	mg/kg wwt	99.9	70-130	
Tissue	CRM	Copper (Cu)-Total	WG1585172-7	VA-NRC-DOLT4	34.1	31.2	mg/kg wwt	109.3	70-130	
Tissue	CRM	Copper (Cu)-Total	WG1585173-4	VA-NRC-TORT2	105	106	mg/kg wwt	99.1	70-130	
Tissue	CRM	Copper (Cu)-Total	WG1585173-5	VA-NRC-DOLT4	33.2	31.2	mg/kg wwt	106.4	70-130	
Tissue	CRM	Iron (Fe)-Total	WG1585172-6	VA-NRC-TORT2	109	105	mg/kg wwt	103.9	70-130	
Tissue	CRM	Iron (Fe)-Total	WG1585172-7	VA-NRC-DOLT4	2080	1830	mg/kg wwt	113.7	70-130	
Tissue	CRM	Iron (Fe)-Total	WG1585173-4	VA-NRC-TORT2	92.9	105	mg/kg wwt	88.5	70-130	
Tissue	CRM	Iron (Fe)-Total	WG1585173-5	VA-NRC-DOLT4	1660	1830	mg/kg wwt	90.7	70-130	
Tissue	CRM	Lead (Pb)-Total	WG1585172-6	VA-NRC-TORT2	0.331	0.350	mg/kg wwt	0.331	.15-.55	
Tissue	CRM	Lead (Pb)-Total	WG1585172-7	VA-NRC-DOLT4	0.221	0.160	mg/kg wwt	0.221	.06-.26	
Tissue	CRM	Lead (Pb)-Total	WG1585173-4	VA-NRC-TORT2	0.319	0.350	mg/kg wwt	0.319	.15-.55	
Tissue	CRM	Lead (Pb)-Total	WG1585173-5	VA-NRC-DOLT4	0.139	0.160	mg/kg wwt	0.139	.06-.26	
Tissue	CRM	Magnesium (Mg)-Total	WG1585172-7	VA-NRC-DOLT4	1550	1500	mg/kg wwt	103.3	70-130	
Tissue	CRM	Magnesium (Mg)-Total	WG1585173-5	VA-NRC-DOLT4	1440	1500	mg/kg wwt	95.8	70-130	
Tissue	CRM	Manganese (Mn)-Total	WG1585172-6	VA-NRC-TORT2	13.4	13.6	mg/kg wwt	98.6	70-130	
Tissue	CRM	Manganese (Mn)-Total	WG1585173-4	VA-NRC-TORT2	13.3	13.6	mg/kg wwt	98.2	70-130	
Tissue	CRM	Mercury (Hg)-Total	WG1585172-6	VA-NRC-TORT2	0.331	0.270	mg/kg wwt	122.5	70-130	
Tissue	CRM	Mercury (Hg)-Total	WG1585172-7	VA-NRC-DOLT4	1.85	2.58	mg/kg wwt	71.8	70-130	
Tissue	CRM	Mercury (Hg)-Total	WG1585173-4	VA-NRC-TORT2	0.254	0.270	mg/kg wwt	93.9	70-130	
Tissue	CRM	Mercury (Hg)-Total	WG1585173-5	VA-NRC-DOLT4	2.09	2.58	mg/kg wwt	81.0	70-130	
Tissue	CRM	Molybdenum (Mo)-Total	WG1585172-6	VA-NRC-TORT2	1.01	0.950	mg/kg wwt	105.8	70-130	
Tissue	CRM	Molybdenum (Mo)-Total	WG1585172-7	VA-NRC-DOLT4	1.14	1.00	mg/kg wwt	113.9	70-130	
Tissue	CRM	Molybdenum (Mo)-Total	WG1585173-4	VA-NRC-TORT2	0.971	0.950	mg/kg wwt	102.2	70-130	
Tissue	CRM	Molybdenum (Mo)-Total	WG1585173-5	VA-NRC-DOLT4	1.06	1.00	mg/kg wwt	106.1	70-130	
Tissue	CRM	Nickel (Ni)-Total	WG1585172-6	VA-NRC-TORT2	2.58	2.50	mg/kg wwt	103.0	70-130	
Tissue	CRM	Nickel (Ni)-Total	WG1585172-7	VA-NRC-DOLT4	0.83	0.97	mg/kg wwt	0.83	.47-1.47	
Tissue	CRM	Nickel (Ni)-Total	WG1585173-4	VA-NRC-TORT2	2.32	2.50	mg/kg wwt	92.8	70-130	
Tissue	CRM	Nickel (Ni)-Total	WG1585173-5	VA-NRC-DOLT4	0.90	0.97	mg/kg wwt	0.90	.47-1.47	
Tissue	CRM	Potassium (K)-Total	WG1585172-7	VA-NRC-DOLT4	10900	9800	mg/kg wwt	111.4	70-130	
Tissue	CRM	Potassium (K)-Total	WG1585173-5	VA-NRC-DOLT4	8960	9800	mg/kg wwt	91.5	70-130	
Tissue	CRM	Selenium (Se)-Total	WG1585172-6	VA-NRC-TORT2	6.24	5.63	mg/kg wwt	110.9	70-130	
Tissue	CRM	Selenium (Se)-Total	WG1585172-7	VA-NRC-DOLT4	10.3	8.30	mg/kg wwt	123.9	70-130	
Tissue	CRM	Selenium (Se)-Total	WG1585173-4	VA-NRC-TORT2	6.41	5.63	mg/kg wwt	113.9	70-130	
Tissue	CRM	Selenium (Se)-Total	WG1585173-5	VA-NRC-DOLT4	9.74	8.30	mg/kg wwt	117.3	70-130	
Tissue	CRM	Sodium (Na)-Total	WG1585172-7	VA-NRC-DOLT4	7570	6800	mg/kg wwt	111.4	70-130	
Tissue	CRM	Sodium (Na)-Total	WG1585173-5	VA-NRC-DOLT4	6280	6800	mg/kg wwt	92.4	70-130	
Tissue	CRM	Strontium (Sr)-Total	WG1585172-6	VA-NRC-TORT2	41.1	45.2	mg/kg wwt	91.0	70-130	
Tissue	CRM	Strontium (Sr)-Total	WG1585172-7	VA-NRC-DOLT4	5.57	5.50	mg/kg wwt	101.3	70-130	
Tissue	CRM	Strontium (Sr)-Total	WG1585173-4	VA-NRC-TORT2	38.4	45.2	mg/kg wwt	85.0	70-130	
Tissue	CRM	Strontium (Sr)-Total	WG1585173-5	VA-NRC-DOLT4	5.25	5.50	mg/kg wwt	95.5	70-130	
Tissue	CRM	Tin (Sn)-Total	WG1585172-7	VA-NRC-DOLT4	0.179	0.170	mg/kg wwt	105.1	70-130	

Appendix 2a. Quality Control Results 2012

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	CRM	Tin (Sn)-Total	WG1585173-5	VA-NRC-DOLT4	0.160	0.170	mg/kg wwt	94.3	70-130	
Tissue	CRM	Vanadium (V)-Total	WG1585172-6	VA-NRC-TORT2	1.83	1.64	mg/kg wwt	1.83	1.14-2.14	
Tissue	CRM	Vanadium (V)-Total	WG1585173-4	VA-NRC-TORT2	1.84	1.64	mg/kg wwt	1.84	1.14-2.14	
Tissue	CRM	Vanadium (V)-Total	WG1585173-5	VA-NRC-DOLT4	0.60	0.60	mg/kg wwt	100.6	70-130	
Tissue	CRM	Zinc (Zn)-Total	WG1585172-6	VA-NRC-TORT2	182	180	mg/kg wwt	101.0	70-130	
Tissue	CRM	Zinc (Zn)-Total	WG1585172-7	VA-NRC-DOLT4	125	116	mg/kg wwt	108.0	70-130	
Tissue	CRM	Zinc (Zn)-Total	WG1585173-4	VA-NRC-TORT2	181	180	mg/kg wwt	100.3	70-130	
Tissue	CRM	Zinc (Zn)-Total	WG1585173-5	VA-NRC-DOLT4	122	116	mg/kg wwt	105.3	70-130	
Tissue	MB	Aluminum (Al)-Total	WG1585172-1		<2.0	<2	mg/kg wwt	-	2	
Tissue	MB	Aluminum (Al)-Total	WG1585172-2		<2.0	<2	mg/kg wwt	-	2	
Tissue	MB	Aluminum (Al)-Total	WG1585172-3		<2.0	<2	mg/kg wwt	-	2	
Tissue	MB	Aluminum (Al)-Total	WG1585173-1		<2.0	<2	mg/kg wwt	-	2	
Tissue	MB	Aluminum (Al)-Total	WG1585173-2		<2.0	<2	mg/kg wwt	-	2	
Tissue	MB	Antimony (Sb)-Total	WG1585172-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Antimony (Sb)-Total	WG1585172-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Antimony (Sb)-Total	WG1585172-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Antimony (Sb)-Total	WG1585173-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Antimony (Sb)-Total	WG1585173-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Arsenic (As)-Total	WG1585172-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Arsenic (As)-Total	WG1585172-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Arsenic (As)-Total	WG1585172-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Arsenic (As)-Total	WG1585173-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Arsenic (As)-Total	WG1585173-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1585172-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1585172-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1585172-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1585173-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1585173-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Beryllium (Be)-Total	WG1585172-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Beryllium (Be)-Total	WG1585172-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Beryllium (Be)-Total	WG1585172-3		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Beryllium (Be)-Total	WG1585173-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Beryllium (Be)-Total	WG1585173-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Bismuth (Bi)-Total	WG1585172-1		<0.030	<0.03	mg/kg wwt	-	0.03	
Tissue	MB	Bismuth (Bi)-Total	WG1585172-2		<0.030	<0.03	mg/kg wwt	-	0.03	
Tissue	MB	Bismuth (Bi)-Total	WG1585172-3		<0.030	<0.03	mg/kg wwt	-	0.03	
Tissue	MB	Bismuth (Bi)-Total	WG1585173-1		<0.030	<0.03	mg/kg wwt	-	0.03	
Tissue	MB	Bismuth (Bi)-Total	WG1585173-2		<0.030	<0.03	mg/kg wwt	-	0.03	
Tissue	MB	Cadmium (Cd)-Total	WG1585172-1		<0.0050	<0.005	mg/kg wwt	-	0.005	
Tissue	MB	Cadmium (Cd)-Total	WG1585172-2		<0.0050	<0.005	mg/kg wwt	-	0.005	
Tissue	MB	Cadmium (Cd)-Total	WG1585172-3		<0.0050	<0.005	mg/kg wwt	-	0.005	
Tissue	MB	Cadmium (Cd)-Total	WG1585173-1		<0.0050	<0.005	mg/kg wwt	-	0.005	
Tissue	MB	Cadmium (Cd)-Total	WG1585173-2		<0.0050	<0.005	mg/kg wwt	-	0.005	
Tissue	MB	Calcium (Ca)-Total	WG1585172-1		<2.0	<2	mg/kg wwt	-	2	
Tissue	MB	Calcium (Ca)-Total	WG1585172-2		<2.0	<2	mg/kg wwt	-	2	
Tissue	MB	Calcium (Ca)-Total	WG1585172-3		2.6	<2	mg/kg wwt	-	2	MB-LOR
Tissue	MB	Calcium (Ca)-Total	WG1585173-1		<2.0	<2	mg/kg wwt	-	2	
Tissue	MB	Calcium (Ca)-Total	WG1585173-2		<2.0	<2	mg/kg wwt	-	2	
Tissue	MB	Chromium (Cr)-Total	WG1585172-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Chromium (Cr)-Total	WG1585172-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Chromium (Cr)-Total	WG1585172-3		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Chromium (Cr)-Total	WG1585173-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Chromium (Cr)-Total	WG1585173-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Cobalt (Co)-Total	WG1585172-1		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Cobalt (Co)-Total	WG1585172-2		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Cobalt (Co)-Total	WG1585172-3		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Cobalt (Co)-Total	WG1585173-1		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Cobalt (Co)-Total	WG1585173-2		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Copper (Cu)-Total	WG1585172-1		<0.010	<0.01	mg/kg wwt	-	0.01	

Appendix 2a. Quality Control Results 2012

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	MB	Copper (Cu)-Total	WG1585172-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Copper (Cu)-Total	WG1585172-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Copper (Cu)-Total	WG1585173-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Copper (Cu)-Total	WG1585173-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Iron (Fe)-Total	WG1585172-1		<2.0	<2	mg/kg wwt	-	2	
Tissue	MB	Iron (Fe)-Total	WG1585172-2		<2.0	<2	mg/kg wwt	-	2	
Tissue	MB	Iron (Fe)-Total	WG1585172-3		<2.0	<2	mg/kg wwt	-	2	
Tissue	MB	Iron (Fe)-Total	WG1585173-1		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Iron (Fe)-Total	WG1585173-2		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Lead (Pb)-Total	WG1585172-1		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Lead (Pb)-Total	WG1585172-2		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Lead (Pb)-Total	WG1585172-3		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Lead (Pb)-Total	WG1585173-1		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Lead (Pb)-Total	WG1585173-2		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Lithium (Li)-Total	WG1585172-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Lithium (Li)-Total	WG1585172-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Lithium (Li)-Total	WG1585172-3		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Lithium (Li)-Total	WG1585173-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Lithium (Li)-Total	WG1585173-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Magnesium (Mg)-Total	WG1585172-1		<1.0	<1	mg/kg wwt	-	1	
Tissue	MB	Magnesium (Mg)-Total	WG1585172-2		<1.0	<1	mg/kg wwt	-	1	
Tissue	MB	Magnesium (Mg)-Total	WG1585172-3		<1.0	<1	mg/kg wwt	-	1	
Tissue	MB	Magnesium (Mg)-Total	WG1585173-1		<1.0	<1	mg/kg wwt	-	1	
Tissue	MB	Magnesium (Mg)-Total	WG1585173-2		<1.0	<1	mg/kg wwt	-	1	
Tissue	MB	Manganese (Mn)-Total	WG1585172-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Manganese (Mn)-Total	WG1585172-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Manganese (Mn)-Total	WG1585172-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Manganese (Mn)-Total	WG1585173-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Manganese (Mn)-Total	WG1585173-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Mercury (Hg)-Total	WG1585172-1		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Mercury (Hg)-Total	WG1585172-2		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Mercury (Hg)-Total	WG1585172-3		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Mercury (Hg)-Total	WG1585173-1		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Mercury (Hg)-Total	WG1585173-2		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Molybdenum (Mo)-Total	WG1585172-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Molybdenum (Mo)-Total	WG1585172-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Molybdenum (Mo)-Total	WG1585172-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Molybdenum (Mo)-Total	WG1585173-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Molybdenum (Mo)-Total	WG1585173-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Nickel (Ni)-Total	WG1585172-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Nickel (Ni)-Total	WG1585172-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Nickel (Ni)-Total	WG1585172-3		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Nickel (Ni)-Total	WG1585173-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Nickel (Ni)-Total	WG1585173-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Phosphorus (P)-Total	WG1585172-1		<50	<50	mg/kg wwt	-	50	
Tissue	MB	Phosphorus (P)-Total	WG1585172-2		<50	<50	mg/kg wwt	-	50	
Tissue	MB	Phosphorus (P)-Total	WG1585172-3		<50	<50	mg/kg wwt	-	50	
Tissue	MB	Phosphorus (P)-Total	WG1585173-1		<5.0	<5	mg/kg wwt	-	5	
Tissue	MB	Phosphorus (P)-Total	WG1585173-2		<5.0	<5	mg/kg wwt	-	5	
Tissue	MB	Potassium (K)-Total	WG1585172-1		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Potassium (K)-Total	WG1585172-2		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Potassium (K)-Total	WG1585172-3		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Potassium (K)-Total	WG1585173-1		<20	<20	mg/kg wwt	-	20	
Tissue	MB	Potassium (K)-Total	WG1585173-2		<20	<20	mg/kg wwt	-	20	
Tissue	MB	Selenium (Se)-Total	WG1585172-1		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Selenium (Se)-Total	WG1585172-2		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Selenium (Se)-Total	WG1585172-3		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Selenium (Se)-Total	WG1585173-1		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Selenium (Se)-Total	WG1585173-2		<0.20	<0.2	mg/kg wwt	-	0.2	

Appendix 2a. Quality Control Results 2012

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	MB	Sodium (Na)-Total	WG1585172-1		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Sodium (Na)-Total	WG1585172-2		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Sodium (Na)-Total	WG1585172-3		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Sodium (Na)-Total	WG1585173-1		<20	<20	mg/kg wwt	-	20	
Tissue	MB	Sodium (Na)-Total	WG1585173-2		<20	<20	mg/kg wwt	-	20	
Tissue	MB	Strontium (Sr)-Total	WG1585172-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Strontium (Sr)-Total	WG1585172-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Strontium (Sr)-Total	WG1585172-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Strontium (Sr)-Total	WG1585173-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Strontium (Sr)-Total	WG1585173-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Thallium (Tl)-Total	WG1585172-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Thallium (Tl)-Total	WG1585172-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Thallium (Tl)-Total	WG1585172-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Thallium (Tl)-Total	WG1585173-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Thallium (Tl)-Total	WG1585173-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Tin (Sn)-Total	WG1585172-1		<0.050	<0.05	mg/kg wwt	-	0.05	
Tissue	MB	Tin (Sn)-Total	WG1585172-2		<0.050	<0.05	mg/kg wwt	-	0.05	
Tissue	MB	Tin (Sn)-Total	WG1585172-3		<0.050	<0.05	mg/kg wwt	-	0.05	
Tissue	MB	Tin (Sn)-Total	WG1585173-1		<0.050	<0.05	mg/kg wwt	-	0.05	
Tissue	MB	Tin (Sn)-Total	WG1585173-2		<0.050	<0.05	mg/kg wwt	-	0.05	
Tissue	MB	Titanium (Ti)-Total	WG1585172-1		<1.0	<1	mg/kg wwt	-	1	
Tissue	MB	Titanium (Ti)-Total	WG1585172-2		<1.0	<1	mg/kg wwt	-	1	
Tissue	MB	Titanium (Ti)-Total	WG1585172-3		<1.0	<1	mg/kg wwt	-	1	
Tissue	MB	Titanium (Ti)-Total	WG1585173-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Titanium (Ti)-Total	WG1585173-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Uranium (U)-Total	WG1585172-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Uranium (U)-Total	WG1585172-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Uranium (U)-Total	WG1585172-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Uranium (U)-Total	WG1585173-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Uranium (U)-Total	WG1585173-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Vanadium (V)-Total	WG1585172-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Vanadium (V)-Total	WG1585172-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Vanadium (V)-Total	WG1585172-3		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Vanadium (V)-Total	WG1585173-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Vanadium (V)-Total	WG1585173-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zinc (Zn)-Total	WG1585172-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zinc (Zn)-Total	WG1585172-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zinc (Zn)-Total	WG1585172-3		0.13	<0.1	mg/kg wwt	-	0.1	MB-LOR
Tissue	MB	Zinc (Zn)-Total	WG1585173-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zinc (Zn)-Total	WG1585173-2		<0.10	<0.1	mg/kg wwt	-	0.1	

QC Type

CRM = Comparison with Reference Material

MB = Method Blank

MB-LOR = Method Blank exceeds ALS DQO. LORs adjusted for samples with positive hits below 5 times blank level. Please contact ALS if re-analysis is required.

% = Percent Recovery. Applicable to LCS, RM, and MS samples only.

Reference refers to the source of the QC sample.

For Reference Materials, the ID of the RM is provided.

Appendix 2b. Quality Control Results 2011

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	CRM	Arsenic (As)-Total	WG1445247-6	VA-NRC-TORT2	23.9	21.6	mg/kg wwt	110.9	70-130	
Tissue	CRM	Arsenic (As)-Total	WG1445247-7	VA-NRC-DOLT4	10.2	9.66	mg/kg wwt	105.6	70-130	
Tissue	CRM	Cadmium (Cd)-Total	WG1445247-6	VA-NRC-TORT2	32.2	26.7	mg/kg wwt	120.8	70-130	
Tissue	CRM	Cadmium (Cd)-Total	WG1445247-7	VA-NRC-DOLT4	26.3	24.3	mg/kg wwt	108.3	70-130	
Tissue	CRM	Calcium (Ca)-Total	WG1445247-7	VA-NRC-DOLT4	757	680	mg/kg wwt	111.3	70-130	
Tissue	CRM	Chromium (Cr)-Total	WG1445247-6	VA-NRC-TORT2	0.639	0.770	mg/kg wwt	82.9	70-130	
Tissue	CRM	Chromium (Cr)-Total	WG1445247-7	VA-NRC-DOLT4	1.17	1.40	mg/kg wwt	83.9	70-130	
Tissue	CRM	Cobalt (Co)-Total	WG1445247-6	VA-NRC-TORT2	0.582	0.510	mg/kg wwt	114.1	70-130	
Tissue	CRM	Cobalt (Co)-Total	WG1445247-7	VA-NRC-DOLT4	0.250	0.250	mg/kg wwt	99.9	70-130	
Tissue	CRM	Copper (Cu)-Total	WG1445247-6	VA-NRC-TORT2	112	106	mg/kg wwt	105.2	70-130	
Tissue	CRM	Copper (Cu)-Total	WG1445247-7	VA-NRC-DOLT4	33.9	31.2	mg/kg wwt	108.8	70-130	
Tissue	CRM	Iron (Fe)-Total	WG1445247-6	VA-NRC-TORT2	111	105	mg/kg wwt	105.3	70-130	
Tissue	CRM	Iron (Fe)-Total	WG1445247-7	VA-NRC-DOLT4	1860	1830	mg/kg wwt	101.4	70-130	
Tissue	CRM	Lead (Pb)-Total	WG1445247-6	VA-NRC-TORT2	0.331	0.350	mg/kg wwt	94.6	70-130	
Tissue	CRM	Lead (Pb)-Total	WG1445247-7	VA-NRC-DOLT4	0.207	0.160	mg/kg wwt	129.3	70-130	
Tissue	CRM	Magnesium (Mg)-Total	WG1445247-7	VA-NRC-DOLT4	1570	1500	mg/kg wwt	104.6	70-130	
Tissue	CRM	Manganese (Mn)-Total	WG1445247-6	VA-NRC-TORT2	14.5	13.6	mg/kg wwt	106.4	70-130	
Tissue	CRM	Mercury (Hg)-Total	WG1445247-6	VA-NRC-TORT2	0.291	0.270	mg/kg wwt	107.9	70-130	
Tissue	CRM	Mercury (Hg)-Total	WG1445247-7	VA-NRC-DOLT4	2.54	2.58	mg/kg wwt	98.6	70-130	
Tissue	CRM	Molybdenum (Mo)-Total	WG1445247-6	VA-NRC-TORT2	1.12	0.950	mg/kg wwt	118.2	70-130	
Tissue	CRM	Molybdenum (Mo)-Total	WG1445247-7	VA-NRC-DOLT4	1.14	1.00	mg/kg wwt	113.8	70-130	
Tissue	CRM	Nickel (Ni)-Total	WG1445247-6	VA-NRC-TORT2	2.58	2.50	mg/kg wwt	103.0	70-130	
Tissue	CRM	Nickel (Ni)-Total	WG1445247-7	VA-NRC-DOLT4	0.943	0.970	mg/kg wwt	97.2	70-130	
Tissue	CRM	Potassium (K)-Total	WG1445247-7	VA-NRC-DOLT4	11000	9800	mg/kg wwt	112.2	70-130	
Tissue	CRM	Selenium (Se)-Total	WG1445247-6	VA-NRC-TORT2	6.28	5.63	mg/kg wwt	111.6	70-130	
Tissue	CRM	Selenium (Se)-Total	WG1445247-7	VA-NRC-DOLT4	8.96	8.30	mg/kg wwt	108.0	70-130	
Tissue	CRM	Sodium (Na)-Total	WG1445247-7	VA-NRC-DOLT4	7660	6800	mg/kg wwt	112.7	70-130	
Tissue	CRM	Strontium (Sr)-Total	WG1445247-6	VA-NRC-TORT2	52.0	45.2	mg/kg wwt	115.1	70-130	
Tissue	CRM	Strontium (Sr)-Total	WG1445247-7	VA-NRC-DOLT4	5.29	5.50	mg/kg wwt	96.3	70-130	
Tissue	CRM	Tin (Sn)-Total	WG1445247-7	VA-NRC-DOLT4	0.192	0.170	mg/kg wwt	112.7	70-130	
Tissue	CRM	Vanadium (V)-Total	WG1445247-6	VA-NRC-TORT2	2.02	1.64	mg/kg wwt	123.4	70-130	
Tissue	CRM	Vanadium (V)-Total	WG1445247-7	VA-NRC-DOLT4	0.711	0.600	mg/kg wwt	118.5	70-130	
Tissue	CRM	Zinc (Zn)-Total	WG1445247-6	VA-NRC-TORT2	206	180	mg/kg wwt	114.7	70-130	
Tissue	CRM	Zinc (Zn)-Total	WG1445247-7	VA-NRC-DOLT4	131	116	mg/kg wwt	112.8	70-130	
Tissue	MB	Aluminum (Al)-Total	WG1445247-1		<0.40	<0.4	mg/kg wwt	-	0.4	
Tissue	MB	Aluminum (Al)-Total	WG1445247-2		<0.40	<0.4	mg/kg wwt	-	0.4	
Tissue	MB	Aluminum (Al)-Total	WG1445247-3		<0.40	<0.4	mg/kg wwt	-	0.4	
Tissue	MB	Antimony (Sb)-Total	WG1445247-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Antimony (Sb)-Total	WG1445247-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Antimony (Sb)-Total	WG1445247-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Arsenic (As)-Total	WG1445247-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Arsenic (As)-Total	WG1445247-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Arsenic (As)-Total	WG1445247-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Barium (Ba)-Total	WG1445247-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1445247-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1445247-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Beryllium (Be)-Total	WG1445247-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Beryllium (Be)-Total	WG1445247-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Beryllium (Be)-Total	WG1445247-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Bismuth (Bi)-Total	WG1445247-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Bismuth (Bi)-Total	WG1445247-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Bismuth (Bi)-Total	WG1445247-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Boron (B)-Total	WG1445247-1		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Boron (B)-Total	WG1445247-2		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Boron (B)-Total	WG1445247-3		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Cadmium (Cd)-Total	WG1445247-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Cadmium (Cd)-Total	WG1445247-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Cadmium (Cd)-Total	WG1445247-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Calcium (Ca)-Total	WG1445247-1		<5.0	<5	mg/kg wwt	-	5	

Appendix 2b. Quality Control Results 2011

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	MB	Calcium (Ca)-Total	WG1445247-2		<5.0	<5	mg/kg wwt	-	5	
Tissue	MB	Calcium (Ca)-Total	WG1445247-3		<5.0	<5	mg/kg wwt	-	5	
Tissue	MB	Cesium (Cs)-Total	WG1445247-1		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Cesium (Cs)-Total	WG1445247-2		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Cesium (Cs)-Total	WG1445247-3		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Chromium (Cr)-Total	WG1445247-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Chromium (Cr)-Total	WG1445247-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Chromium (Cr)-Total	WG1445247-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Cobalt (Co)-Total	WG1445247-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Cobalt (Co)-Total	WG1445247-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Cobalt (Co)-Total	WG1445247-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Copper (Cu)-Total	WG1445247-1		0.039	<0.01	mg/kg wwt	-	0.01	MB-LOR
Tissue	MB	Copper (Cu)-Total	WG1445247-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Copper (Cu)-Total	WG1445247-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Gallium (Ga)-Total	WG1445247-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Gallium (Ga)-Total	WG1445247-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Gallium (Ga)-Total	WG1445247-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Iron (Fe)-Total	WG1445247-1		6.36	<0.2	mg/kg wwt	-	0.2	MB-LOR
Tissue	MB	Iron (Fe)-Total	WG1445247-2		0.61	<0.2	mg/kg wwt	-	0.2	MB-LOR
Tissue	MB	Iron (Fe)-Total	WG1445247-3		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Lead (Pb)-Total	WG1445247-1		0.0046	<0.004	mg/kg wwt	-	0.004	MB-LOR
Tissue	MB	Lead (Pb)-Total	WG1445247-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Lead (Pb)-Total	WG1445247-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Lithium (Li)-Total	WG1445247-1		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Lithium (Li)-Total	WG1445247-2		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Lithium (Li)-Total	WG1445247-3		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Magnesium (Mg)-Total	WG1445247-1		<10	<10	mg/kg wwt	-	10	
Tissue	MB	Magnesium (Mg)-Total	WG1445247-2		<10	<10	mg/kg wwt	-	10	
Tissue	MB	Magnesium (Mg)-Total	WG1445247-3		<10	<10	mg/kg wwt	-	10	
Tissue	MB	Manganese (Mn)-Total	WG1445247-1		0.0526	<0.004	mg/kg wwt	-	0.004	MB-LOR
Tissue	MB	Manganese (Mn)-Total	WG1445247-2		0.0045	<0.004	mg/kg wwt	-	0.004	MB-LOR
Tissue	MB	Manganese (Mn)-Total	WG1445247-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Mercury (Hg)-Total	WG1445247-1		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Mercury (Hg)-Total	WG1445247-2		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Mercury (Hg)-Total	WG1445247-3		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Molybdenum (Mo)-Total	WG1445247-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Molybdenum (Mo)-Total	WG1445247-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Molybdenum (Mo)-Total	WG1445247-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Nickel (Ni)-Total	WG1445247-1		0.020	<0.01	mg/kg wwt	-	0.01	MB-LOR
Tissue	MB	Nickel (Ni)-Total	WG1445247-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Nickel (Ni)-Total	WG1445247-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Phosphorus (P)-Total	WG1445247-1		<50	<50	mg/kg wwt	-	50	
Tissue	MB	Phosphorus (P)-Total	WG1445247-2		<50	<50	mg/kg wwt	-	50	
Tissue	MB	Phosphorus (P)-Total	WG1445247-3		<50	<50	mg/kg wwt	-	50	
Tissue	MB	Potassium (K)-Total	WG1445247-1		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Potassium (K)-Total	WG1445247-2		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Potassium (K)-Total	WG1445247-3		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Rhenium (Re)-Total	WG1445247-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Rhenium (Re)-Total	WG1445247-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Rhenium (Re)-Total	WG1445247-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Rubidium (Rb)-Total	WG1445247-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Rubidium (Rb)-Total	WG1445247-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Rubidium (Rb)-Total	WG1445247-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Selenium (Se)-Total	WG1445247-1		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Selenium (Se)-Total	WG1445247-2		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Selenium (Se)-Total	WG1445247-3		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Sodium (Na)-Total	WG1445247-1		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Sodium (Na)-Total	WG1445247-2		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Sodium (Na)-Total	WG1445247-3		<200	<200	mg/kg wwt	-	200	

Appendix 2b. Quality Control Results 2011

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	MB	Strontium (Sr)-Total	WG1445247-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Strontium (Sr)-Total	WG1445247-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Strontium (Sr)-Total	WG1445247-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Tellurium (Te)-Total	WG1445247-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tellurium (Te)-Total	WG1445247-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tellurium (Te)-Total	WG1445247-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Thallium (Tl)-Total	WG1445247-1		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Thallium (Tl)-Total	WG1445247-2		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Thallium (Tl)-Total	WG1445247-3		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Thorium (Th)-Total	WG1445247-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Thorium (Th)-Total	WG1445247-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Thorium (Th)-Total	WG1445247-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Tin (Sn)-Total	WG1445247-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tin (Sn)-Total	WG1445247-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tin (Sn)-Total	WG1445247-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Titanium (Ti)-Total	WG1445247-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Titanium (Ti)-Total	WG1445247-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Titanium (Ti)-Total	WG1445247-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Uranium (U)-Total	WG1445247-1		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Uranium (U)-Total	WG1445247-2		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Uranium (U)-Total	WG1445247-3		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Vanadium (V)-Total	WG1445247-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Vanadium (V)-Total	WG1445247-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Vanadium (V)-Total	WG1445247-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Yttrium (Y)-Total	WG1445247-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Yttrium (Y)-Total	WG1445247-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Yttrium (Y)-Total	WG1445247-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Zinc (Zn)-Total	WG1445247-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zinc (Zn)-Total	WG1445247-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zinc (Zn)-Total	WG1445247-3		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zirconium (Zr)-Total	WG1445247-1		<0.040	<0.04	mg/kg wwt	-	0.04	
Tissue	MB	Zirconium (Zr)-Total	WG1445247-2		<0.040	<0.04	mg/kg wwt	-	0.04	
Tissue	MB	Zirconium (Zr)-Total	WG1445247-3		<0.040	<0.04	mg/kg wwt	-	0.04	

QC Type

CRM = Comparison with Reference Material

MB = Method Blank

MB-LOR = Method Blank exceeds ALS DQO. LORs adjusted for samples with positive hits below 5 times blank level. Please contact ALS if re-analysis is required.

% = Percent Recovery. Applicable to LCS, RM, and MS samples only.

Reference refers to the source of the QC sample.

For Reference Materials, the ID of the RM is provided.

Appendix 2c. Quality Control Results 2011 - (Quintette Project)

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	CRM	Arsenic (As)-Total	WG1414169-6	VA-NRC-TORT2	23.0	21.6	mg/kg wwt	106.6	70-130	
Tissue	CRM	Arsenic (As)-Total	WG1414169-7	VA-NRC-DOLT4	9.17	9.66	mg/kg wwt	94.9	70-130	
Tissue	CRM	Arsenic (As)-Total	WG1414720-6	VA-NRC-TORT2	26.1	21.6	mg/kg wwt	120.9	70-130	
Tissue	CRM	Arsenic (As)-Total	WG1414720-7	VA-NRC-DOLT4	10.8	9.66	mg/kg wwt	111.4	70-130	
Tissue	CRM	Arsenic (As)-Total	WG1420722-5	VA-NRC-TORT2	20.9	21.6	mg/kg wwt	96.6	70-130	
Tissue	CRM	Arsenic (As)-Total	WG1420722-6	VA-NRC-DOLT4	10.1	9.66	mg/kg wwt	105.0	70-130	
Tissue	CRM	Cadmium (Cd)-Total	WG1414169-6	VA-NRC-TORT2	30.0	26.7	mg/kg wwt	112.5	70-130	
Tissue	CRM	Cadmium (Cd)-Total	WG1414169-7	VA-NRC-DOLT4	25.1	24.3	mg/kg wwt	103.2	70-130	
Tissue	CRM	Cadmium (Cd)-Total	WG1414720-6	VA-NRC-TORT2	32.7	26.7	mg/kg wwt	122.3	70-130	
Tissue	CRM	Cadmium (Cd)-Total	WG1414720-7	VA-NRC-DOLT4	27.7	24.3	mg/kg wwt	114.0	70-130	
Tissue	CRM	Cadmium (Cd)-Total	WG1420722-5	VA-NRC-TORT2	29.0	26.7	mg/kg wwt	108.6	70-130	
Tissue	CRM	Cadmium (Cd)-Total	WG1420722-6	VA-NRC-DOLT4	29.7	24.3	mg/kg wwt	122.3	70-130	
Tissue	CRM	Calcium (Ca)-Total	WG1414169-7	VA-NRC-DOLT4	632	680	mg/kg wwt	93.0	70-130	
Tissue	CRM	Calcium (Ca)-Total	WG1414720-7	VA-NRC-DOLT4	725	680	mg/kg wwt	106.6	70-130	
Tissue	CRM	Chromium (Cr)-Total	WG1414169-6	VA-NRC-TORT2	0.778	0.770	mg/kg wwt	101.0	70-130	
Tissue	CRM	Chromium (Cr)-Total	WG1414169-7	VA-NRC-DOLT4	1.21	1.40	mg/kg wwt	86.1	70-130	
Tissue	CRM	Chromium (Cr)-Total	WG1414720-6	VA-NRC-TORT2	0.654	0.770	mg/kg wwt	84.9	70-130	
Tissue	CRM	Chromium (Cr)-Total	WG1414720-7	VA-NRC-DOLT4	1.61	1.40	mg/kg wwt	115.1	70-130	
Tissue	CRM	Chromium (Cr)-Total	WG1420722-5	VA-NRC-TORT2	0.590	0.770	mg/kg wwt	76.6	70-130	
Tissue	CRM	Chromium (Cr)-Total	WG1420722-6	VA-NRC-DOLT4	1.35	1.40	mg/kg wwt	96.3	70-130	
Tissue	CRM	Cobalt (Co)-Total	WG1414169-6	VA-NRC-TORT2	0.582	0.510	mg/kg wwt	114.1	70-130	
Tissue	CRM	Cobalt (Co)-Total	WG1414169-7	VA-NRC-DOLT4	0.243	0.250	mg/kg wwt	97.2	70-130	
Tissue	CRM	Cobalt (Co)-Total	WG1414720-6	VA-NRC-TORT2	0.608	0.510	mg/kg wwt	119.2	70-130	
Tissue	CRM	Cobalt (Co)-Total	WG1414720-7	VA-NRC-DOLT4	0.273	0.250	mg/kg wwt	109.4	70-130	
Tissue	CRM	Cobalt (Co)-Total	WG1420722-5	VA-NRC-TORT2	0.536	0.510	mg/kg wwt	105.0	70-130	
Tissue	CRM	Cobalt (Co)-Total	WG1420722-6	VA-NRC-DOLT4	0.294	0.250	mg/kg wwt	117.4	70-130	
Tissue	CRM	Copper (Cu)-Total	WG1414169-6	VA-NRC-TORT2	110	106	mg/kg wwt	103.7	70-130	
Tissue	CRM	Copper (Cu)-Total	WG1414169-7	VA-NRC-DOLT4	34.0	31.2	mg/kg wwt	109.1	70-130	
Tissue	CRM	Copper (Cu)-Total	WG1414720-6	VA-NRC-TORT2	119	106	mg/kg wwt	112.0	70-130	
Tissue	CRM	Copper (Cu)-Total	WG1414720-7	VA-NRC-DOLT4	36.7	31.2	mg/kg wwt	117.5	70-130	
Tissue	CRM	Copper (Cu)-Total	WG1420722-5	VA-NRC-TORT2	105	106	mg/kg wwt	99.4	70-130	
Tissue	CRM	Copper (Cu)-Total	WG1420722-6	VA-NRC-DOLT4	40.5	31.2	mg/kg wwt	129.8	70-130	
Tissue	CRM	Iron (Fe)-Total	WG1414169-6	VA-NRC-TORT2	104	105	mg/kg wwt	99.4	70-130	
Tissue	CRM	Iron (Fe)-Total	WG1414169-7	VA-NRC-DOLT4	1770	1830	mg/kg wwt	96.3	70-130	
Tissue	CRM	Iron (Fe)-Total	WG1414720-6	VA-NRC-TORT2	116	105	mg/kg wwt	110.6	70-130	
Tissue	CRM	Iron (Fe)-Total	WG1414720-7	VA-NRC-DOLT4	1980	1830	mg/kg wwt	107.8	70-130	
Tissue	CRM	Iron (Fe)-Total	WG1420722-5	VA-NRC-TORT2	107	105	mg/kg wwt	101.7	70-130	
Tissue	CRM	Iron (Fe)-Total	WG1420722-6	VA-NRC-DOLT4	2140	1830	mg/kg wwt	117.0	70-130	
Tissue	CRM	Lead (Pb)-Total	WG1414169-6	VA-NRC-TORT2	0.271	0.350	mg/kg wwt	77.6	70-130	
Tissue	CRM	Lead (Pb)-Total	WG1414720-6	VA-NRC-TORT2	0.307	0.350	mg/kg wwt	87.9	70-130	
Tissue	CRM	Lead (Pb)-Total	WG1414720-7	VA-NRC-DOLT4	0.136	0.160	mg/kg wwt	85.0	70-130	
Tissue	CRM	Lead (Pb)-Total	WG1420722-5	VA-NRC-TORT2	0.267	0.350	mg/kg wwt	76.2	70-130	
Tissue	CRM	Lead (Pb)-Total	WG1420722-6	VA-NRC-DOLT4	0.153	0.160	mg/kg wwt	95.9	70-130	
Tissue	CRM	Magnesium (Mg)-Total	WG1414169-7	VA-NRC-DOLT4	1380	1500	mg/kg wwt	92.2	70-130	
Tissue	CRM	Magnesium (Mg)-Total	WG1414720-7	VA-NRC-DOLT4	1450	1500	mg/kg wwt	96.9	70-130	
Tissue	CRM	Manganese (Mn)-Total	WG1414169-6	VA-NRC-TORT2	13.7	13.6	mg/kg wwt	100.7	70-130	
Tissue	CRM	Manganese (Mn)-Total	WG1414720-6	VA-NRC-TORT2	14.5	13.6	mg/kg wwt	106.4	70-130	
Tissue	CRM	Manganese (Mn)-Total	WG1420722-5	VA-NRC-TORT2	13.5	13.6	mg/kg wwt	99.6	70-130	
Tissue	CRM	Mercury (Hg)-Total	WG1414169-6	VA-NRC-TORT2	0.296	0.270	mg/kg wwt	109.7	70-130	
Tissue	CRM	Mercury (Hg)-Total	WG1414169-7	VA-NRC-DOLT4	2.15	2.58	mg/kg wwt	83.2	70-130	
Tissue	CRM	Mercury (Hg)-Total	WG1414720-6	VA-NRC-TORT2	0.307	0.270	mg/kg wwt	113.7	70-130	
Tissue	CRM	Mercury (Hg)-Total	WG1414720-7	VA-NRC-DOLT4	2.54	2.58	mg/kg wwt	98.3	70-130	
Tissue	CRM	Molybdenum (Mo)-Total	WG1414169-6	VA-NRC-TORT2	1.04	0.950	mg/kg wwt	109.5	70-130	
Tissue	CRM	Molybdenum (Mo)-Total	WG1414169-7	VA-NRC-DOLT4	1.07	1.00	mg/kg wwt	106.6	70-130	
Tissue	CRM	Molybdenum (Mo)-Total	WG1414720-6	VA-NRC-TORT2	1.10	0.950	mg/kg wwt	116.0	70-130	
Tissue	CRM	Molybdenum (Mo)-Total	WG1414720-7	VA-NRC-DOLT4	1.15	1.00	mg/kg wwt	114.9	70-130	
Tissue	CRM	Molybdenum (Mo)-Total	WG1420722-5	VA-NRC-TORT2	1.00	0.950	mg/kg wwt	105.7	70-130	
Tissue	CRM	Molybdenum (Mo)-Total	WG1420722-6	VA-NRC-DOLT4	1.27	1.00	mg/kg wwt	127.2	70-130	
Tissue	CRM	Nickel (Ni)-Total	WG1414169-6	VA-NRC-TORT2	2.54	2.50	mg/kg wwt	101.8	70-130	

Appendix 2c. Quality Control Results 2011 - (Quintette Project)

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	CRM	Nickel (Ni)-Total	WG1414169-7	VA-NRC-DOLT4	0.891	0.970	mg/kg wwt	91.9	70-130	
Tissue	CRM	Nickel (Ni)-Total	WG1414720-6	VA-NRC-TORT2	2.71	2.50	mg/kg wwt	108.6	70-130	
Tissue	CRM	Nickel (Ni)-Total	WG1414720-7	VA-NRC-DOLT4	0.999	0.970	mg/kg wwt	103.0	70-130	
Tissue	CRM	Nickel (Ni)-Total	WG1420722-5	VA-NRC-TORT2	2.36	2.50	mg/kg wwt	94.5	70-130	
Tissue	CRM	Nickel (Ni)-Total	WG1420722-6	VA-NRC-DOLT4	1.02	0.970	mg/kg wwt	105.6	70-130	
Tissue	CRM	Potassium (K)-Total	WG1414169-7	VA-NRC-DOLT4	9610	9800	mg/kg wwt	98.0	70-130	
Tissue	CRM	Potassium (K)-Total	WG1414720-7	VA-NRC-DOLT4	10200	9800	mg/kg wwt	104.5	70-130	
Tissue	CRM	Selenium (Se)-Total	WG1414169-6	VA-NRC-TORT2	5.87	5.63	mg/kg wwt	104.3	70-130	
Tissue	CRM	Selenium (Se)-Total	WG1414169-7	VA-NRC-DOLT4	8.50	8.30	mg/kg wwt	102.4	70-130	
Tissue	CRM	Selenium (Se)-Total	WG1414720-6	VA-NRC-TORT2	6.44	5.63	mg/kg wwt	114.4	70-130	
Tissue	CRM	Selenium (Se)-Total	WG1414720-7	VA-NRC-DOLT4	9.27	8.30	mg/kg wwt	111.7	70-130	
Tissue	CRM	Selenium (Se)-Total	WG1420722-5	VA-NRC-TORT2	5.92	5.63	mg/kg wwt	105.2	70-130	
Tissue	CRM	Selenium (Se)-Total	WG1420722-6	VA-NRC-DOLT4	10.6	8.30	mg/kg wwt	127.2	70-130	
Tissue	CRM	Sodium (Na)-Total	WG1414169-7	VA-NRC-DOLT4	6800	6800	mg/kg wwt	99.9	70-130	
Tissue	CRM	Sodium (Na)-Total	WG1414720-7	VA-NRC-DOLT4	7110	6800	mg/kg wwt	104.5	70-130	
Tissue	CRM	Strontium (Sr)-Total	WG1414169-6	VA-NRC-TORT2	41.8	45.2	mg/kg wwt	92.5	70-130	
Tissue	CRM	Strontium (Sr)-Total	WG1414169-7	VA-NRC-DOLT4	4.94	5.50	mg/kg wwt	89.8	70-130	
Tissue	CRM	Strontium (Sr)-Total	WG1414720-6	VA-NRC-TORT2	38.8	45.2	mg/kg wwt	85.9	70-130	
Tissue	CRM	Strontium (Sr)-Total	WG1414720-7	VA-NRC-DOLT4	5.26	5.50	mg/kg wwt	95.7	70-130	
Tissue	CRM	Strontium (Sr)-Total	WG1420722-5	VA-NRC-TORT2	38.1	45.2	mg/kg wwt	84.2	70-130	
Tissue	CRM	Strontium (Sr)-Total	WG1420722-6	VA-NRC-DOLT4	6.47	5.50	mg/kg wwt	117.7	70-130	
Tissue	CRM	Tin (Sn)-Total	WG1414720-7	VA-NRC-DOLT4	0.149	0.170	mg/kg wwt	87.9	70-130	
Tissue	CRM	Vanadium (V)-Total	WG1414169-6	VA-NRC-TORT2	1.94	1.64	mg/kg wwt	118.1	70-130	
Tissue	CRM	Vanadium (V)-Total	WG1414169-7	VA-NRC-DOLT4	0.603	0.600	mg/kg wwt	100.4	70-130	
Tissue	CRM	Vanadium (V)-Total	WG1414720-6	VA-NRC-TORT2	2.13	1.64	mg/kg wwt	129.7	70-130	
Tissue	CRM	Vanadium (V)-Total	WG1414720-7	VA-NRC-DOLT4	0.773	0.600	mg/kg wwt	128.8	70-130	
Tissue	CRM	Vanadium (V)-Total	WG1420722-5	VA-NRC-TORT2	1.87	1.64	mg/kg wwt	113.7	70-130	
Tissue	CRM	Vanadium (V)-Total	WG1420722-6	VA-NRC-DOLT4	0.715	0.600	mg/kg wwt	119.1	70-130	
Tissue	CRM	Zinc (Zn)-Total	WG1414169-6	VA-NRC-TORT2	205	180	mg/kg wwt	113.7	70-130	
Tissue	CRM	Zinc (Zn)-Total	WG1414169-7	VA-NRC-DOLT4	130	116	mg/kg wwt	112.2	70-130	
Tissue	CRM	Zinc (Zn)-Total	WG1414720-6	VA-NRC-TORT2	228	180	mg/kg wwt	126.9	70-130	
Tissue	CRM	Zinc (Zn)-Total	WG1414720-7	VA-NRC-DOLT4	144	116	mg/kg wwt	124.0	70-130	
Tissue	CRM	Zinc (Zn)-Total	WG1420722-5	VA-NRC-TORT2	190	180	mg/kg wwt	105.6	70-130	
Tissue	CRM	Zinc (Zn)-Total	WG1420722-6	VA-NRC-DOLT4	149	116	mg/kg wwt	128.9	70-130	
Tissue	MB	Aluminum (Al)-Total	WG1414169-1		<0.40	<0.4	mg/kg wwt	-	0.4	
Tissue	MB	Aluminum (Al)-Total	WG1414169-2		<0.40	<0.4	mg/kg wwt	-	0.4	
Tissue	MB	Aluminum (Al)-Total	WG1414169-3		<0.40	<0.4	mg/kg wwt	-	0.4	
Tissue	MB	Aluminum (Al)-Total	WG1414720-1		<0.40	<0.4	mg/kg wwt	-	0.4	
Tissue	MB	Aluminum (Al)-Total	WG1414720-2		<0.40	<0.4	mg/kg wwt	-	0.4	
Tissue	MB	Aluminum (Al)-Total	WG1414720-3		<0.40	<0.4	mg/kg wwt	-	0.4	
Tissue	MB	Aluminum (Al)-Total	WG1420722-1		<0.40	<0.4	mg/kg wwt	-	0.4	
Tissue	MB	Aluminum (Al)-Total	WG1420722-2		<0.40	<0.4	mg/kg wwt	-	0.4	
Tissue	MB	Aluminum (Al)-Total	WG1420722-3		<0.40	<0.4	mg/kg wwt	-	0.4	
Tissue	MB	Antimony (Sb)-Total	WG1414169-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Antimony (Sb)-Total	WG1414169-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Antimony (Sb)-Total	WG1414169-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Antimony (Sb)-Total	WG1414720-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Antimony (Sb)-Total	WG1414720-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Antimony (Sb)-Total	WG1414720-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Antimony (Sb)-Total	WG1420722-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Antimony (Sb)-Total	WG1420722-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Antimony (Sb)-Total	WG1420722-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Arsenic (As)-Total	WG1414169-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Arsenic (As)-Total	WG1414169-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Arsenic (As)-Total	WG1414169-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Arsenic (As)-Total	WG1414720-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Arsenic (As)-Total	WG1414720-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Arsenic (As)-Total	WG1414720-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Arsenic (As)-Total	WG1420722-1		<0.0040	<0.004	mg/kg wwt	-	0.004	

Appendix 2c. Quality Control Results 2011 - (Quintette Project)

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	MB	Arsenic (As)-Total	WG1420722-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Arsenic (As)-Total	WG1420722-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Barium (Ba)-Total	WG1414169-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1414169-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1414169-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1414720-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1414720-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1414720-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1420722-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1420722-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Barium (Ba)-Total	WG1420722-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Beryllium (Be)-Total	WG1414169-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Beryllium (Be)-Total	WG1414169-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Beryllium (Be)-Total	WG1414169-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Beryllium (Be)-Total	WG1414720-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Beryllium (Be)-Total	WG1414720-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Beryllium (Be)-Total	WG1414720-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Beryllium (Be)-Total	WG1420722-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Beryllium (Be)-Total	WG1420722-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Beryllium (Be)-Total	WG1420722-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Bismuth (Bi)-Total	WG1414169-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Bismuth (Bi)-Total	WG1414169-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Bismuth (Bi)-Total	WG1414169-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Bismuth (Bi)-Total	WG1414720-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Bismuth (Bi)-Total	WG1414720-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Bismuth (Bi)-Total	WG1414720-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Bismuth (Bi)-Total	WG1420722-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Bismuth (Bi)-Total	WG1420722-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Bismuth (Bi)-Total	WG1420722-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Boron (B)-Total	WG1414169-1		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Boron (B)-Total	WG1414169-2		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Boron (B)-Total	WG1414169-3		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Boron (B)-Total	WG1414720-1		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Boron (B)-Total	WG1414720-2		0.45	<0.2	mg/kg wwt	-	0.2	MB-LOR
Tissue	MB	Boron (B)-Total	WG1414720-3		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Boron (B)-Total	WG1420722-1		0.28	<0.2	mg/kg wwt	-	0.2	MB-LOR
Tissue	MB	Boron (B)-Total	WG1420722-2		0.40	<0.2	mg/kg wwt	-	0.2	MB-LOR
Tissue	MB	Boron (B)-Total	WG1420722-3		0.21	<0.2	mg/kg wwt	-	0.2	MB-LOR
Tissue	MB	Cadmium (Cd)-Total	WG1414169-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Cadmium (Cd)-Total	WG1414169-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Cadmium (Cd)-Total	WG1414169-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Cadmium (Cd)-Total	WG1414720-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Cadmium (Cd)-Total	WG1414720-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Cadmium (Cd)-Total	WG1414720-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Cadmium (Cd)-Total	WG1420722-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Cadmium (Cd)-Total	WG1420722-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Cadmium (Cd)-Total	WG1420722-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Calcium (Ca)-Total	WG1414169-1		<5.0	<5	mg/kg wwt	-	5	
Tissue	MB	Calcium (Ca)-Total	WG1414169-2		<5.0	<5	mg/kg wwt	-	5	
Tissue	MB	Calcium (Ca)-Total	WG1414169-3		<5.0	<5	mg/kg wwt	-	5	
Tissue	MB	Calcium (Ca)-Total	WG1414720-1		<5.0	<5	mg/kg wwt	-	5	
Tissue	MB	Calcium (Ca)-Total	WG1414720-2		<5.0	<5	mg/kg wwt	-	5	
Tissue	MB	Calcium (Ca)-Total	WG1414720-3		<5.0	<5	mg/kg wwt	-	5	
Tissue	MB	Cesium (Cs)-Total	WG1414169-1		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Cesium (Cs)-Total	WG1414169-2		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Cesium (Cs)-Total	WG1414169-3		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Cesium (Cs)-Total	WG1414720-1		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Cesium (Cs)-Total	WG1414720-2		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Cesium (Cs)-Total	WG1414720-3		<0.0010	<0.001	mg/kg wwt	-	0.001	

Appendix 2c. Quality Control Results 2011 - (Quintette Project)

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	MB	Cesium (Cs)-Total	WG1420722-1		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Cesium (Cs)-Total	WG1420722-2		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Cesium (Cs)-Total	WG1420722-3		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Chromium (Cr)-Total	WG1414169-1		0.052	<0.01	mg/kg wwt	-	0.01	MB-LOR
Tissue	MB	Chromium (Cr)-Total	WG1414169-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Chromium (Cr)-Total	WG1414169-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Chromium (Cr)-Total	WG1414720-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Chromium (Cr)-Total	WG1414720-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Chromium (Cr)-Total	WG1414720-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Chromium (Cr)-Total	WG1420722-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Chromium (Cr)-Total	WG1420722-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Chromium (Cr)-Total	WG1420722-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Cobalt (Co)-Total	WG1414169-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Cobalt (Co)-Total	WG1414169-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Cobalt (Co)-Total	WG1414169-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Cobalt (Co)-Total	WG1414720-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Cobalt (Co)-Total	WG1414720-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Cobalt (Co)-Total	WG1414720-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Cobalt (Co)-Total	WG1420722-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Cobalt (Co)-Total	WG1420722-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Cobalt (Co)-Total	WG1420722-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Copper (Cu)-Total	WG1414169-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Copper (Cu)-Total	WG1414169-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Copper (Cu)-Total	WG1414169-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Copper (Cu)-Total	WG1414720-1		0.011	<0.01	mg/kg wwt	-	0.01	MB-LOR
Tissue	MB	Copper (Cu)-Total	WG1414720-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Copper (Cu)-Total	WG1414720-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Copper (Cu)-Total	WG1420722-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Copper (Cu)-Total	WG1420722-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Copper (Cu)-Total	WG1420722-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Gallium (Ga)-Total	WG1414169-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Gallium (Ga)-Total	WG1414169-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Gallium (Ga)-Total	WG1414169-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Gallium (Ga)-Total	WG1414720-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Gallium (Ga)-Total	WG1414720-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Gallium (Ga)-Total	WG1414720-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Gallium (Ga)-Total	WG1420722-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Gallium (Ga)-Total	WG1420722-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Gallium (Ga)-Total	WG1420722-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Iron (Fe)-Total	WG1414169-1		1.13	<0.2	mg/kg wwt	-	0.2	MB-LOR
Tissue	MB	Iron (Fe)-Total	WG1414169-2		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Iron (Fe)-Total	WG1414169-3		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Iron (Fe)-Total	WG1414720-1		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Iron (Fe)-Total	WG1414720-2		0.32	<0.2	mg/kg wwt	-	0.2	MB-LOR
Tissue	MB	Iron (Fe)-Total	WG1414720-3		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Iron (Fe)-Total	WG1420722-1		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Iron (Fe)-Total	WG1420722-2		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Iron (Fe)-Total	WG1420722-3		<0.20	<0.2	mg/kg wwt	-	0.2	
Tissue	MB	Lead (Pb)-Total	WG1414169-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Lead (Pb)-Total	WG1414169-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Lead (Pb)-Total	WG1414169-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Lead (Pb)-Total	WG1414720-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Lead (Pb)-Total	WG1414720-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Lead (Pb)-Total	WG1414720-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Lead (Pb)-Total	WG1420722-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Lead (Pb)-Total	WG1420722-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Lead (Pb)-Total	WG1420722-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Lithium (Li)-Total	WG1414169-1		0.068	<0.02	mg/kg wwt	-	0.02	MB-LOR
Tissue	MB	Lithium (Li)-Total	WG1414169-2		0.062	<0.02	mg/kg wwt	-	0.02	MB-LOR

Appendix 2c. Quality Control Results 2011 - (Quintette Project)

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	MB	Lithium (Li)-Total	WG1414169-3		0.061	<0.02	mg/kg wwt	-	0.02	MB-LOR
Tissue	MB	Lithium (Li)-Total	WG1414720-1		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Lithium (Li)-Total	WG1414720-2		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Lithium (Li)-Total	WG1414720-3		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Lithium (Li)-Total	WG1420722-1		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Lithium (Li)-Total	WG1420722-2		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Lithium (Li)-Total	WG1420722-3		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Magnesium (Mg)-Total	WG1414169-1		<10	<10	mg/kg wwt	-	10	
Tissue	MB	Magnesium (Mg)-Total	WG1414169-2		<10	<10	mg/kg wwt	-	10	
Tissue	MB	Magnesium (Mg)-Total	WG1414169-3		<10	<10	mg/kg wwt	-	10	
Tissue	MB	Magnesium (Mg)-Total	WG1414720-1		<10	<10	mg/kg wwt	-	10	
Tissue	MB	Magnesium (Mg)-Total	WG1414720-2		<10	<10	mg/kg wwt	-	10	
Tissue	MB	Magnesium (Mg)-Total	WG1414720-3		<10	<10	mg/kg wwt	-	10	
Tissue	MB	Manganese (Mn)-Total	WG1414169-1		0.0047	<0.004	mg/kg wwt	-	0.004	MB-LOR
Tissue	MB	Manganese (Mn)-Total	WG1414169-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Manganese (Mn)-Total	WG1414169-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Manganese (Mn)-Total	WG1414720-1		0.0184	<0.004	mg/kg wwt	-	0.004	MB-LOR
Tissue	MB	Manganese (Mn)-Total	WG1414720-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Manganese (Mn)-Total	WG1414720-3		0.0041	<0.004	mg/kg wwt	-	0.004	MB-LOR
Tissue	MB	Manganese (Mn)-Total	WG1420722-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Manganese (Mn)-Total	WG1420722-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Manganese (Mn)-Total	WG1420722-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Mercury (Hg)-Total	WG1414169-1		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Mercury (Hg)-Total	WG1414169-2		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Mercury (Hg)-Total	WG1414169-3		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Mercury (Hg)-Total	WG1414720-1		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Mercury (Hg)-Total	WG1414720-2		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Mercury (Hg)-Total	WG1414720-3		<0.0010	<0.001	mg/kg wwt	-	0.001	
Tissue	MB	Molybdenum (Mo)-Total	WG1414169-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Molybdenum (Mo)-Total	WG1414169-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Molybdenum (Mo)-Total	WG1414169-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Molybdenum (Mo)-Total	WG1414720-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Molybdenum (Mo)-Total	WG1414720-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Molybdenum (Mo)-Total	WG1414720-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Molybdenum (Mo)-Total	WG1420722-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Molybdenum (Mo)-Total	WG1420722-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Molybdenum (Mo)-Total	WG1420722-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Nickel (Ni)-Total	WG1414169-1		0.013	<0.01	mg/kg wwt	-	0.01	MB-LOR
Tissue	MB	Nickel (Ni)-Total	WG1414169-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Nickel (Ni)-Total	WG1414169-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Nickel (Ni)-Total	WG1414720-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Nickel (Ni)-Total	WG1414720-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Nickel (Ni)-Total	WG1414720-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Nickel (Ni)-Total	WG1420722-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Nickel (Ni)-Total	WG1420722-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Nickel (Ni)-Total	WG1420722-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Phosphorus (P)-Total	WG1414169-1		<50	<50	mg/kg wwt	-	50	
Tissue	MB	Phosphorus (P)-Total	WG1414169-2		<50	<50	mg/kg wwt	-	50	
Tissue	MB	Phosphorus (P)-Total	WG1414169-3		<50	<50	mg/kg wwt	-	50	
Tissue	MB	Phosphorus (P)-Total	WG1414720-1		<50	<50	mg/kg wwt	-	50	
Tissue	MB	Phosphorus (P)-Total	WG1414720-2		<50	<50	mg/kg wwt	-	50	
Tissue	MB	Phosphorus (P)-Total	WG1414720-3		<50	<50	mg/kg wwt	-	50	
Tissue	MB	Potassium (K)-Total	WG1414169-1		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Potassium (K)-Total	WG1414169-2		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Potassium (K)-Total	WG1414169-3		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Potassium (K)-Total	WG1414720-1		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Potassium (K)-Total	WG1414720-2		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Potassium (K)-Total	WG1414720-3		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Rhenium (Re)-Total	WG1414169-1		<0.0020	<0.002	mg/kg wwt	-	0.002	

Appendix 2c. Quality Control Results 2011 - (Quintette Project)

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	MB	Rhenium (Re)-Total	WG1414169-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Rhenium (Re)-Total	WG1414169-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Rhenium (Re)-Total	WG1414720-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Rhenium (Re)-Total	WG1414720-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Rhenium (Re)-Total	WG1414720-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Rhenium (Re)-Total	WG1420722-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Rhenium (Re)-Total	WG1420722-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Rhenium (Re)-Total	WG1420722-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Rubidium (Rb)-Total	WG1414169-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Rubidium (Rb)-Total	WG1414169-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Rubidium (Rb)-Total	WG1414169-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Rubidium (Rb)-Total	WG1414720-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Rubidium (Rb)-Total	WG1414720-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Rubidium (Rb)-Total	WG1414720-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Rubidium (Rb)-Total	WG1420722-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Rubidium (Rb)-Total	WG1420722-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Rubidium (Rb)-Total	WG1420722-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Selenium (Se)-Total	WG1414169-1		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Selenium (Se)-Total	WG1414169-2		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Selenium (Se)-Total	WG1414169-3		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Selenium (Se)-Total	WG1414720-1		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Selenium (Se)-Total	WG1414720-2		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Selenium (Se)-Total	WG1414720-3		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Selenium (Se)-Total	WG1420722-1		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Selenium (Se)-Total	WG1420722-2		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Selenium (Se)-Total	WG1420722-3		<0.020	<0.02	mg/kg wwt	-	0.02	
Tissue	MB	Sodium (Na)-Total	WG1414169-1		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Sodium (Na)-Total	WG1414169-2		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Sodium (Na)-Total	WG1414169-3		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Sodium (Na)-Total	WG1414720-1		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Sodium (Na)-Total	WG1414720-2		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Sodium (Na)-Total	WG1414720-3		<200	<200	mg/kg wwt	-	200	
Tissue	MB	Strontium (Sr)-Total	WG1414169-1		0.011	<0.01	mg/kg wwt	-	0.01	MB-LOR
Tissue	MB	Strontium (Sr)-Total	WG1414169-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Strontium (Sr)-Total	WG1414169-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Strontium (Sr)-Total	WG1414720-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Strontium (Sr)-Total	WG1414720-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Strontium (Sr)-Total	WG1414720-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Strontium (Sr)-Total	WG1420722-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Strontium (Sr)-Total	WG1420722-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Strontium (Sr)-Total	WG1420722-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Tellurium (Te)-Total	WG1414169-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tellurium (Te)-Total	WG1414169-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tellurium (Te)-Total	WG1414169-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tellurium (Te)-Total	WG1414720-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tellurium (Te)-Total	WG1414720-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tellurium (Te)-Total	WG1414720-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tellurium (Te)-Total	WG1420722-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tellurium (Te)-Total	WG1420722-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tellurium (Te)-Total	WG1420722-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Thallium (Tl)-Total	WG1414169-1		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Thallium (Tl)-Total	WG1414169-2		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Thallium (Tl)-Total	WG1414169-3		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Thallium (Tl)-Total	WG1414720-1		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Thallium (Tl)-Total	WG1414720-2		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Thallium (Tl)-Total	WG1414720-3		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Thallium (Tl)-Total	WG1420722-1		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Thallium (Tl)-Total	WG1420722-2		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Thallium (Tl)-Total	WG1420722-3		<0.00040	<0.0004	mg/kg wwt	-	0.0004	

Appendix 2c. Quality Control Results 2011 - (Quintette Project)

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	MB	Thorium (Th)-Total	WG1414169-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Thorium (Th)-Total	WG1414169-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Thorium (Th)-Total	WG1414169-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Thorium (Th)-Total	WG1414720-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Thorium (Th)-Total	WG1414720-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Thorium (Th)-Total	WG1414720-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Thorium (Th)-Total	WG1420722-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Thorium (Th)-Total	WG1420722-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Thorium (Th)-Total	WG1420722-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Tin (Sn)-Total	WG1414169-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tin (Sn)-Total	WG1414169-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tin (Sn)-Total	WG1414169-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tin (Sn)-Total	WG1414720-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tin (Sn)-Total	WG1414720-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tin (Sn)-Total	WG1414720-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tin (Sn)-Total	WG1420722-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tin (Sn)-Total	WG1420722-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Tin (Sn)-Total	WG1420722-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Titanium (Ti)-Total	WG1414169-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Titanium (Ti)-Total	WG1414169-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Titanium (Ti)-Total	WG1414169-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Titanium (Ti)-Total	WG1414720-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Titanium (Ti)-Total	WG1414720-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Titanium (Ti)-Total	WG1414720-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Titanium (Ti)-Total	WG1420722-1		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Titanium (Ti)-Total	WG1420722-2		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Titanium (Ti)-Total	WG1420722-3		<0.010	<0.01	mg/kg wwt	-	0.01	
Tissue	MB	Uranium (U)-Total	WG1414169-1		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Uranium (U)-Total	WG1414169-2		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Uranium (U)-Total	WG1414169-3		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Uranium (U)-Total	WG1414720-1		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Uranium (U)-Total	WG1414720-2		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Uranium (U)-Total	WG1414720-3		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Uranium (U)-Total	WG1420722-1		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Uranium (U)-Total	WG1420722-2		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Uranium (U)-Total	WG1420722-3		<0.00040	<0.0004	mg/kg wwt	-	0.0004	
Tissue	MB	Vanadium (V)-Total	WG1414169-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Vanadium (V)-Total	WG1414169-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Vanadium (V)-Total	WG1414169-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Vanadium (V)-Total	WG1414720-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Vanadium (V)-Total	WG1414720-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Vanadium (V)-Total	WG1414720-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Vanadium (V)-Total	WG1420722-1		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Vanadium (V)-Total	WG1420722-2		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Vanadium (V)-Total	WG1420722-3		<0.0040	<0.004	mg/kg wwt	-	0.004	
Tissue	MB	Yttrium (Y)-Total	WG1414169-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Yttrium (Y)-Total	WG1414169-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Yttrium (Y)-Total	WG1414169-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Yttrium (Y)-Total	WG1414720-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Yttrium (Y)-Total	WG1414720-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Yttrium (Y)-Total	WG1414720-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Yttrium (Y)-Total	WG1420722-1		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Yttrium (Y)-Total	WG1420722-2		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Yttrium (Y)-Total	WG1420722-3		<0.0020	<0.002	mg/kg wwt	-	0.002	
Tissue	MB	Zinc (Zn)-Total	WG1414169-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zinc (Zn)-Total	WG1414169-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zinc (Zn)-Total	WG1414169-3		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zinc (Zn)-Total	WG1414720-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zinc (Zn)-Total	WG1414720-2		<0.10	<0.1	mg/kg wwt	-	0.1	

Appendix 2c. Quality Control Results 2011 - (Quintette Project)

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier
Tissue	MB	Zinc (Zn)-Total	WG1414720-3		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zinc (Zn)-Total	WG1420722-1		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zinc (Zn)-Total	WG1420722-2		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zinc (Zn)-Total	WG1420722-3		<0.10	<0.1	mg/kg wwt	-	0.1	
Tissue	MB	Zirconium (Zr)-Total	WG1414169-1		<0.040	<0.04	mg/kg wwt	-	0.04	
Tissue	MB	Zirconium (Zr)-Total	WG1414169-2		<0.040	<0.04	mg/kg wwt	-	0.04	
Tissue	MB	Zirconium (Zr)-Total	WG1414169-3		<0.040	<0.04	mg/kg wwt	-	0.04	
Tissue	MB	Zirconium (Zr)-Total	WG1414720-1		<0.040	<0.04	mg/kg wwt	-	0.04	
Tissue	MB	Zirconium (Zr)-Total	WG1414720-2		<0.040	<0.04	mg/kg wwt	-	0.04	
Tissue	MB	Zirconium (Zr)-Total	WG1414720-3		<0.040	<0.04	mg/kg wwt	-	0.04	
Tissue	MB	Zirconium (Zr)-Total	WG1420722-1		<0.040	<0.04	mg/kg wwt	-	0.04	
Tissue	MB	Zirconium (Zr)-Total	WG1420722-2		<0.040	<0.04	mg/kg wwt	-	0.04	
Tissue	MB	Zirconium (Zr)-Total	WG1420722-3		<0.040	<0.04	mg/kg wwt	-	0.04	

QC Type

CRM = Comparison with Reference Material

MB = Method Blank

MB-LOR = Method Blank exceeds ALS DQO. LORs adjusted for samples with positive hits below 5 times blank level. Please contact ALS if re-analysis is required.

% = Percent Recovery. Applicable to LCS, RM, and MS samples only.

Reference refers to the source of the QC sample.

For Reference Materials, the ID of the RM is provided.

Appendix 2d. Quality Control Results 2004 - (Hermann Project)

QC Type	Analyte		QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier	DL	Method
NRC Lobster Hepatopancreas, TORT-2												
	Arsenic	T-As	413090		22.5	21.6	mg/kg				0.05	a
	Arsenic	T-As	413091		22.6	21.6	mg/kg				0.05	a
	Cadmium	T-Cd	413090		28.3	26.7	mg/kg				0.03	a
	Cadmium	T-Cd	413091		27.9	26.7	mg/kg				0.03	a
	Chromium	T-Cr	413090		0.66	0.77	mg/kg				0.5	a
	Chromium	T-Cr	413091		0.55	0.77	mg/kg				0.5	a
	Cobalt	T-Co	413090		0.53	0.51	mg/kg				0.1	a
	Cobalt	T-Co	413091		0.51	0.51	mg/kg				0.1	a
	Copper	T-Cu	413090		103	106	mg/kg				0.05	a
	Copper	T-Cu	413091		102	106	mg/kg				0.05	a
	Lead	T-Pb	413090		0.42	0.35	mg/kg				0.1	a
	Lead	T-Pb	413091		0.41	0.35	mg/kg				0.1	a
	Manganese	T-Mn	413090		13.3	13.6	mg/kg				0.05	a
	Manganese	T-Mn	413091		13.5	13.6	mg/kg				0.05	a
	Mercury	T-Hg	412398		0.277	0.27	mg/kg				0.005	b
	Mercury	T-Hg	413379		0.287	0.27	mg/kg				0.005	b
	Molybdenum	T-Mo	413090		1.06	0.95	mg/kg				0.05	a
	Molybdenum	T-Mo	413091		0.994	0.95	mg/kg				0.05	a
	Nickel	T-Ni	413090		2.29	2.5	mg/kg				0.1	a
	Nickel	T-Ni	413091		2.18	2.5	mg/kg				0.1	a
	Selenium	T-Se	412410		5.5	5.63	mg/kg				0.1	c
	Selenium	T-Se	412411		5.39	5.63	mg/kg				0.1	c
	Selenium	T-Se	413090		6.7	5.6	mg/kg				1	a
	Selenium	T-Se	413091		6.5	5.6	mg/kg				1	a
	Strontium	T-Sr	413090		44.5	45.2	mg/kg				0.05	a
	Strontium	T-Sr	413091		45.9	45.2	mg/kg				0.05	a
	Tin	T-Sn	413090		<0.20	<0.20	mg/kg				0.2	a
	Tin	T-Sn	413091		<0.20	<0.20	mg/kg				0.2	a
	Vanadium	T-V	413090		1.8	1.64	mg/kg				0.5	a
	Vanadium	T-V	413091		1.79	1.64	mg/kg				0.5	a
	Zinc	T-Zn	413090		188	180	mg/kg				0.5	a
	Zinc	T-Zn	413091		185	180	mg/kg				0.5	a
NRC Dogfish Liver, DOLT-3												
	Aluminum	T-Al	413378		31	25	mg/kg				10	a
	Aluminum	T-Al	413421		27	25	mg/kg				10	a
	Arsenic	T-As	413378		9.64	10.2	mg/kg				0.05	a
	Arsenic	T-As	413421		9.73	10.2	mg/kg				0.05	a
	Cadmium	T-Cd	413378		19.7	19.4	mg/kg				0.03	a
	Cadmium	T-Cd	413421		19.7	19.4	mg/kg				0.03	a
	Chromium	T-Cr	413378		2.88	3.5	mg/kg				0.5	a
	Chromium	T-Cr	413421		2.99	3.5	mg/kg				0.5	a
	Copper	T-Cu	413378		32.1	31.2	mg/kg				0.05	a
	Copper	T-Cu	413421		31.5	31.2	mg/kg				0.05	a
	Lead	T-Pb	413378		0.33	0.32	mg/kg				0.1	a
	Lead	T-Pb	413421		0.38	0.32	mg/kg				0.1	a
	Mercury	T-Hg	412395		3.44	3.37	mg/kg				0.005	b
	Mercury	T-Hg	413375		3.54	3.37	mg/kg				0.005	b
	Nickel	T-Ni	413378		2.6	2.72	mg/kg				0.5	a
	Nickel	T-Ni	413421		2.68	2.72	mg/kg				0.5	a
	Selenium	T-Se	412408		6.83	7.06	mg/kg				0.5	c
	Selenium	T-Se	412409		6.88	7.06	mg/kg				0.5	c
	Selenium	T-Se	413378		7.8	7.1	mg/kg				1	a
	Selenium	T-Se	413421		7.8	7.1	mg/kg				1	a
	Tin	T-Sn	413378		0.43	0.4	mg/kg				0.2	a
	Tin	T-Sn	413421		0.5	0.4	mg/kg				0.2	a

Appendix 2d. Quality Control Results 2004 - (Hermann Project)

QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier	DL	Method
	Zinc T-Zn	413378		91.9	86.6	mg/kg				0.5	a
	Zinc T-Zn	413421		90.8	86.6	mg/kg				0.5	a
Blanks											
	Aluminum T-Al	413086		<10	<10	mg/kg				10	a
	Aluminum T-Al	413087		<10	<10	mg/kg				10	a
	Aluminum T-Al	413088		<10	<10	mg/kg				10	a
	Aluminum T-Al	413089		<10	<10	mg/kg				10	a
	Antimony T-Sb	413086		<0.030	<0.030	mg/kg				0.03	a
	Antimony T-Sb	413087		<0.030	<0.030	mg/kg				0.03	a
	Antimony T-Sb	413088		<0.030	<0.030	mg/kg				0.03	a
	Antimony T-Sb	413089		<0.030	<0.030	mg/kg				0.03	a
	Arsenic T-As	413086		<0.050	<0.050	mg/kg				0.05	a
	Arsenic T-As	413087		<0.050	<0.050	mg/kg				0.05	a
	Arsenic T-As	413088		<0.050	<0.050	mg/kg				0.05	a
	Arsenic T-As	413089		<0.050	<0.050	mg/kg				0.05	a
	Barium T-Ba	413086		<0.050	<0.050	mg/kg				0.05	a
	Barium T-Ba	413087		<0.050	<0.050	mg/kg				0.05	a
	Barium T-Ba	413088		<0.050	<0.050	mg/kg				0.05	a
	Barium T-Ba	413089		<0.050	<0.050	mg/kg				0.05	a
	Beryllium T-Be	413086		<0.10	<0.10	mg/kg				0.1	a
	Beryllium T-Be	413087		<0.10	<0.10	mg/kg				0.1	a
	Beryllium T-Be	413088		<0.10	<0.10	mg/kg				0.1	a
	Beryllium T-Be	413089		<0.10	<0.10	mg/kg				0.1	a
	Bismuth T-Bi	413086		<0.10	<0.10	mg/kg				0.1	a
	Bismuth T-Bi	413087		<0.10	<0.10	mg/kg				0.1	a
	Bismuth T-Bi	413088		<0.10	<0.10	mg/kg				0.1	a
	Bismuth T-Bi	413089		<0.10	<0.10	mg/kg				0.1	a
	Cadmium T-Cd	413086		<0.030	<0.030	mg/kg				0.03	a
	Cadmium T-Cd	413087		<0.030	<0.030	mg/kg				0.03	a
	Cadmium T-Cd	413088		<0.030	<0.030	mg/kg				0.03	a
	Cadmium T-Cd	413089		<0.030	<0.030	mg/kg				0.03	a
	Calcium T-Ca	413086		<10	<10	mg/kg				10	a
	Calcium T-Ca	413087		<10	<10	mg/kg				10	a
	Calcium T-Ca	413088		<10	<10	mg/kg				10	a
	Calcium T-Ca	413089		<10	<10	mg/kg				10	a
	Chromium T-Cr	413086		<0.50	<0.50	mg/kg				0.5	a
	Chromium T-Cr	413087		<0.50	<0.50	mg/kg				0.5	a
	Chromium T-Cr	413088		<0.50	<0.50	mg/kg				0.5	a
	Chromium T-Cr	413089		<0.50	<0.50	mg/kg				0.5	a
	Cobalt T-Co	413086		<0.10	<0.10	mg/kg				0.1	a
	Cobalt T-Co	413087		<0.10	<0.10	mg/kg				0.1	a
	Cobalt T-Co	413088		<0.10	<0.10	mg/kg				0.1	a
	Cobalt T-Co	413089		<0.10	<0.10	mg/kg				0.1	a
	Copper T-Cu	413088		<0.050	<0.050	mg/kg				0.05	a
	Copper T-Cu	413089		<0.050	<0.050	mg/kg				0.05	a
	Lead T-Pb	413086		<0.10	<0.10	mg/kg				0.1	a
	Lead T-Pb	413087		<0.10	<0.10	mg/kg				0.1	a
	Lead T-Pb	413088		<0.10	<0.10	mg/kg				0.1	a
	Lead T-Pb	413089		<0.10	<0.10	mg/kg				0.1	a
	Lithium T-Li	413086		<0.20	<0.20	mg/kg				0.2	a
	Lithium T-Li	413087		<0.20	<0.20	mg/kg				0.2	a
	Lithium T-Li	413088		<0.20	<0.20	mg/kg				0.2	a
	Lithium T-Li	413089		<0.20	<0.20	mg/kg				0.2	a
	Magnesium T-Mg	413086		<3.0	<3.0	mg/kg				3	a
	Magnesium T-Mg	413087		<3.0	<3.0	mg/kg				3	a
	Magnesium T-Mg	413088		<3.0	<3.0	mg/kg				3	a

Appendix 2d. Quality Control Results 2004 - (Hermann Project)

QC Type	Analyte	QC Spl. No.	Reference	Results	Target	Units	%	Limits	Qualifier	DL	Method
	Magnesium T-Mg	413089		<3.0	<3.0	mg/kg				3	a
	Manganese T-Mn	413086		<0.050	<0.050	mg/kg				0.05	a
	Manganese T-Mn	413087		<0.050	<0.050	mg/kg				0.05	a
	Manganese T-Mn	413088		<0.050	<0.050	mg/kg				0.05	a
	Manganese T-Mn	413089		<0.050	<0.050	mg/kg				0.05	a
	Mercury T-Hg	412396		<0.0050	<0.0050	mg/kg				0.005	b
	Mercury T-Hg	412397		<0.0050	<0.0050	mg/kg				0.005	b
	Mercury T-Hg	413325		<0.0050	<0.0050	mg/kg				0.005	b
	Mercury T-Hg	413326		<0.0050	<0.0050	mg/kg				0.005	b
	Molybdenum T-Mo	413086		<0.050	<0.050	mg/kg				0.05	a
	Molybdenum T-Mo	413087		<0.050	<0.050	mg/kg				0.05	a
	Molybdenum T-Mo	413088		<0.050	<0.050	mg/kg				0.05	a
	Molybdenum T-Mo	413089		<0.050	<0.050	mg/kg				0.05	a
	Nickel T-Ni	413086		<0.10	<0.10	mg/kg				0.1	a
	Nickel T-Ni	413087		<0.10	<0.10	mg/kg				0.1	a
	Nickel T-Ni	413088		<0.10	<0.10	mg/kg				0.1	a
	Nickel T-Ni	413089		<0.10	<0.10	mg/kg				0.1	a
	Selenium T-Se	412404		<0.10	<0.10	mg/kg				0.1	c
	Selenium T-Se	412405		<0.10	<0.10	mg/kg				0.1	c
	Selenium T-Se	412406		<0.10	<0.10	mg/kg				0.1	c
	Selenium T-Se	412407		<0.10	<0.10	mg/kg				0.1	c
	Selenium T-Se	413086		<1.0	<1.0	mg/kg				1	a
	Selenium T-Se	413087		<1.0	<1.0	mg/kg				1	a
	Selenium T-Se	413088		<1.0	<1.0	mg/kg				1	a
	Selenium T-Se	413089		<1.0	<1.0	mg/kg				1	a
	Strontium T-Sr	413086		<0.050	<0.050	mg/kg				0.05	a
	Strontium T-Sr	413087		<0.050	<0.050	mg/kg				0.05	a
	Strontium T-Sr	413088		<0.050	<0.050	mg/kg				0.05	a
	Strontium T-Sr	413089		<0.050	<0.050	mg/kg				0.05	a
	Thallium T-Tl	413086		<0.030	<0.030	mg/kg				0.03	a
	Thallium T-Tl	413087		<0.030	<0.030	mg/kg				0.03	a
	Thallium T-Tl	413088		<0.030	<0.030	mg/kg				0.03	a
	Thallium T-Tl	413089		<0.030	<0.030	mg/kg				0.03	a
	Tin T-Sn	413086		<0.20	<0.20	mg/kg				0.2	a
	Tin T-Sn	413087		<0.20	<0.20	mg/kg				0.2	a
	Tin T-Sn	413088		<0.20	<0.20	mg/kg				0.2	a
	Tin T-Sn	413089		<0.20	<0.20	mg/kg				0.2	a
	Uranium T-U	413086		<0.010	<0.010	mg/kg				0.01	a
	Uranium T-U	413087		<0.010	<0.010	mg/kg				0.01	a
	Uranium T-U	413088		<0.010	<0.010	mg/kg				0.01	a
	Uranium T-U	413089		<0.010	<0.010	mg/kg				0.01	a
	Vanadium T-V	413086		<0.50	<0.50	mg/kg				0.5	a
	Vanadium T-V	413087		<0.50	<0.50	mg/kg				0.5	a
	Vanadium T-V	413088		<0.50	<0.50	mg/kg				0.5	a
	Vanadium T-V	413089		<0.50	<0.50	mg/kg				0.5	a
	Zinc T-Zn	413086		<0.50	<0.50	mg/kg				0.5	a
	Zinc T-Zn	413087		<0.50	<0.50	mg/kg				0.5	a
	Zinc T-Zn	413088		<0.50	<0.50	mg/kg				0.5	a
	Zinc T-Zn	413089		<0.50	<0.50	mg/kg				0.5	a

Methods:

a = HNO3-H2O2/ICPMS

b = HNO3-H2O2/CVAAS

c = HNO3-H2O2/HVAAS

Appendix 3

Replicate Results

Appendix 3a. Replicate Results 2012

Sample ID	Matrix	ALS ID	Analyte	Replicate 1	Replicate 2	Units	RPD	RPD Limit	Diff	Diff Limit	Qualifier
Physical Tests											
L1220862-17	Tissue	WG1585134-8	% Moisture	75.9	75.7	%	0.2	20	-	-	-
L1220862-33	Tissue	WG1585134-9	% Moisture	74.1	74.7	%	0.8	20	-	-	-
L1220862-41	Tissue	WG1585153-1	% Moisture	76.9	76.2	%	0.9	20	-	-	-
Metals											
L1220862-17	Tissue	WG1585172-4	Aluminum (Al)-Total	77.5	72.4	mg/kg wwt	6.7	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Aluminum (Al)-Total	19.5	18.8	mg/kg wwt	3.9	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Aluminum (Al)-Total	15.5	15.9	mg/kg wwt	2.3	30	-	-	-
L1220862-17	Tissue	WG1585172-4	Antimony (Sb)-Total	<0.010	<0.010	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-33	Tissue	WG1585172-5	Antimony (Sb)-Total	<0.010	<0.010	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-41	Tissue	WG1585173-3	Antimony (Sb)-Total	<0.010	<0.010	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-17	Tissue	WG1585172-4	Arsenic (As)-Total	0.072	0.070	mg/kg wwt	3.2	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Arsenic (As)-Total	0.055	0.052	mg/kg wwt	5.1	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Arsenic (As)-Total	0.014	<0.010	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-17	Tissue	WG1585172-4	Barium (Ba)-Total	2.36	2.21	mg/kg wwt	6.8	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Barium (Ba)-Total	5.57	5.65	mg/kg wwt	1.4	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Barium (Ba)-Total	1.85	1.91	mg/kg wwt	3.2	30	-	-	-
L1220862-17	Tissue	WG1585172-4	Beryllium (Be)-Total	<0.10	<0.10	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-33	Tissue	WG1585172-5	Beryllium (Be)-Total	<0.10	<0.10	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-41	Tissue	WG1585173-3	Beryllium (Be)-Total	<0.10	<0.10	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-17	Tissue	WG1585172-4	Bismuth (Bi)-Total	<0.030	<0.030	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-33	Tissue	WG1585172-5	Bismuth (Bi)-Total	<0.030	<0.030	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-41	Tissue	WG1585173-3	Bismuth (Bi)-Total	<0.030	<0.030	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-17	Tissue	WG1585172-4	Cadmium (Cd)-Total	0.170	0.157	mg/kg wwt	8.1	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Cadmium (Cd)-Total	0.0789	0.0766	mg/kg wwt	2.9	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Cadmium (Cd)-Total	0.0503	0.0519	mg/kg wwt	3.0	30	-	-	-
L1220862-17	Tissue	WG1585172-4	Calcium (Ca)-Total	7620	6570	mg/kg wwt	15	50	-	-	-
L1220862-33	Tissue	WG1585172-5	Calcium (Ca)-Total	11900	11500	mg/kg wwt	3.2	50	-	-	-
L1220862-41	Tissue	WG1585173-3	Calcium (Ca)-Total	5400	5530	mg/kg wwt	2.4	50	-	-	-
L1220862-17	Tissue	WG1585172-4	Chromium (Cr)-Total	0.13	0.13	mg/kg wwt	0.8	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Chromium (Cr)-Total	<0.10	<0.10	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-41	Tissue	WG1585173-3	Chromium (Cr)-Total	<0.10	<0.10	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-17	Tissue	WG1585172-4	Cobalt (Co)-Total	0.164	0.152	mg/kg wwt	7.6	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Cobalt (Co)-Total	0.250	0.248	mg/kg wwt	1.0	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Cobalt (Co)-Total	0.045	0.046	mg/kg wwt	2.7	30	-	-	-
L1220862-17	Tissue	WG1585172-4	Copper (Cu)-Total	1.67	1.57	mg/kg wwt	5.7	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Copper (Cu)-Total	0.718	0.716	mg/kg wwt	0.2	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Copper (Cu)-Total	0.629	0.651	mg/kg wwt	3.4	30	-	-	-
L1220862-17	Tissue	WG1585172-4	Iron (Fe)-Total	81.9	82.7	mg/kg wwt	1.0	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Iron (Fe)-Total	33.3	29.7	mg/kg wwt	12	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Iron (Fe)-Total	18.9	17.4	mg/kg wwt	8.5	30	-	-	-
L1220862-17	Tissue	WG1585172-4	Lead (Pb)-Total	0.042	0.039	mg/kg wwt	6.9	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Lead (Pb)-Total	0.022	0.022	mg/kg wwt	0.7	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Lead (Pb)-Total	<0.020	<0.020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-17	Tissue	WG1585172-4	Lithium (Li)-Total	0.11	0.11	mg/kg wwt	8.1	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Lithium (Li)-Total	<0.10	<0.10	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-41	Tissue	WG1585173-3	Lithium (Li)-Total	<0.10	<0.10	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-17	Tissue	WG1585172-4	Magnesium (Mg)-Total	310	295	mg/kg wwt	5.2	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Magnesium (Mg)-Total	358	352	mg/kg wwt	1.7	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Magnesium (Mg)-Total	344	340	mg/kg wwt	1.4	30	-	-	-
L1220862-17	Tissue	WG1585172-4	Manganese (Mn)-Total	3.34	3.13	mg/kg wwt	6.5	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Manganese (Mn)-Total	3.26	3.24	mg/kg wwt	0.4	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Manganese (Mn)-Total	1.17	1.22	mg/kg wwt	4.3	30	-	-	-
L1220862-17	Tissue	WG1585172-4	Mercury (Hg)-Total	0.0261	0.0254	mg/kg wwt	2.4	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Mercury (Hg)-Total	0.0287	0.0297	mg/kg wwt	3.5	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Mercury (Hg)-Total	0.0181	0.0182	mg/kg wwt	0.7	30	-	-	-
L1220862-17	Tissue	WG1585172-4	Molybdenum (Mo)-Total	0.024	0.022	mg/kg wwt	6.9	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Molybdenum (Mo)-Total	0.013	0.013	mg/kg wwt	0.8	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Molybdenum (Mo)-Total	0.015	0.015	mg/kg wwt	1.0	30	-	-	-

Appendix 3a. Replicate Results 2012

Sample ID	Matrix	ALS ID	Analyte	Replicate 1	Replicate 2	Units	RPD	RPD Limit	Diff	Diff Limit	Qualifier
L1220862-17	Tissue	WG1585172-4	Nickel (Ni)-Total	0.20	0.18	mg/kg wwt	11	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Nickel (Ni)-Total	0.12	0.12	mg/kg wwt	3.0	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Nickel (Ni)-Total	<0.10	<0.10	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-17	Tissue	WG1585172-4	Phosphorus (P)-Total	4950	4880	mg/kg wwt	1.4	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Phosphorus (P)-Total	8560	7830	mg/kg wwt	9.0	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Phosphorus (P)-Total	4300	3980	mg/kg wwt	7.7	30	-	-	-
L1220862-17	Tissue	WG1585172-4	Potassium (K)-Total	2570	2590	mg/kg wwt	0.6	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Potassium (K)-Total	2970	2610	mg/kg wwt	13	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Potassium (K)-Total	2890	2810	mg/kg wwt	2.7	30	-	-	-
L1220862-17	Tissue	WG1585172-4	Selenium (Se)-Total	1.06	1.02	mg/kg wwt	4.0	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Selenium (Se)-Total	2.02	1.96	mg/kg wwt	3.0	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Selenium (Se)-Total	1.04	1.09	mg/kg wwt	5.3	30	-	-	-
L1220862-17	Tissue	WG1585172-4	Sodium (Na)-Total	1000	990	mg/kg wwt	0.3	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Sodium (Na)-Total	1290	1110	mg/kg wwt	15	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Sodium (Na)-Total	838	766	mg/kg wwt	9.1	30	-	-	-
L1220862-17	Tissue	WG1585172-4	Strontium (Sr)-Total	4.96	4.61	mg/kg wwt	7.3	50	-	-	-
L1220862-33	Tissue	WG1585172-5	Strontium (Sr)-Total	9.94	9.69	mg/kg wwt	2.5	50	-	-	-
L1220862-41	Tissue	WG1585173-3	Strontium (Sr)-Total	3.92	4.12	mg/kg wwt	5.0	50	-	-	-
L1220862-17	Tissue	WG1585172-4	Thallium (Tl)-Total	<0.010	<0.010	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-33	Tissue	WG1585172-5	Thallium (Tl)-Total	<0.010	<0.010	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-41	Tissue	WG1585173-3	Thallium (Tl)-Total	<0.010	<0.010	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-17	Tissue	WG1585172-4	Tin (Sn)-Total	<0.050	<0.050	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-33	Tissue	WG1585172-5	Tin (Sn)-Total	0.107	0.103	mg/kg wwt	4.6	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Tin (Sn)-Total	<0.050	<0.050	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-17	Tissue	WG1585172-4	Titanium (Ti)-Total	2.0	2.0	mg/kg wwt	1.6	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Titanium (Ti)-Total	1.9	1.7	mg/kg wwt	9.1	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Titanium (Ti)-Total	0.53	0.48	mg/kg wwt	11	30	-	-	-
L1220862-17	Tissue	WG1585172-4	Uranium (U)-Total	0.0039	0.0036	mg/kg wwt	7.9	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Uranium (U)-Total	0.0021	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-41	Tissue	WG1585173-3	Uranium (U)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-17	Tissue	WG1585172-4	Vanadium (V)-Total	0.35	0.32	mg/kg wwt	7.8	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Vanadium (V)-Total	0.11	0.11	mg/kg wwt	5.2	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Vanadium (V)-Total	<0.10	<0.10	mg/kg wwt	N/A	30	-	-	RPD-NA
L1220862-17	Tissue	WG1585172-4	Zinc (Zn)-Total	21.1	19.7	mg/kg wwt	6.6	30	-	-	-
L1220862-33	Tissue	WG1585172-5	Zinc (Zn)-Total	24.2	23.7	mg/kg wwt	2.1	30	-	-	-
L1220862-41	Tissue	WG1585173-3	Zinc (Zn)-Total	22.6	23.4	mg/kg wwt	3.7	30	-	-	-

RPD = Relative Percent Difference

Diff = the difference between the replicate values in concentration units. Used where Replicate 1 value is <10x detection limit.

Appendix 3b. Replicate Results 2011

Sample ID	Matrix	ALS ID	Analyte	Replicate 1	Replicate 2	Units	RPD	RPD Limit	Diff	Diff Limit	Qualifier
Physical Tests											
L1111173-3	Tissue	WG1445245-1	% Moisture	77.3	76.9	%	0.50	20	-	-	-
L1111173-17	Tissue	WG1445245-2	% Moisture	75.1	75.9	%	0.94	20	-	-	-
Metals											
L1111173-3	Tissue	WG1445247-4	Aluminum (Al)-Total	5.44	6.65	mg/kg wwt	20	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Aluminum (Al)-Total	13.4	12.7	mg/kg wwt	4.9	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Antimony (Sb)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-17	Tissue	WG1445247-5	Antimony (Sb)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-3	Tissue	WG1445247-4	Arsenic (As)-Total	0.0128	0.0145	mg/kg wwt	13	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Arsenic (As)-Total	0.0240	0.0235	mg/kg wwt	2.0	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Barium (Ba)-Total	0.715	0.997	mg/kg wwt	33	30	-	-	DUP-H
L1111173-17	Tissue	WG1445247-5	Barium (Ba)-Total	1.44	1.74	mg/kg wwt	19	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Beryllium (Be)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-17	Tissue	WG1445247-5	Beryllium (Be)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-3	Tissue	WG1445247-4	Bismuth (Bi)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-17	Tissue	WG1445247-5	Bismuth (Bi)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-3	Tissue	WG1445247-4	Boron (B)-Total	<0.20	<0.20	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-17	Tissue	WG1445247-5	Boron (B)-Total	<0.20	<0.20	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-3	Tissue	WG1445247-4	Cadmium (Cd)-Total	0.0309	0.0335	mg/kg wwt	8.2	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Cadmium (Cd)-Total	0.0191	0.0227	mg/kg wwt	17	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Calcium (Ca)-Total	2140	3640	mg/kg wwt	52	50	-	-	DUP-H
L1111173-17	Tissue	WG1445247-5	Calcium (Ca)-Total	4480	5440	mg/kg wwt	19	50	-	-	-
L1111173-3	Tissue	WG1445247-4	Cesium (Cs)-Total	0.0036	0.0036	mg/kg wwt	0.12	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Cesium (Cs)-Total	0.0034	0.0034	mg/kg wwt	0.71	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Chromium (Cr)-Total	0.090	0.108	mg/kg wwt	19	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Chromium (Cr)-Total	0.218	0.143	mg/kg wwt	42	30	-	-	DUP-H
L1111173-3	Tissue	WG1445247-4	Cobalt (Co)-Total	0.0376	0.0406	mg/kg wwt	7.7	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Cobalt (Co)-Total	0.0433	0.0419	mg/kg wwt	3.3	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Copper (Cu)-Total	0.568	0.605	mg/kg wwt	6.3	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Copper (Cu)-Total	0.869	0.841	mg/kg wwt	3.2	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Gallium (Ga)-Total	<0.0040	<0.0040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-17	Tissue	WG1445247-5	Gallium (Ga)-Total	<0.0040	<0.0040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-3	Tissue	WG1445247-4	Iron (Fe)-Total	<20	<20	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-17	Tissue	WG1445247-5	Iron (Fe)-Total	<25	<25	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-3	Tissue	WG1445247-4	Lead (Pb)-Total	<0.016	<0.016	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-17	Tissue	WG1445247-5	Lead (Pb)-Total	<0.020	<0.020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-3	Tissue	WG1445247-4	Lithium (Li)-Total	0.044	0.048	mg/kg wwt	6.9	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Lithium (Li)-Total	<0.020	<0.020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-3	Tissue	WG1445247-4	Magnesium (Mg)-Total	280	292	mg/kg wwt	4.1	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Magnesium (Mg)-Total	291	311	mg/kg wwt	6.7	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Manganese (Mn)-Total	0.709	0.928	mg/kg wwt	27	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Manganese (Mn)-Total	2.03	2.24	mg/kg wwt	9.8	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Mercury (Hg)-Total	0.0190	0.0178	mg/kg wwt	6.4	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Mercury (Hg)-Total	0.0174	0.0210	mg/kg wwt	19	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Molybdenum (Mo)-Total	0.0119	0.0113	mg/kg wwt	5.7	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Molybdenum (Mo)-Total	0.0126	0.0122	mg/kg wwt	2.8	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Nickel (Ni)-Total	<0.090	<0.090	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-17	Tissue	WG1445247-5	Nickel (Ni)-Total	0.130	0.088	mg/kg wwt	38	30	-	-	DUP-H
L1111173-3	Tissue	WG1445247-4	Phosphorus (P)-Total	3270	3930	mg/kg wwt	18	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Phosphorus (P)-Total	4500	5050	mg/kg wwt	12	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Potassium (K)-Total	3910	3760	mg/kg wwt	4.1	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Potassium (K)-Total	3780	3790	mg/kg wwt	0.22	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Rhenium (Re)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-17	Tissue	WG1445247-5	Rhenium (Re)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-3	Tissue	WG1445247-4	Rubidium (Rb)-Total	1.05	1.03	mg/kg wwt	2.0	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Rubidium (Rb)-Total	0.977	1.02	mg/kg wwt	4.5	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Selenium (Se)-Total	0.754	0.779	mg/kg wwt	3.3	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Selenium (Se)-Total	0.503	0.554	mg/kg wwt	9.7	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Sodium (Na)-Total	1050	1050	mg/kg wwt	0.28	30	-	-	-

Appendix 3b. Replicate Results 2011

Sample ID	Matrix	ALS ID	Analyte	Replicate 1	Replicate 2	Units	RPD	RPD Limit	Diff	Diff Limit	Qualifier
L1111173-17	Tissue	WG1445247-5	Sodium (Na)-Total	950	980	mg/kg wwt	2.6	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Strontium (Sr)-Total	1.49	2.45	mg/kg wwt	49	50	-	-	-
L1111173-17	Tissue	WG1445247-5	Strontium (Sr)-Total	3.76	4.72	mg/kg wwt	23	50	-	-	-
L1111173-3	Tissue	WG1445247-4	Tellurium (Te)-Total	<0.0040	<0.0040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-17	Tissue	WG1445247-5	Tellurium (Te)-Total	<0.0040	<0.0040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-3	Tissue	WG1445247-4	Thallium (Tl)-Total	0.00434	0.00443	mg/kg wwt	2.0	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Thallium (Tl)-Total	0.00317	0.00352	mg/kg wwt	11	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Thorium (Th)-Total	0.0032	0.0033	mg/kg wwt	2.1	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Thorium (Th)-Total	0.0039	0.0030	mg/kg wwt	25	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Tin (Sn)-Total	0.0146	0.0097	mg/kg wwt	-	-	0.0049	0.008	J
L1111173-17	Tissue	WG1445247-5	Tin (Sn)-Total	0.0131	0.0072	mg/kg wwt	-	-	0.0059	0.008	J
L1111173-3	Tissue	WG1445247-4	Titanium (Ti)-Total	0.049	0.067	mg/kg wwt	-	-	0.018	0.02	J
L1111173-17	Tissue	WG1445247-5	Titanium (Ti)-Total	0.136	0.136	mg/kg wwt	0.087	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Uranium (U)-Total	0.00055	0.00080	mg/kg wwt	-	-	0.00024	0.0008	J
L1111173-17	Tissue	WG1445247-5	Uranium (U)-Total	0.00126	0.00149	mg/kg wwt	17	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Vanadium (V)-Total	0.0234	0.0303	mg/kg wwt	26	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Vanadium (V)-Total	0.0603	0.0545	mg/kg wwt	10	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Yttrium (Y)-Total	0.0039	0.0050	mg/kg wwt	23	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Yttrium (Y)-Total	0.0093	0.0096	mg/kg wwt	2.4	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Zinc (Zn)-Total	20.1	22.8	mg/kg wwt	12	30	-	-	-
L1111173-17	Tissue	WG1445247-5	Zinc (Zn)-Total	23.9	26.5	mg/kg wwt	10	30	-	-	-
L1111173-3	Tissue	WG1445247-4	Zirconium (Zr)-Total	<0.040	<0.040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1111173-17	Tissue	WG1445247-5	Zirconium (Zr)-Total	0.054	<0.040	mg/kg wwt	N/A	30	-	-	RPD-NA

RPD = Relative Percent Difference

Diff = the difference between the replicate values in concentration units. Used where Replicate 1 value is <10x detection limit.

J = Duplicate results and limits are expressed in terms of absolute difference.

RPD-NA = Relative Percent Difference Not Available due to result(s) being less than detection limit.

DUP-H = Duplicate results outside ALS DQO, due to sample heterogeneity.

Appendix 3c. Replicate Results 2011 - (Quintette Project)

Sample ID	Matrix	ALS ID	Analyte	Replicate 1	Replicate 2	Units	RPD	RPD Limit	Diff	Diff Limit	Qualifier
Physical Tests											
L1092391-17	Tissue	WG1414166-1	% Moisture	73.6	74.2	%	0.88	20	-	-	-
L1092391-20	Tissue	WG1414166-2	% Moisture	74.7	75.7	%	1.4	20	-	-	-
L1092391-24	Tissue	WG1414718-1	% Moisture	77.5	77.4	%	0.069	20	-	-	-
L1092391-59	Tissue	WG1414718-2	% Moisture	75.1	76.2	%	1.5	20	-	-	-
Metals											
L1092391-17	Tissue	WG1420722-4	Aluminum (Al)-Total	58.0	56.4	mg/kg wwt	2.7	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Aluminum (Al)-Total	47.2	46.0	mg/kg wwt	2.6	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Aluminum (Al)-Total	11.2	14.3	mg/kg wwt	24	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Aluminum (Al)-Total	63.0	36.7	mg/kg wwt	53	30	-	-	DUP-H
L1092391-17	Tissue	WG1420722-4	Antimony (Sb)-Total	0.0021	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-20	Tissue	WG1414169-5	Antimony (Sb)-Total	<0.0020	0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-24	Tissue	WG1414720-4	Antimony (Sb)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-59	Tissue	WG1414720-5	Antimony (Sb)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-17	Tissue	WG1420722-4	Arsenic (As)-Total	0.0467	0.0523	mg/kg wwt	11	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Arsenic (As)-Total	0.0547	0.0539	mg/kg wwt	1.4	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Arsenic (As)-Total	0.0450	0.0466	mg/kg wwt	3.4	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Arsenic (As)-Total	0.0159	0.0185	mg/kg wwt	15	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Barium (Ba)-Total	17.1	16.0	mg/kg wwt	6.6	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Barium (Ba)-Total	20.1	17.6	mg/kg wwt	13	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Barium (Ba)-Total	8.38	9.08	mg/kg wwt	8.0	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Barium (Ba)-Total	2.33	1.29	mg/kg wwt	57	30	-	-	DUP-H
L1092391-17	Tissue	WG1420722-4	Beryllium (Be)-Total	0.0020	0.0021	mg/kg wwt	3.3	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Beryllium (Be)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-24	Tissue	WG1414720-4	Beryllium (Be)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-59	Tissue	WG1414720-5	Beryllium (Be)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-17	Tissue	WG1420722-4	Bismuth (Bi)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-20	Tissue	WG1414169-5	Bismuth (Bi)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-24	Tissue	WG1414720-4	Bismuth (Bi)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-59	Tissue	WG1414720-5	Bismuth (Bi)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-17	Tissue	WG1420722-4	Boron (B)-Total	<0.30	0.21	mg/kg wwt	26	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Boron (B)-Total	<0.20	<0.20	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-24	Tissue	WG1414720-4	Boron (B)-Total	<0.60	<0.60	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-59	Tissue	WG1414720-5	Boron (B)-Total	<0.20	<0.20	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-17	Tissue	WG1420722-4	Cadmium (Cd)-Total	0.0210	0.0196	mg/kg wwt	7.0	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Cadmium (Cd)-Total	0.0132	0.0142	mg/kg wwt	7.5	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Cadmium (Cd)-Total	0.0082	0.0083	mg/kg wwt	1.9	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Cadmium (Cd)-Total	0.0324	0.0272	mg/kg wwt	17	30	-	-	-
L1092391-17	Tissue	WG1414169-4	Calcium (Ca)-Total	12600	9760	mg/kg wwt	26	50	-	-	-
L1092391-20	Tissue	WG1414169-5	Calcium (Ca)-Total	12800	11700	mg/kg wwt	9.1	50	-	-	-
L1092391-24	Tissue	WG1414720-4	Calcium (Ca)-Total	8530	9720	mg/kg wwt	13	50	-	-	-
L1092391-59	Tissue	WG1414720-5	Calcium (Ca)-Total	6790	1790	mg/kg wwt	117	50	-	-	DUP-H
L1092391-17	Tissue	WG1420722-4	Cesium (Cs)-Total	0.0091	0.0084	mg/kg wwt	7.5	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Cesium (Cs)-Total	0.0068	0.0068	mg/kg wwt	0.55	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Cesium (Cs)-Total	0.0033	0.0039	mg/kg wwt	18	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Cesium (Cs)-Total	0.0127	0.0103	mg/kg wwt	21	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Chromium (Cr)-Total	0.186	0.166	mg/kg wwt	11	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Chromium (Cr)-Total	0.155	0.164	mg/kg wwt	5.9	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Chromium (Cr)-Total	0.078	0.052	mg/kg wwt	39	30	-	-	DUP-H
L1092391-59	Tissue	WG1414720-5	Chromium (Cr)-Total	0.172	0.083	mg/kg wwt	70	30	-	-	DUP-H
L1092391-17	Tissue	WG1420722-4	Cobalt (Co)-Total	0.0375	0.0369	mg/kg wwt	1.7	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Cobalt (Co)-Total	0.0321	0.0347	mg/kg wwt	7.7	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Cobalt (Co)-Total	0.0129	0.0125	mg/kg wwt	3.3	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Cobalt (Co)-Total	0.119	0.136	mg/kg wwt	13	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Copper (Cu)-Total	1.80	1.78	mg/kg wwt	1.3	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Copper (Cu)-Total	1.27	1.45	mg/kg wwt	13	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Copper (Cu)-Total	1.48	1.69	mg/kg wwt	13	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Copper (Cu)-Total	0.672	0.949	mg/kg wwt	34	30	-	-	DUP-H
L1092391-17	Tissue	WG1420722-4	Gallium (Ga)-Total	0.0152	0.0127	mg/kg wwt	18	30	-	-	-

Appendix 3c. Replicate Results 2011 - (Quintette Project)

Sample ID	Matrix	ALS ID	Analyte	Replicate 1	Replicate 2	Units	RPD	RPD Limit	Diff	Diff Limit	Qualifier
L1092391-20	Tissue	WG1414169-5	Gallium (Ga)-Total	0.0116	0.0114	mg/kg wwt	1.7	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Gallium (Ga)-Total	<0.0040	<0.0040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-59	Tissue	WG1414720-5	Gallium (Ga)-Total	0.0153	0.0093	mg/kg wwt	-	-	0.0059	0.008	J
L1092391-17	Tissue	WG1420722-4	Iron (Fe)-Total	56.3	53.1	mg/kg wwt	5.8	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Iron (Fe)-Total	50.4	52.7	mg/kg wwt	4.4	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Iron (Fe)-Total	29.2	31.1	mg/kg wwt	6.3	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Iron (Fe)-Total	37.3	38.6	mg/kg wwt	3.4	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Lead (Pb)-Total	0.0254	0.0237	mg/kg wwt	6.9	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Lead (Pb)-Total	0.0203	0.0223	mg/kg wwt	9.5	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Lead (Pb)-Total	0.0060	0.0097	mg/kg wwt	-	-	0.0037	0.008	J
L1092391-59	Tissue	WG1414720-5	Lead (Pb)-Total	0.0160	0.0127	mg/kg wwt	23	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Lithium (Li)-Total	0.097	<0.020	mg/kg wwt	N/A	30	-	-	DUP-H
L1092391-20	Tissue	WG1414169-5	Lithium (Li)-Total	<0.10	<0.10	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-24	Tissue	WG1414720-4	Lithium (Li)-Total	0.035	0.039	mg/kg wwt	11	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Lithium (Li)-Total	0.055	0.027	mg/kg wwt	-	-	0.028	0.04	J
L1092391-17	Tissue	WG1414169-4	Magnesium (Mg)-Total	445	400	mg/kg wwt	10	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Magnesium (Mg)-Total	447	443	mg/kg wwt	0.92	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Magnesium (Mg)-Total	352	373	mg/kg wwt	6.0	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Magnesium (Mg)-Total	329	253	mg/kg wwt	26	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Manganese (Mn)-Total	6.38	6.07	mg/kg wwt	5.0	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Manganese (Mn)-Total	6.97	5.99	mg/kg wwt	15	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Manganese (Mn)-Total	3.25	3.43	mg/kg wwt	5.4	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Manganese (Mn)-Total	1.19	0.679	mg/kg wwt	55	30	-	-	DUP-H
L1092391-17	Tissue	WG1414169-4	Mercury (Hg)-Total	0.114	0.130	mg/kg wwt	13	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Mercury (Hg)-Total	0.104	0.115	mg/kg wwt	10	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Mercury (Hg)-Total	0.0851	0.0838	mg/kg wwt	1.6	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Mercury (Hg)-Total	0.0277	0.0299	mg/kg wwt	7.8	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Molybdenum (Mo)-Total	0.0422	0.0398	mg/kg wwt	5.7	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Molybdenum (Mo)-Total	0.0454	0.0457	mg/kg wwt	0.62	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Molybdenum (Mo)-Total	0.0224	0.0254	mg/kg wwt	13	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Molybdenum (Mo)-Total	0.0136	0.0176	mg/kg wwt	26	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Nickel (Ni)-Total	0.106	0.093	mg/kg wwt	13	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Nickel (Ni)-Total	0.073	0.077	mg/kg wwt	5.7	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Nickel (Ni)-Total	0.035	0.080	mg/kg wwt	78	30	-	-	DUP-H
L1092391-59	Tissue	WG1414720-5	Nickel (Ni)-Total	0.063	0.064	mg/kg wwt	2.8	30	-	-	-
L1092391-17	Tissue	WG1414169-4	Phosphorus (P)-Total	7850	6640	mg/kg wwt	17	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Phosphorus (P)-Total	8090	7610	mg/kg wwt	6.0	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Phosphorus (P)-Total	5670	6270	mg/kg wwt	10	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Phosphorus (P)-Total	5390	3170	mg/kg wwt	52	30	-	-	-
L1092391-17	Tissue	WG1414169-4	Potassium (K)-Total	3070	3060	mg/kg wwt	0.22	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Potassium (K)-Total	3010	3370	mg/kg wwt	11	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Potassium (K)-Total	3050	3130	mg/kg wwt	2.5	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Potassium (K)-Total	3730	3760	mg/kg wwt	0.90	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Rhenium (Re)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-20	Tissue	WG1414169-5	Rhenium (Re)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-24	Tissue	WG1414720-4	Rhenium (Re)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-59	Tissue	WG1414720-5	Rhenium (Re)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-17	Tissue	WG1420722-4	Rubidium (Rb)-Total	1.49	1.40	mg/kg wwt	6.1	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Rubidium (Rb)-Total	1.25	1.31	mg/kg wwt	4.5	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Rubidium (Rb)-Total	1.42	1.56	mg/kg wwt	9.1	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Rubidium (Rb)-Total	1.58	1.53	mg/kg wwt	3.0	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Selenium (Se)-Total	0.693	0.618	mg/kg wwt	11	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Selenium (Se)-Total	0.546	0.584	mg/kg wwt	6.7	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Selenium (Se)-Total	0.505	0.498	mg/kg wwt	1.4	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Selenium (Se)-Total	1.36	1.42	mg/kg wwt	4.4	30	-	-	-
L1092391-17	Tissue	WG1414169-4	Sodium (Na)-Total	990	920	mg/kg wwt	7.0	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Sodium (Na)-Total	930	1010	mg/kg wwt	9.0	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Sodium (Na)-Total	830	860	mg/kg wwt	3.4	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Sodium (Na)-Total	1040	1000	mg/kg wwt	3.2	30	-	-	-

Appendix 3c. Replicate Results 2011 - (Quintette Project)

Sample ID	Matrix	ALS ID	Analyte	Replicate 1	Replicate 2	Units	RPD	RPD Limit	Diff	Diff Limit	Qualifier
L1092391-17	Tissue	WG1420722-4	Strontium (Sr)-Total	11.6	10.9	mg/kg wwt	6.1	50	-	-	-
L1092391-20	Tissue	WG1414169-5	Strontium (Sr)-Total	13.5	11.6	mg/kg wwt	15	50	-	-	-
L1092391-24	Tissue	WG1414720-4	Strontium (Sr)-Total	8.25	9.51	mg/kg wwt	14	50	-	-	-
L1092391-59	Tissue	WG1414720-5	Strontium (Sr)-Total	5.10	1.56	mg/kg wwt	106	50	-	-	DUP-H
L1092391-17	Tissue	WG1420722-4	Tellurium (Te)-Total	<0.0040	<0.0040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-20	Tissue	WG1414169-5	Tellurium (Te)-Total	<0.0040	<0.0040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-24	Tissue	WG1414720-4	Tellurium (Te)-Total	<0.0040	<0.0040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-59	Tissue	WG1414720-5	Tellurium (Te)-Total	<0.0040	<0.0040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-17	Tissue	WG1420722-4	Thallium (Tl)-Total	0.00197	0.00194	mg/kg wwt	1.6	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Thallium (Tl)-Total	0.00159	0.00169	mg/kg wwt	6.5	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Thallium (Tl)-Total	0.00139	0.00154	mg/kg wwt	11	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Thallium (Tl)-Total	0.00932	0.00976	mg/kg wwt	4.6	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Thorium (Th)-Total	0.0067	0.0063	mg/kg wwt	5.6	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Thorium (Th)-Total	0.0056	0.0061	mg/kg wwt	8.2	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Thorium (Th)-Total	<0.0020	<0.0020	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-59	Tissue	WG1414720-5	Thorium (Th)-Total	0.0055	0.0041	mg/kg wwt	-	-	0.0015	0.004	J
L1092391-17	Tissue	WG1420722-4	Tin (Sn)-Total	<0.0040	<0.0040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-20	Tissue	WG1414169-5	Tin (Sn)-Total	<0.0040	<0.0040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-24	Tissue	WG1414720-4	Tin (Sn)-Total	<0.0040	<0.0040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-59	Tissue	WG1414720-5	Tin (Sn)-Total	0.0097	0.0130	mg/kg wwt	28	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Titanium (Ti)-Total	0.961	0.917	mg/kg wwt	4.6	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Titanium (Ti)-Total	1.66	1.50	mg/kg wwt	10	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Titanium (Ti)-Total	0.092	0.337	mg/kg wwt	114	30	-	-	DUP-H
L1092391-59	Tissue	WG1414720-5	Titanium (Ti)-Total	0.323	0.281	mg/kg wwt	14	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Uranium (U)-Total	0.00209	0.00203	mg/kg wwt	2.6	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Uranium (U)-Total	0.00188	0.00195	mg/kg wwt	3.6	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Uranium (U)-Total	0.00059	0.00068	mg/kg wwt	15	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Uranium (U)-Total	0.00237	0.00180	mg/kg wwt	27	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Vanadium (V)-Total	0.214	0.203	mg/kg wwt	5.5	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Vanadium (V)-Total	0.168	0.162	mg/kg wwt	3.9	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Vanadium (V)-Total	0.0397	0.0484	mg/kg wwt	20	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Vanadium (V)-Total	0.230	0.130	mg/kg wwt	55	30	-	-	DUP-H
L1092391-17	Tissue	WG1420722-4	Yttrium (Y)-Total	0.0212	0.0202	mg/kg wwt	5.0	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Yttrium (Y)-Total	0.0138	0.0180	mg/kg wwt	26	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Yttrium (Y)-Total	0.0031	0.0040	mg/kg wwt	25	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Yttrium (Y)-Total	0.0130	0.0140	mg/kg wwt	7.4	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Zinc (Zn)-Total	55.8	52.2	mg/kg wwt	6.6	30	-	-	-
L1092391-20	Tissue	WG1414169-5	Zinc (Zn)-Total	78.5	77.6	mg/kg wwt	1.1	30	-	-	-
L1092391-24	Tissue	WG1414720-4	Zinc (Zn)-Total	62.4	60.3	mg/kg wwt	3.5	30	-	-	-
L1092391-59	Tissue	WG1414720-5	Zinc (Zn)-Total	19.8	20.2	mg/kg wwt	2.2	30	-	-	-
L1092391-17	Tissue	WG1420722-4	Zirconium (Zr)-Total	<0.040	<0.040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-20	Tissue	WG1414169-5	Zirconium (Zr)-Total	<0.040	<0.040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-24	Tissue	WG1414720-4	Zirconium (Zr)-Total	<0.040	<0.040	mg/kg wwt	N/A	30	-	-	RPD-NA
L1092391-59	Tissue	WG1414720-5	Zirconium (Zr)-Total	0.041	<0.040	mg/kg wwt	N/A	30	-	-	RPD-NA

RPD = Relative Percent Difference

Diff = the difference between the replicate values in concentration units. Used where Replicate 1 value is <10x detection limit.

J = Duplicate results and limits are expressed in terms of absolute difference.

RPD-NA = Relative Percent Difference Not Available due to result(s) being less than detection limit.

DUP-H = Duplicate results outside ALS DQO, due to sample heterogeneity.

Appendix 3d. Replicate Results 2004 - (Hermann Project)

Sample ID	Matrix	ALS ID	Analyte	Replicate 1	Replicate 2	Units	RPD	RPD Limit	Diff	Diff Limit	Qualifier
SESYN- CLINE-4	Tissue	4	Aluminum T-Al	69	73		5.63				QC# 411593
SESYN- CLINE-4	Tissue	4	Antimony T-Sb	<0.20	<0.20		N/A				QC# 411593
SESYN- CLINE-4	Tissue	4	Arsenic T-As	0.21	0.21		0.00				QC# 411593
SESYN- CLINE-4	Tissue	4	Barium T-Ba	10.8	13.3		20.75				QC# 411593
SESYN- CLINE-4	Tissue	4	Beryllium T-Be	<1.2	<1.2		N/A				QC# 411593
SESYN- CLINE-4	Tissue	4	Bismuth T-Bi	<1.2	<1.2		N/A				QC# 411593
SESYN- CLINE-4	Tissue	4	Cadmium T-Cd	0.45	0.61		30.19				QC# 411593
SESYN- CLINE-4	Tissue	4	Calcium T-Ca	46800	61000		26.35				QC# 411593
SESYN- CLINE-4	Tissue	4	Chromium T-Cr	<2.0	<2.0		N/A				QC# 411593
SESYN- CLINE-4	Tissue	4	Cobalt T-Co	<0.40	<0.40		N/A				QC# 411593
SESYN- CLINE-4	Tissue	4	Copper T-Cu	2.76	2.95		6.65				QC# 411593
SESYN- CLINE-4	Tissue	4	Lead T-Pb	<0.40	<0.40		N/A				QC# 411593
SESYN- CLINE-4	Tissue	4	Lithium T-Li	<2.0	<2.0		N/A				QC# 411593
SESYN- CLINE-4	Tissue	4	Magnesium T-Mg	1670	1790		6.94				QC# 411593
SESYN- CLINE-4	Tissue	4	Manganese T-Mn	14.9	17		13.17				QC# 411593
SESYN- CLINE-4	Tissue	4	Mercury T-Hg	0.139	0.113		20.63				QC# 411593
SESYN- CLINE-4	Tissue	4	Molybdenum T-Mo	<0.20	<0.20		N/A				QC# 411593
SESYN- CLINE-4	Tissue	4	Nickel T-Ni	<2.0	<2.0		N/A				QC# 411593
SESYN- CLINE-4	Tissue	4	Selenium T-Se	3.91	3.7		5.52				QC# 411593
SESYN- CLINE-4	Tissue	4	Strontium T-Sr	32.3	40.9		23.50				QC# 411593
SESYN- CLINE-4	Tissue	4	Thallium T-Tl	<0.12	<0.12		N/A				QC# 411593
SESYN- CLINE-4	Tissue	4	Tin T-Sn	<0.80	<0.80		N/A				QC# 411593
SESYN- CLINE-4	Tissue	4	Uranium T-U	<0.040	<0.040		N/A				QC# 411593
SESYN- CLINE-4	Tissue	4	Vanadium T-V	<2.0	<2.0		N/A				QC# 411593
SESYN- CLINE-4	Tissue	4	Zinc T-Zn	101	103		1.96				QC# 411593
M20 d/s-1	Tissue	6	Aluminum T-Al	48	<40		N/A				QC# 411801
M20 d/s-1	Tissue	6	Antimony T-Sb	<0.20	<0.20		N/A				QC# 411801
M20 d/s-1	Tissue	6	Arsenic T-As	<0.20	<0.20		N/A				QC# 411801
M20 d/s-1	Tissue	6	Barium T-Ba	24.5	18.6		27.38				QC# 411801
M20 d/s-1	Tissue	6	Beryllium T-Be	<1.2	<1.2		N/A				QC# 411801
M20 d/s-1	Tissue	6	Bismuth T-Bi	<1.2	<1.2		N/A				QC# 411801
M20 d/s-1	Tissue	6	Cadmium T-Cd	0.14	<0.12		N/A				QC# 411801
M20 d/s-1	Tissue	6	Calcium T-Ca	69300	51200		30.04				QC# 411801
M20 d/s-1	Tissue	6	Chromium T-Cr	<2.0	<2.0		N/A				QC# 411801
M20 d/s-1	Tissue	6	Cobalt T-Co	<0.40	<0.40		N/A				QC# 411801
M20 d/s-1	Tissue	6	Copper T-Cu	2.24	1.87		18.00				QC# 411801
M20 d/s-1	Tissue	6	Lead T-Pb	<0.40	<0.40		N/A				QC# 411801
M20 d/s-1	Tissue	6	Lithium T-Li	<2.0	<2.0		N/A				QC# 411801
M20 d/s-1	Tissue	6	Magnesium T-Mg	1750	1500		15.38				QC# 411801
M20 d/s-1	Tissue	6	Manganese T-Mn	9.19	7.14		25.11				QC# 411801
M20 d/s-1	Tissue	6	Mercury T-Hg	0.082	0.0666		20.73				QC# 411801
M20 d/s-1	Tissue	6	Molybdenum T-Mo	<0.20	<0.20		N/A				QC# 411801
M20 d/s-1	Tissue	6	Nickel T-Ni	<2.0	<2.0		N/A				QC# 411801
M20 d/s-1	Tissue	6	Selenium T-Se	5.66	5.35		5.63				QC# 411801
M20 d/s-1	Tissue	6	Strontium T-Sr	55.4	40.9		30.11				QC# 411801
M20 d/s-1	Tissue	6	Thallium T-Tl	<0.12	<0.12		N/A				QC# 411801
M20 d/s-1	Tissue	6	Tin T-Sn	<0.80	<0.80		N/A				QC# 411801
M20 d/s-1	Tissue	6	Uranium T-U	<0.040	<0.040		N/A				QC# 411801
M20 d/s-1	Tissue	6	Vanadium T-V	<2.0	<2.0		N/A				QC# 411801
M20 d/s-1	Tissue	6	Zinc T-Zn	120	111		7.79				QC# 411801

RPD = Relative Percent Difference (RPD = 100((sample - duplicate)/((sample + duplicate)/2))).

Diff = the difference between the replicate values in concentration units. Used where Replicate 1 value is <10x detection limit.

Appendix 3e. Tests of Variability of Fish Tissue Metal Concentrations, Murray River Project (a) 2011, and (b) 2011 – Quintette Project

(a)

Qualifier	Number of Potential RPD	Percent
RPD-NA	22	28
DUP-H	4	5
J	4	5
RPD	50	63
Total	**80**	**100**

(b)

Qualifier	Number of Potential RPD	Percent
RPD-NA	32	20
DUP-H	12	8
J	4	3
RPD	112	70
Total	**160**	**100**

Notes: RPD = Relative Percent Different, RPD-NA = RPD not available due to result(s) being less than detection limit, J = Duplicate results and limits are expressed in terms of absolute difference, DUP-H = Duplicate results outside ALS DQO, due to sample heterogeneity.

Appendix 4

FHAP Data

ERM

Appendix 4a. FHAP Data, 2013

Rescan

Murray River Project

FHAP Survey Form

Station ID: M19A-1

Survey Date (d/m/y): 14-Jun-13

Survey Crew: FR

Survey Distance (m) 100

Coordinates: 10 U 626904 6099476

Coordinates: 10 U 626959 6099413

Temperature (°C): 10

Channel Velocity (m/s):

Current Flow Conditions: High

Discharge estimate (m^3/s)

Transparency:

Conductivity (uS/cm): 59

pH: 7.9

Comments

Flow high, some areas flooded beyond channel but water is relatively clear.

Weather:

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Pool Depth (m) Crest	Fish Passage Barriers Type	T/P
1	G	0	34	1.0	0.34	0.50	1.0	1.2	20	50	20	10					Log Jam	T/P
2	P	34	30	0.0	0.35	0.35	28.0	28.0	100					D	0.55	0.1	Log Jam	T/P
3	G	64	36	1 to 2	0.40	0.40	3.0	3.0	80	20							Several Log Jams	T/P
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow

Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2

Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden

Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed

Pool Type S = scour, D = dammed, U = unknown

Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)

Fish Passage Barriers IF = Impassible waterfall

BF = Boulder Field, passage through the boulder arrangement is not possible for fish

D = dry channel, no stream flow

NC = no distinct channel, water drains over land

N = no barrier to fish passage through the habitat unit

T/P T = temporary, portion of open water season

P = Permanent, all year round

Overall Rating

Spawning: Poor **Rearing:** Fair **Adult Feeding:** Fair **Over-wintering:** Fair

Migration: Poor- several log jams that may restrict fish movement

Appendix 4a. FHAP Data, 2013

Rescan

Murray River Project
FHAP Survey Form

Station ID: ____________________

Hab Unit No.	Banks of Channel: L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover: Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover: Canopy %	LB %	RB %
1	0.85	0.85	Stab	Stab		10	20	40	10	10	10	Log jam, 72 c	There is a log jam that is over 1 m high at the upstre	80	80	80
2			U	U	20		40	20		10	10	76	This is not a typical pool. There is a long log jam tha	30	30	30
3	0.20	0.20	U	u			20	20	10	20	20	77 to 82		40	40	40
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Appendix 4a. FHAP Data, 2013

Murray River Project
FHAP Survey Form

Station ID: M19A-2
Survey Date (d/m/y): 14-Jun-13
Survey Crew: FR
Survey Distance (m) 100

Coordinates: 10 U 626995 6099374
Coordinates: 10 U 627084 6099365

Temperature (°C): 10
Channel Velocity (m/s):
Current Flow Conditions: High
Discharge estimate (m^3/s)

Transparency:
Conductivity (uS/cm): 38
pH: 7.8

Comments
Flow high, some areas flooded beyond channel but water is relatively clear.

Weather:

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Bed Material Gravel (%)	Bed Material Cobble (%)	Bed Material Boulder (%)	Bed Material Bedrock (%)	Pool Info Type	Pool Info Depth (m) Max	Pool Info Depth (m) Crest	Fish Passage Barriers Type	Fish Passage Barriers T/P
1	G	0	34	1 to 2	0.23	0.23	2.1	2.1	10	70	20						N	
2	P	34	8	0.0	0.37	0.37	4.2	4.2	100					D	0.41	0.11	Log Jam	T/P
3	G	42	31	2.0	0.31	0.31	2.8	2.8	10	60	20	10						
4	R	73	11	>3	0.14	0.14	1.8	1.8		80	20							
5	G	84	16	1 to 2	0.32	0.32	3.1	3.1	10	70	20						Log jam	T/P
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow
Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2
Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden
Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed
Pool Type S = scour, D = dammed, U = unknown
Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)
Fish Passage Barriers IF = Impassible waterfall
BF = Boulder Field, passage through the boulder arrangement is not possible for fish
D = dry channel, no stream flow
NC = no distinct channel, water drains over land
N = no barrier to fish passage through the habitat unit
T/P T = temporary, portion of open water season
P = Permanent, all year round

Overall Rating

Spawning: Good **Rearing:** Good **Adult Feeding:** Fair **Over-wintering:** Good

Migration: Fair- several log jams along this creek may restrict fish movement in some flow conditions

Appendix 4a. FHAP Data, 2013

Murray River Project
FHAP Survey Form

Station ID: ____________________

Hab Unit No.	Banks of Channel L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover Canopy %	LB %	RB %
1	0.10	0.25	Stab	Stab				20		40	10	85	Nice glide with lots of LWD. Good flow, good substra	20	20	20
2	0.15	0.20	Stab	Stab	30		30	20		10	10	87	Small "pool" where a log jam has backed up water. Tl	60	60	60
3	0.35	0.40	Stab	Stab		10	10	40	10	20	10	88 and 89	Glide, close to being a riffle in places. Good overhea	60	60	60
4	0.45	0.30	Stab	Stab			10	40		20	20	90 and 91		30	30	30
5	0.20	0.20	Stab	Stab			20	20		30	20	92 to 93		40	40	40
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Appendix 4a. FHAP Data, 2013

Rescan

Murray River Project
FHAP Survey Form

Station ID:	M19A-3	Survey Date (d/m/y):	25/08/2013	Coordinates:	Coordinates:
		Survey Crew:	KE/PH	Easting 627360	Northing 6099292
Survey Distance (m)	50			gps	gps

Temperature (°C):		Transparency:	clear	Comments
Channel Velocity (m/s):		Conductivity (uS/cm):		
Current Flow Conditions:	low	pH:		Weather:
Discharge estimate (m^3/s)	n/a			

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Pool Depth (m) Crest	Fish Passage Barriers Type	T/P
1	R	0	50	1.5	0.09	0.30	0.8	1.5	10	65	20	5	0	n/a	n/a	n/a	n/a	n/a
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions	H = High flow, M = Medium flow, L = Low flow
Habitat Unit	Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2
Hab Type	P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden
Dist. fr start	distance from beginning of the survey to the beginning of the habitat unit being surveyed
Pool Type	S = scour, D = dammed, U = unknown
Substrate	Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)
Fish Passage Barriers	IF = Impassible waterfall
	BF = Boulder Field, passage through the boulder arrangement is not possible for fish
	D = dry channel, no stream flow
	NC = no distinct channel, water drains over land
	N = no barrier to fish passage through the habitat unit
T/P	T = temporary, portion of open water season
	P = Permanent, all year round

Overall Rating: Marginal habitat, no permanent barriers, beaver dams (temporary/ephemeral barriers) located downstream between site and M19 confluence

Spawning: poor | **Rearing:** fair (no pools, shallow) | **Adult Feeding:** none | **Over-wintering:** none

Notes:

Possible habitat use by finescale dace and/or brook trout.

Stream is very closed in by riparian vegetation and tree fall, preventing access to the stream.

Appendix 4a. FHAP Data, 2013

Rescan

Murray River Project
FHAP Survey Form

Station ID: M19A

Hab Unit No.	Banks of Channel L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover Canopy %	LB %	RB %
1	0.15	0.15	H	H	0	5	10	20	5	20	40	803-810		100	100	100
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability)   H = highly stable, S = stable, U = unstable

Migration: poor

very shallow

Appendix 4a. FHAP Data, 2013

Rescan

Murray River Project
FHAP Survey Form

Station ID:	CS1	Survey Date (d/m/y):	24/08/2013
		Survey Crew:	KE/PH
Survey Distance (m)	43		

Coordinates: 625930 6096834 gps

Coordinates: 625954 6096797 gps

Temperature (°C):		Transparency:	clear
Channel Velocity (m/s):		Conductivity (uS/cm):	
Current Flow Conditions:	low	pH:	
Discharge estimate (m^3/s)	n/a		

Comments

Weather:

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Pool Depth (m) Crest	Fish Passage Barriers Type	T/P
1	W	0	43	0.0	0.50	1.10	9.0	11.0	100	0	0	0	0	n/a	n/a	n/a	n/a	n/a
2					0.35	1.00	6.0	8.0										
3					0.30	0.90	4.0	5.0										
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions	H = High flow, M = Medium flow, L = Low flow
Habitat Unit	Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2
Hab Type	P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden
Dist. fr start	distance from beginning of the survey to the beginning of the habitat unit being surveyed
Pool Type	S = scour, D = dammed, U = unknown
Substrate	Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)
Fish Passage Barriers	IF = Impassible waterfall
	BF = Boulder Field, passage through the boulder arrangement is not possible for fish
	D = dry channel, no stream flow
	NC = no distinct channel, water drains over land
	N = no barrier to fish passage through the habitat unit
T/P	T = temporary, portion of open water season
	P = Permanent, all year round

Overall Rating: Marginal habitat, no permanent barriers, beaver dams (temporary/ephemeral barriers) located downstream between site and M19 confluence

Spawning: good (for NP) **Rearing:** good (for NP and BB) **Adult Feeding:** fair (for NP) **Over-wintering:** none

Notes:

NP and BB presence confirmed by beach seining and minnow trapping

Appendix 4a. FHAP Data, 2013

Murray River Project
FHAP Survey Form

Station ID: CS5

Hab Unit No.	Banks of Channel L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover Canopy %	LB %	RB %
1	0.60	0.50	S	S	0	1	100	0	0	0	0			100	100	100
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Migration: good (to Murray River)

Appendix 4a. FHAP Data, 2013

Rescan

Murray River Project

FHAP Survey Form

Station ID: CS5	Survey Date (d/m/y): 23/08/2013	Coordinates:		Coordinates:
	Survey Crew: KE/PH	620538	6090655	620586 6090577
Survey Distance (m) 93		gps		gps

Temperature (°C):

Channel Velocity (m/s):

Current Flow Conditions: low

Discharge estimate (ft^3/s) 0.5

Transparency: clear

Conductivity (uS/cm):

pH:

Comments

Weather:
sunny

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Pool Depth (m) Crest	Fish Passage Barriers Type	T/P
1	R	0	12	2.0	0.12	0.30	2.3	2.6	45	50	5	0	0	n/a	n/a	n/a	n/a	n/a
2	P	12	3.5	0.0			2.6	3.4	50	45	5	0	0	S	0.43	0.07	n/a	n/a
3	G	15.5	54.9	1.5	0.20	0.70	1.0	2.6	100	0	0	0	0	n/a	n/a	n/a	n/a	n/a
4	P	70.4	1.6	0.0			0.8	2.8	50	50	0	0	0	S	0.42	0.12	n/a	n/a
5	R	72	6	3.0	0.10	0.35	1.9	3.4	20	75	5	0	0	n/a	n/a	n/a	n/a	n/a
6	G	78	15	1.0	0.22	0.62	2	5.3	90	10	0	0	0	n/a	n/a	n/a	n/a	n/a
7		93																
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions	H = High flow, M = Medium flow, L = Low flow
Habitat Unit	Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2
Hab Type	P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden
Dist. fr start	distance from beginning of the survey to the beginning of the habitat unit being surveyed
Pool Type	S = scour, D = dammed, U = unknown
Substrate	Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)
Fish Passage Barriers	IF = Impassible waterfall
	BF = Boulder Field, passage through the boulder arrangement is not possible for fish
	D = dry channel, no stream flow
	NC = no distinct channel, water drains over land
	N = no barrier to fish passage through the habitat unit
T/P	T = temporary, portion of open water season
	P = Permanent, all year round

Overall Rating: Marginal habitat, no permanent barriers, beaver dams (temporary/ephemeral barriers) located downstream between site and M19 confluence

Spawning: poor **Rearing:** fair **Adult Feeding:** none **Over-wintering:** none

no pools, shallow

Notes:

Possible habitat use by finescale dace and/or Eastern brook trout.

Stream is very closed in by riparian vegetation and tree fall, preventing access to the stream.

Appendix 4a. FHAP Data, 2013

Rescan

Murray River Project
FHAP Survey Form

Station ID: CS5

Hab Unit	Banks of Channel				Instream Cover							Photos	Comments	Riparian Cover		
No.	L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	(Role #) (Photo #)		Canopy %	LB %	RB %
1	0.35	0.20	U	U	0	0	5	20	20	0	5	430-434		0	0	0
2	0.70	0.50	U	U	50	0	0	0	5	0	0			0	0	0
3	0.50	0.40	S	S	0	0	75	0	2	10	13			0	0	0
4	0.40	0.30	S	S	20	0	10	0	40	10	26			0	0	0
5	0.30	0.25	S	S	0	0	30	0	0	5	10			0	0	0
6	0.15	0.10	S	S	0	0	10	0	15	5	50			0	0	0
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Migration: poor

Appendix 4b. FHAP Data, 2012

Rescan

Murray River
Fish Habitat Stream Survey Form 2012

Station ID:	M20 den	Survey Date (d/m/y):	23-Sep-12	Coordinates: D/S 626268 6097924 gps 994	Coordinates: U/S 626248 6097956 gps 995
		Company	Rescan		
Survey Distance (m)	25	Survey Crew:	KE/ JC		

Temperature (°C):
Channel Velocity (m/s):
Current Flow Conditions: low
Discharge estimate (m^3/s)

Transparency: clear
Conductivity (uS/cm):
pH:

Comments
density survey for fish population/ monitoring abundance
photos 233 to 237 (U/S) 238 to 240 (D/S)

Weather:
see 'combined fish collection card'

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Pool Depth (m) Crest	Fish Passage Barriers Type	T/P
1	R	0	4	1 to 2	0.14	0.75	4.0	9.0	5	10	65	20	0	-	-	-	no	no
2	P	4	5	0.0	0.34	1.00	1.9	8.0	50	25	15	10	0	s	0.35	0.15	no	no
3	C	9	3	3.0	0.15	1.00	4.0	8.0	0	10	40	50	0	-	-	-	no	no
4	R	12	13	2.0	0.20	1.00	4	8	30	40	25	5	0	-	-	-	no	no
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow
Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2
Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden
Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed
Pool Type S = scour, D = dammed, U = unknown
Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)
Fish Passage Barriers IF = Impassible waterfall
BF = Boulder Field, passage through the boulder arrangement is not possible for fish
D = dry channel, no stream flow
NC = no distinct channel, water drains over land
N = no barrier to fish passage through the habitat unit
T/P T = temporary, portion of open water season
P = Permanent, all year round

Overall Rating

Spawning: poor **Rearing:** good **Adult Feeding:** poor **Over-wintering:** none **Migration:** good

Rescan

Murray River
Fish Habitat Stream Survey Form 2012

Station ID: M20 den

Hab Unit No.	Banks of Channel L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover Canopy %	LB %	RB %
1	0.75	0.40	s	s	0	0	0	0	0	0	see front page		10	10	0
2	0.75	0.40	u	s	10	2	0	30	30	10			50	50	0
3	0.75	0.40	u	s	0	50	0	20	0	5			20	20	0
4	0.75	0.40	u	s	0	5	0	10	0	5			10	10	0
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Rescan

Murray River
Fish Habitat Stream Survey Form 2012

Station ID:	OBL 1	Survey Date (d/m/y):	23-Sep-12	Coordinates: D/S	Coordinates: U/S 626910 6098392
		Company	Rescan		
Survey Distance (m)		Survey Crew:	KE/ JC	gps 981	gps

Temperature (°C):		Transparency:	clear	Comments
Channel Velocity (m/s):		Conductivity (uS/cm):		
Current Flow Conditions:	low	pH:		Weather:
Discharge estimate (m^3/s)				

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Pool Depth (m) Crest	Fish Passage Barriers Type	T/P
1	SC	0	170	0.0	35.00		20.0	39.0	40	0	60	0	0	0	0.00	0	D	T
2					52.00													
3					60.00													
4					75.00													
5					64.00													
6					29.00													
7					19.00													
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions	H = High flow, M = Medium flow, L = Low flow
Habitat Unit	Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2
Hab Type	P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden, SC = side channel
Dist. fr start	distance from beginning of the survey to the beginning of the habitat unit being surveyed
Pool Type	S = scour, D = dammed, U = unknown
Substrate	Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)
Fish Passage Barriers	IF = Impassible waterfall
	BF = Boulder Field, passage through the boulder arrangement is not possible for fish
	D = dry channel, no stream flow
	NC = no distinct channel, water drains over land
	N = no barrier to fish passage through the habitat unit
T/P	T = temporary, portion of open water season
	P = Permanent, all year round

Overall Rating

Spawning: none **Rearing:** good **Adult Feeding:** poor **Over-wintering:** poor **Migration:** poor

Appendix 4b. Steam Sampling 2012

Murray River
Fish Habitat Stream Survey Form 2012

Station ID: OBL 1

Hab Unit No.	Banks of Channel L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover Canopy %	LB %	RB %
1			U	H	0	0	0	1	0	10	192 to 202		0	0	0
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Rescan

Murray River
Fish Habitat Stream Survey Form 2012

Station ID: OBL 2	Survey Date (d/m/y): 22-Sep-12	Coordinates: D/S 626894 6098325 gps	Coordinates: U/S gps
	Company: Rescan		
Survey Distance (m):	Survey Crew: KE/ JC		

Temperature (°C):	Transparency: clear	Comments
Channel Velocity (m/s):	Conductivity (uS/cm):	Habitat type- OBL SC = oxbow lake side channel
Current Flow Conditions: low	pH:	Barrier- D = dry channel at inflow from Murray River
Discharge estimate (m^3/s)		Weather:

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Pool Depth (m) Crest	Fish Passage Barriers Type	T/P
1	OBL SC	0	200	0.0	1.00	1.50	32.0	34.0	10	40	45	5	0				D	T
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		
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12																		
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15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow

Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2

Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden, SC = side channel

Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed

Pool Type S = scour, D = dammed, U = unknown

Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)

Fish Passage Barriers IF = Impassible waterfall
BF = Boulder Field, passage through the boulder arrangement is not possible for fish
D = dry channel, no stream flow
NC = no distinct channel, water drains over land
N = no barrier to fish passage through the habitat unit

T/P T = temporary, portion of open water season
P = Permanent, all year round

Overall Rating

Spawning: none Rearing: good Adult Feeding: poor Over-wintering: none Migration: poor

Appendix 4b. Steam Sampling 2012

Rescan

Murray River
Fish Habitat Stream Survey Form 2012

Station ID: OBL 2

Hab Unit No.	Banks of Channel L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover Canopy %	LB %	RB %
1	0.90	0.90	H	H	0	5	0	10	0	10	Pic 204-206		0	10	10
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Rescan

Murray River
Fish Habitat Stream Survey Form 2012

Station ID:	OBL 3	Survey Date (d/m/y):	23-Sep-12
		Company	Rescan
Survey Distance (m)	25	Survey Crew:	KE/ JC

Coordinates: D/S 626577 6097888, gps 989

Coordinates: U/S 626562 6097863, gps 990

Temperature (°C):		Transparency:	clear
Channel Velocity (m/s):		Conductivity (uS/cm):	
Current Flow Conditions:	low	pH:	
Discharge estimate (m^3/s)			

Comments
Potential fish habitat compensation site
3 pass density site to determine fish abundance
Habitat type- SC- P = side channel pool- not scour pool

Weather:

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Bed Material Gravel (%)	Bed Material Cobble (%)	Bed Material Boulder (%)	Bed Material Bedrock (%)	Pool Info Type	Pool Info Depth (m) Max	Pool Info Depth (m) Crest	Fish Passage Barriers Type	Fish Passage Barriers T/P
1	SC- P	0	25	0.0	19.00	59.00	6.0	14.0	0	0	95	5	0	-	-	-	none	none
2					26.00	66.00												
3					18.00	58.00												
4					10.00	50.00												
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions	H = High flow, M = Medium flow, L = Low flow
Habitat Unit	Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2
Hab Type	P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden, SC = side channel
Dist. fr start	distance from beginning of the survey to the beginning of the habitat unit being surveyed
Pool Type	S = scour, D = dammed, U = unknown
Substrate	Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)
Fish Passage Barriers	IF = Impassible waterfall
	BF = Boulder Field, passage through the boulder arrangement is not possible for fish
	D = dry channel, no stream flow
	NC = no distinct channel, water drains over land
	N = no barrier to fish passage through the habitat unit
T/P	T = temporary, portion of open water season
	P = Permanent, all year round

Overall Rating

Spawning: none **Rearing:** poor **Adult Feeding:** none **Over-wintering:** none **Migration:** good U/S to Murray River, none D/S into side channel

Rescan

Murray River
Fish Habitat Stream Survey Form 2012

Station ID: OBL 3

Hab Unit	Banks of Channel				Instream Cover							Photos	Comments	Riparian Cover		
No.	L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	(Role #) (Photo #)		Canopy %	LB %	RB %
1	0.40	0.86	U	H	0	5	0	0	0	0	5		photos 218 U/S end looking D/S	2	0	2
2													219 U/S end to Murray River			
3													220 middle of site looking D/S			
4													221 D/S end looking U/S			
5													222 D/S connection at D/S end of site			
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability)   H = highly stable, S = stable, U = unstable

Rescan

Murray River
Fish Habitat Stream Survey Form 2012

Station ID: OBL 4

Survey Distance (m): 25

Survey Date (d/m/y): 24-Sep-12

Company: Rescan

Survey Crew: KE/ JC

Coordinates: D/S 626600 6097900 gps 991

Coordinates: U/S 626577 6097888 gps 990

Temperature (°C):

Channel Velocity (m/s):

Current Flow Conditions: low

Discharge estimate (m^3/s):

Transparency: clear

Conductivity (uS/cm):

pH:

Comments: continuation of 3 pass density for potential fish habitat compensation site

Weather:

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Pool Depth (m) Crest	Fish Passage Barriers Type	T/P
1	R	0	25	1 to 2	10.00	50.00	5.0	16.0	0	5	70	25	0				none	none
2					12.00	52.00												
3					8.00	48.00												
4					4.00	44.00												
5					11.00	51.00												
6					11.00	54.00												
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow

Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2

Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden, SC = side channel

Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed

Pool Type S = scour, D = dammed, U = unknown

Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)

Fish Passage Barriers IF = Impassible waterfall
BF = Boulder Field, passage through the boulder arrangement is not possible for fish
D = dry channel, no stream flow
NC = no distinct channel, water drains over land
N = no barrier to fish passage through the habitat unit

T/P T = temporary, portion of open water season
P = Permanent, all year round

Overall Rating

Spawning: none **Rearing:** poor **Adult Feeding:** none **Over-wintering:** none **Migration:** poor

Rescan

Murray River
Fish Habitat Stream Survey Form 2012

Station ID: OBL 4

Hab Unit No.	Banks of Channel L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover Canopy %	LB %	RB %
1	40.00	40.00	S	H	0	25	0	0	0	0	0	223 U/S		0	0	0
2												224 X/S				
3												225 D/S				
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Rescan

Murray River
Fish Habitat Stream Survey Form 2012

Station ID: OBL 5
Survey Distance (m) 200
Survey Date (d/m/y): 23-Sep-12
Company Rescan
Survey Crew: KE/ JC
Coordinates: D/S 626736 6098029 gps 992
Coordinates: U/S 626562 6097863 gps 990

Temperature (°C):
Channel Velocity (m/s):
Current Flow Conditions: low
Discharge estimate (m^3/s)
Transparency: clear
Conductivity (uS/cm):
pH:
Comments
Weather:

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Bed Material Gravel (%)	Bed Material Cobble (%)	Bed Material Boulder (%)	Bed Material Bedrock (%)	Pool Info Type	Pool Info Depth (m) Max	Pool Info Depth (m) Crest	Fish Passage Barriers Type	Fish Passage Barriers T/P
1	P	0	25	0.0	0.19	0.59	6.0	14.0	0	0	95	5	0	-	-	-	none	none
2	R	25	25	1 to 2	0.10	0.50	5.0	16.0	0	5	70	25	0	-	-	-	none	none
3	P	50	65	0.0	0.30	0.70	9.0	17.0	20	5	63	2	0	-	-	-	none	none
4	R	115	16	1 to 2	0.15	0.45	7	20	0	20	80	0	0	-	-	-	none	none
5	P	131	91	0.0	0.23	1.10	11	22	50	0	50	0	0	-	-	-	none	none
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow
Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2
Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden, SC = side channel
Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed
Pool Type S = scour, D = dammed, U = unknown
Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)

Fish Passage Barriers IF = Impassible waterfall
BF = Boulder Field, passage through the boulder arrangement is not possible for fish
D = dry channel, no stream flow
NC = no distinct channel, water drains over land
N = no barrier to fish passage through the habitat unit
T/P T = temporary, portion of open water season
P = Permanent, all year round

Overall Rating
Spawning: none **Rearing:** poor **Adult Feeding:** none **Over-wintering:** none **Migration:** poor

Murray River
Fish Habitat Stream Survey Form 2012

Station ID: OBL 5

Hab Unit No.	Banks of Channel L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover Canopy %	LB %	RB %
1	0.40	0.86	U	H	0	5	0	0	0	0	5	218 to 222		2	0	2
2	0.40	0.40	S	H	0	25	0	0	0	0	0	223 to 225		0	0	0
3	0.40	0.40	H	H	0	2	0	0	0	0	20		226 U/S, 227 X/S, 228 D/S	0	0	0
4	0.50	0.50	H	S	0	0	0	0	0	0	0	229		10	0	10
5	0.45	0.45	H	H	0	0	0	0	0	0	10		230 U/S, 231 X/S, 232 D/S	30	15	15
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:
stream/ side channel has excellent potential for compensation opportunities
development of rearing habitat for BT
Murray River appears to be limited by side channel and connecting wetland habitat
constant water supply - could improve water
improve existing habitat (channel) by increasing water volume flow by digging at U/S end of side channel and installing flow deflector to push more water into channel.
Increase habitat complexity of channel by designing R/P complexes, digging out pools and installing LWD and large boulders to increase cover.
Project is highly feasible, provides biological benefit for blue listed BT and increase available juvenile BT habitat

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Appendix 4c. FHAP Data, 2010

Rescan

Murray River Project
FHAP Survey Form

Station ID: Twenty Cr.	Survey Date (d/m/y): 4-Jun-10	Coordinates: D/S 625500 6096907 gps	Coordinates: U/S 625380 6096920 gps
	Company: Rescan		
Survey Distance (m): 200	Survey Crew: KE/NA		

Temperature (°C):
Channel Velocity (m/s):
Current Flow Conditions: med
Discharge estimate (m^3/s):

Transparency: medium/clear
Conductivity (uS/cm):
pH:

Comments
site ends at pipeline ROW
S4 pending fish-bearing status

Weather:
clear and sunny

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Crest	Fish Passage Barriers Type	T/P
1	R	0	13	2.0	0.10	0.50	2.7	4.0	20	40	40	0	0	n/a	n/a	n/a	none	
2	P	14	3	1.0	0.30	0.70	2.5	3.6	95	5	0	0	0	S	0.35	0.1	none	
3	R	18	44	2.0	0.20	0.60	2.0	2.0	5	85	10	0	0	n/a	n/a	n/a	none	
4	P	65	3	1.0	0.15	0.70	2.1	3.3	50	50	0	0	0	S	0.52	0.1	none	
5	R	69	60	2.0	0.15	0.65	2	3.2	10	80	10	0	0	n/a	n/a	n/a	none	
6	P	130	3	0.0	0.30	0.80	2.3	2.5	10	70	20	0	0	S	0.35	0.1	none	
7																		
8																		
9																		
10																		
11																		
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13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow
Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2
Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden
Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed
Pool Type S = scour, D = dammed, U = unknown
Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)
Fish Passage Barriers IF = Impassible waterfall
BF = Boulder Field, passage through the boulder arrangement is not possible for fish
D = dry channel, no stream flow
NC = no distinct channel, water drains over land
N = no barrier to fish passage through the habitat unit
T/P T = temporary, portion of open water season
P = Permanent, all year round

Overall Rating

Spawning: Poor
abundant gravel substrate but stream generally too shallow for good spawning and incubation

Rearing: Fair
abundant cover

Adult Feeding: Poor
little adult habitat

Over-wintering: None
no pools > 1m

Appendix 4c. FHAP Data, 2010

Murray River Project
FHAP Survey Form

Station ID: Twenty Creek

Hab Unit No.	Banks of Channel L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover Canopy %	LB %	RB %
1	0.50	1.00	S	S	0	0	0	10	15	10	5	39		90	90	90
2	0.70	0.70	S	S	20	0	0	10	0	10	5	40		70	90	60
3	0.60	0.60	S	S	0	0	0	40	10	10	10			30	75	75
4	0.50	0.40	S	S	20	0	0	5	0	10	5			50	30	70
5	0.50	0.50	S	S	90	0	0	5	0	5	0			80	75	75
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Twenty Creek
M20-FT
MR4
MR5A
MR6
MR-REF
REF-ST

Migration: Fair
no observed barriers from site
upstream to MR FSR
shallow depth in freshet

Rescan

Murray River Project

FHAP Survey Form

Station ID:	M20-FT	Survey Date (d/m/y):	3-Jun-10	Coordinates: D/S 626195 6098127 gps	Coordinates: U/S 626195 6097960 gps
		Company	Rescan		
Survey Distance (m)	200	Survey Crew:	KE/NA		

Temperature (°C):

Channel Velocity (m/s):

Current Flow Conditions:

Discharge estimate (m³/s)

Transparency: turbid

Conductivity (uS/cm):

pH:

Comments

Weather:
clear, windy

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Pool Depth (m) Crest	Fish Passage Barriers Type	T/P
1	C	0	52	2.0	0.40	1.57	10.2	13.5	30	10	55	5	0	n/a	n/a	n/a	none	
2	P	53	12	1.0	0.50	0.70	4.0	5.0	65	15	15	5	0	S	0.50	0.3	none	
3	R	66	55	2.0	0.20	1.50	10.8	18.2	35	20	20	5	0	n/a	n/a	n/a	none	
4	C	122	78	4.0	0.40	1.00	8.1	15.5	30	20	45	5	0	n/a	n/a	n/a	none	
5																		
6																		
7																		
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18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow

Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2

Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden

Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed

Pool Type S = scour, D = dammed, U = unknown

Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)

Fish Passage Barriers IF = Impassible waterfall
BF = Boulder Field, passage through the boulder arrangement is not possible for fish
D = dry channel, no stream flow
NC = no distinct channel, water drains over land
N = no barrier to fish passage through the habitat unit

T/P T = temporary, portion of open water season
P = Permanent, all year round

Overall Rating

Spawning: Poor
few areas of loose gravel
heavy sedimentation

Rearing: Fair
some areas of shallow pools
with abundant cover
some side channel habitat

Adult Feeding: Poor
few pool areas
little cover for adult fish

Over-wintering: Poor
no deep pools > 1 m

Appendix 4c. FHAP Data, 2010

Rescan

Murray River Project
FHAP Survey Form

Station ID: M20-FT

Hab Unit No.	Banks of Channel: L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover: Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover: Canopy %	LB %	RB %
1	1.50	1.50	S	U	0	5	0	15	0	5	5	100-0007		0	95	95
2	0.70	2.00	S	U	15	5	0	15	30	30	5	100-0008		50	100	80
3	0.60	1.50	S	U	0	5	0	5	0	10	0	100-0009		10	5	100
4	2.00	0.40	U	S	0	5	0	10	0	25	5	100-0010		10	85	85
5																
6																
7																
8																
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10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Migration: Good
no impediments to migration

Rescan

Murray River Project
FHAP Survey Form

Station ID:	MR4	Survey Date (d/m/y):	3-Jun-10	Coordinates: D/S 626000 6097330 gps	Coordinates: U/S 626029 6097474 gps
		Company	Rescan		
Survey Distance (m)	200	Survey Crew:	KE/NA		

Temperature (°C):		Transparency:	turbid	Comments: observed in freshet/high flow
Channel Velocity (m/s):		Conductivity (uS/cm):		
Current Flow Conditions:	high	pH:		Weather: clear, windy
Discharge estimate (m^3/s)				

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Pool Depth (m) Crest	Fish Passage Barriers Type	T/P
1	G	0	200	2.0	1.00	1.00	96.0	1.0	45	45	10	0	0	n/a	n/a	n/a	none	
2																		
3																		
4																		
5																		
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18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow
Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2
Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden
Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed
Pool Type S = scour, D = dammed, U = unknown
Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)
Fish Passage Barriers IF = Impassible waterfall
BF = Boulder Field, passage through the boulder arrangement is not possible for fish
D = dry channel, no stream flow
NC = no distinct channel, water drains over land
N = no barrier to fish passage through the habitat unit
T/P T = temporary, portion of open water season
P = Permanent, all year round

Overall Rating

Spawning: Poor
lack of gravel spawning substrate unable to observe substrate in channel due to poor visibility

Rearing: Good
abundant rearing and resting areas for fish in the form of LWD jams

Adult Feeding: Good
good LWD cover for adult fish

Over-wintering: Poor
no deep pools > 1 m
appears to be a large pool
d/s of site on LB d/s of a high
cliff/bank

Appendix 4c. FHAP Data, 2010

Murray River Project
FHAP Survey Form

Station ID: MR4

Hab Unit No.	Banks of Channel: L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover: Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover: Canopy %	LB %	RB %
1	cliff	1.00	U	H	5	0	0	5	0	15	5	100-0001	d/s end LWD side channel	5	0	5
2												100-0002	x/s LWD jam			
3												100-0003	LWD jam and side channel			
4												100-0004	head of LWD jam			
5												100-0005	x/s full channel			
6												100-0006	x/s bankfull			
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Migration: Good
no impediments to migration

Appendix 4c. FHAP Data, 2010

Rescan

Murray River Project
FHAP Survey Form

Station ID:	MR5A	Survey Date (d/m/y):	3-Jun-10	Coordinates: D/S 626724 6101080 gps	Coordinates: U/S gps
		Company	Rescan		
Survey Distance (m)	200	Survey Crew:	KE/NA		
Temperature (°C):		Transparency:	turbid	Comments: surveyed in freshet	
Channel Velocity (m/s):		Conductivity (uS/cm):			
Current Flow Conditions:	high	pH:		Weather:	
Discharge estimate (m^3/s)					

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Pool Depth (m) Crest	Fish Passage Barriers Type	T/P
1	G	0	200	2.0	2.00	2.50	85.0	105.0	could not record due to high turbidity					u	U/S	u	none	
2														pool has formed in mid-channel				
3														behind an island				
4																		
5																		
6																		
7																		
8																		
9																		
10																		
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16																		
17																		
18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow
Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2
Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden
Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed
Pool Type S = scour, D = dammed, U = unknown
Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)
Fish Passage Barriers IF = Impassible waterfall
BF = Boulder Field, passage through the boulder arrangement is not possible for fish
D = dry channel, no stream flow
NC = no distinct channel, water drains over land
N = no barrier to fish passage through the habitat unit
T/P T = temporary, portion of open water season
P = Permanent, all year round

Overall
Important
however this type of habitat is relatively normal for this section of the Murray River

Overall Rating

Spawning: poor
no loose gravel flow was too fast in freshet for spawning habitat

Rearing: good
some LWD side channel and pool habitat on LB

Adult Feeding: good
good cover for juvenile fish approp. flow access to pool and side channel

Over-wintering: Good
large mid-channel pool behind the island/bar in the channel

Appendix 4c. FHAP Data, 2010

Rescan

Murray River Project
FHAP Survey Form

Station ID: MR5A

Hab Unit No.	Banks of Channel L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover Canopy %	LB %	RB %
1	1.00	2.50	S	U	5	20	0	5	0	10	0	11	d/s	0	75	75
2												12	x/s			
3												13	u/s			
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Migration: Good
no impediments to migration

Rescan

Murray River Project
FHAP Survey Form

Station ID: MR6 | Survey Distance (m): 200
Survey Date (d/m/y): 4-Jun-10
Company: Rescan
Survey Crew: KE/NA
Coordinates: D/S 625364 6109309 gps
Coordinates: U/S gps

Temperature (°C):
Channel Velocity (m/s):
Current Flow Conditions: high
Discharge estimate (m^3/s):
Transparency: turbid
Conductivity (uS/cm):
pH:

Comments: S1 - large river

Weather: sunny, clear

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Pool Depth (m) Crest	Fish Passage Barriers Type	T/P
1	G	0	200	2.0	2.00	3.00	70.0	75.0	unknown due to poor visibility					n/a	n/a	n/a	none	
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow
Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2
Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden
Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed
Pool Type S = scour, D = dammed, U = unknown
Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)
Fish Passage Barriers IF = Impassible waterfall
BF = Boulder Field, passage through the boulder arrangement is not possible for fish
D = dry channel, no stream flow
NC = no distinct channel, water drains over land
N = no barrier to fish passage through the habitat unit
T/P T = temporary, portion of open water season
P = Permanent, all year round

Overall
marginal
Note: must reclassify in low flow
site located immediately d/s of Hwy 29 Bridge

Overall Rating

Spawning: Poor
unable to observe substrate due to poor visibility

Rearing: Poor
no side channels or pool habitat

Adult Feeding: Good
poor visibility but good adult trout habitat

Over-wintering: Good
sufficient depth for all year habitat use

Appendix 4c. FHAP Data, 2010

Rescan

Murray River Project
FHAP Survey Form

Station ID: MR6

Hab Unit No.	Banks of Channel				Instream Cover							Photos (Role #) (Photo #)	Comments	Riparian Cover		
	L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %			Canopy %	LB %	RB %
1	2.00	2.00	S	S	unknown due to poor visibility							46	d/s	0	75	75
2												47	x/s			
3																
4																
5																
6																
7																
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15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Migration: Good
no impediments to migration

Rescan

Murray River Project
FHAP Survey Form

Station ID: MR-REF	Survey Date (d/m/y): 3-Jun-10	Coordinates: D/S 614218 6086910 gps	Coordinates: U/S gps
	Company: Rescan		
Survey Distance (m): 200	Survey Crew: KE/NA		

Temperature (°C):
Channel Velocity (m/s):
Current Flow Conditions: med/high
Discharge estimate (m^3/s):
Transparency: turbid
Conductivity (uS/cm):
pH:
Comments: surveyed in freshet
Weather:

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Bed Material Gravel (%)	Bed Material Cobble (%)	Bed Material Boulder (%)	Bed Material Bedrock (%)	Pool Info Type	Pool Info Depth (m) Max	Pool Info Depth (m) Crest	Fish Passage Barriers Type	Fish Passage Barriers T/P
1	G	0	200	2.0	1.50	3.50	60.0	70.0	15	20	60	5	0	S	U/S	U	none	
2	P	180	20	1.0	U	U	5.0	5.0										
3	pool located on RB at end of site area, eddy occurs along RB shoreline near a small inflow creek																	
4																		
5																		
6																		
7																		
8																		
9																		
10																		
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17																		
18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow
Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2
Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden
Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed
Pool Type S = scour, D = dammed, U = unknown
Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)
Fish Passage Barriers IF = Impassible waterfall
BF = Boulder Field, passage through the boulder arrangement is not possible for fish
D = dry channel, no stream flow
NC = no distinct channel, water drains over land
N = no barrier to fish passage through the habitat unit
T/P T = temporary, portion of open water season
P = Permanent, all year round

Overall Rating

Spawning: Poor
no side channel
some loose gravel
and cobble

Rearing: Good
good cover w/LWD and
SWD and pool habitat

Adult Feeding: Good
pool, river bend/eddy
location for possible
feeding site

Over-wintering: Poor
no deep pools > 1 m

Appendix 4c. FHAP Data, 2010

Murray River Project
FHAP Survey Form

Station ID: MR-REF

Hab Unit No.	Banks of Channel: L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover: Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover: Canopy %	LB %	RB %
1	0.50	1.00	S	U	20	10	0	10	5	5	5	14	d/s	10	100	100
2												15	x/s			
3												16	u/s			
4																
5																
6																
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14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Migration: Good
no impediments to migration

Appendix 4c. FHAP Data, 2010

Rescan

Murray River Project

FHAP Survey Form

Station ID:	REF-ST	Survey Date (d/m/y):	4-Jun-10	Coordinates:	Coordinates:
	Club Ck	Company	Rescan	D/S 611518 6080817	U/S 611594 6080686
Survey Distance (m)	200	Survey Crew:	KE/NA	gps	gps

Temperature (°C):

Channel Velocity (m/s):

Current Flow Conditions: med/high

Discharge estimate (m^3/s)

Transparency: clear

Conductivity (uS/cm):

pH:

Comments

S3; fish-bearing stream

Weather:

sunny, clear

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Pool Depth (m) Crest	Fish Passage Barriers Type	T/P
1	C	0	131	3.0	0.40	1.25	9.5	30.0	15	20	60	5	0	n/a	n/a	n/a	none	
2	R	131	17	1.0	0.45	n/a	5.0	n/a	25	20	30	25	0	n/a	n/a	n/a	none	
3																		
4																		
5																		
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15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow

Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2

Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden

Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed

Pool Type S = scour, D = dammed, U = unknown

Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)

Fish Passage Barriers IF = Impassible waterfall

BF = Boulder Field, passage through the boulder arrangement is not possible for fish

D = dry channel, no stream flow

NC = no distinct channel, water drains over land

N = no barrier to fish passage through the habitat unit

T/P T = temporary, portion of open water season

P = Permanent, all year round

Overall

Important

Note: must reclassify in low flow

site located immediately d/s of Hwy 29 Bridge

Overall Rating

Spawning: Poor in main channel good in small side channel

Rearing: Good several side channels with good cover and flow

Adult Feeding: Good good flow w/ abundant resting sites numerous insect hatches observed in side-channels

Over-wintering: Poor no pools deeper than 1 m deep pools found d/s of site near Murray River confluence

Rescan

Murray River Project
FHAP Survey Form

Station ID: REF-ST

Hab Unit No.	Banks of Channel: L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover: Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover: Canopy %	LB %	RB %
1	1.50	0.50	S	S	0	10	0	5	0	20	5	31	in-channel riffle	10	75	75
2	n/a	n/a	n/a	n/a	0	25	0	5	0	15	10	32	in-channel riffle	0	0	0
3												33	u/s section			
4												34	u/s section			
5												35	d/s section			
6												36	d/s section			
7												37	d/s section			
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Migration: Good
no impediments to migration
Good connection d/s to
Murray River

Appendix 4c. FHAP Data, 2010

Rescan

Murray River Project

FHAP Survey Form

Station ID:	upper Mast	Survey Date (d/m/y):	4-Jun-10	Coordinates: D/S 619459 6100577 gps	Coordinates: U/S 619410 6100360 gps
Survey Distance (m)	200	Company	Rescan		
		Survey Crew:	KE/NA		

Temperature (°C):

Channel Velocity (m/s):

Current Flow Conditions: med/high

Discharge estimate (m^3/s)

Transparency:

Conductivity (uS/cm):

pH:

Comments

Weather:

Hab Unit No.	Hab Type	Dist. fr start (m)	Length (m)	Slope (%)	Depth (m) Mean	Depth (m) Bank-full	Width (m) Mean	Width (m) Bank-full	Bed Material Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Pool Info Type	Pool Depth (m) Max	Pool Depth (m) Crest	Fish Passage Barriers Type	T/P
1	R	0	200	2.0	0.40	0.70	4.0	8.0	5	10	80	5	0	n/a	n/a	n/a	none	
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Flow Conditions H = High flow, M = Medium flow, L = Low flow

Habitat Unit Under bankfull conditions: 0 - 2.5 m = > 1 m^2, 2.5 - 5 m = > 2 m^2, 5 - 10 m = > 4 m^2, 10 -15 m = > 6 m^2, 15 -20 = > 8 m^2, > 20 m = > 10 m^2

Hab Type P = pool, G = glide, R = riffle, C = cascade, UG = underground, BG = boulder garden

Dist. fr start distance from beginning of the survey to the beginning of the habitat unit being surveyed

Pool Type S = scour, D = dammed, U = unknown

Substrate Sand (< 2 mm), Gravel (2 - 64 mm), Cobble (64 - 256), Boulders (256 - 4000 mm), Bedrock (>4000 mm)

Fish Passage Barriers IF = Impassible waterfall
BF = Boulder Field, passage through the boulder arrangement is not possible for fish
D = dry channel, no stream flow
NC = no distinct channel, water drains over land
N = no barrier to fish passage through the habitat unit

T/P T = temporary, portion of open water season
P = Permanent, all year round

Overall
marginal

Overall Rating

Spawning: Poor
very little small gravel
mainly cobble substrate

Rearing: Good
some side channel habitat
some cover from LWD
and bank vegetation

Adult Feeding: Poor
few deep areas for adult fish

Over-wintering: None
no pools deeper than 1 m

Appendix 4c. FHAP Data, 2010

Rescan

Murray River Project
FHAP Survey Form

Station ID: Upper Mast

Hab Unit No.	Banks of Channel: L Bank Height (m)	R Bank Height (m)	L Bank Stab	R Bank Stab	Instream Cover: Pool %	Boulder %	Instream Veg %	Overhang Veg %	Undercut Bank %	LWD %	SWD %	Photos (Role #) (Photo #)	Comments	Riparian Cover: Canopy %	LB %	RB %
1	1.20	0.70	S	S	0	10	0	10	5	15	5	42		10	40	40
2												43				
3												44				
4												45				
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Comments:

Banks of Channel (Stability) H = highly stable, S = stable, U = unstable

Migration: Good
no impediments to migration

Appendix 5

FHAP Data Summary and Site Photographs

ERM

Stream Name: M19A Creek
Station ID: M19A-1
Upstream UTM Coordinates: 10 U 626904 6099476
Downstream UTM Coordinates: 10 U 626959 6099416
Province: BC
Survey Date(s): 14-JUN-2013
Stream Class: S4, default fish-bearing
Crew: FR

SITE PHOTOS

BIOPHYSICAL DATA

Survey distance (m): 100
Transparency: Clear
Flow Conditions: High
Water temperature (˚C): 10
Specific cond. (µs/cm): 59
Oxygen conc. (mg/L): N/A
pH: 7.9

Mean bankfull width (m): 10.7
Mean wetted width (m): 10.7
Mean bankfull depth (m): 0.42
Mean wetted depth (m): 0.36
Mean channel gradient (%): 0.8

Left Bank (LB)
Mean LB height (m): 0.53
LB Stability: Unstable
Mean LB riparian cover (%): 50

Right Bank (RB)
Mean RB height (m): 0.53
RB Stability: Unstable
Mean RB riparian cover (%): 50

Mean fish cover total (%): 100
Dominant cover type: Instream veg.
Sub-dom. cover type: Overhang veg.
Dominant bed material: Fines
Sub-dom. bed material: Gravel
Mean canopy cover (%): 50

HABITAT

Spawning: Poor
Overwintering: Fair
Rearing: Fair
Migration: Poor
Adult Feeding: Fair

FISH
Sampling methods: EF, MT
Fish captured: none

Known species occurrence: N/A

COMMENTS
Log jam over 1 m high in survey reach. There is surface flow over the log jam but it likely creates a barrier to fish passage in most or all flow conditions.

Murray River Mine Project	**Project No.:** 0194106-0003	**Date:** 9-APR-2014	

Stream Name: M19A Creek
Station ID: M19A-2
Upstream UTM Coordinates: 10U 627084 6099365
Downstream UTM Coordinates: 10U 626995 6099374
Province: BC
Survey Date(s): 14-JUN-2013
Stream Class: S4, default fish-bearing
Crew: FR

SITE PHOTO

BIOPHYSICAL DATA

Survey distance (m): 100
Transparency: Clear
Flow Conditions: High
Water temperature (˚C): 10
Specific cond. (µs/cm): 38
Oxygen conc. (mg/L): N/A
pH: 7.8

Mean bankfull width (m): 2.8
Mean wetted width (m): 2.8
Mean bankfull depth (m): 0.27
Mean wetted depth (m): 0.27
Mean channel gradient (%): 1.6

Left Bank (LB)
Mean LB height (m): 0.25
LB Stability: Stable
Mean LB riparian cover (%): 42

Right Bank (RB)
Mean RB height (m): 0.27
RB Stability: Stable
Mean RB riparian cover (%): 42

Mean fish cover total (%): 90
Dominant cover type: Overhang veg.
Sub-dom. cover type: LWD
Dominant bed material: Gravel
Sub-dom. bed material: Fines
Mean canopy cover (%): 42

HABITAT

Spawning: Good
Overwintering: Good
Rearing: Good
Migration: Fair
Adult Feeding: Fair

FISH
Sampling methods: EF; MT
Fish captured: none

Known species occurrence: N/A

COMMENTS
Several log jams along this creek may restrict fish movement in some flow conditions.

Murray River Mine Project	**Project No.:** 0194106-0003	**Date:** 9-APR-2014	ERM

Stream Name: M19A Creek
Station ID: M19A-3
Upstream UTM Coordinates: N/A
Downstream UTM Coordinates: 10U 627360 6099292
Province: BC
Survey Date(s): 25-AUG-2013
Stream Class: S4, default fish-bearing
Crew: KE, PH

SITE PHOTOS

BIOPHYSICAL DATA

Survey distance (m): 50
Transparency: Clear
Flow Conditions: Low
Water temperature (˚C): N/A
Specific cond. (µs/cm): N/A
Oxygen conc. (mg/L): N/A
pH: N/A

Mean bankfull width (m): 1.5
Mean wetted width (m): 0.8
Mean bankfull depth (m): 0.30
Mean wetted depth (m): 0.09
Mean channel gradient (%): 1.5

Left Bank (LB)
Mean LB height (m): 0.15
LB Stability: Highly Stable
Mean LB riparian cover (%): 100

Right Bank (RB)
Mean RB height (m): 0.15
RB Stability: Highly Stable
Mean RB riparian cover (%): 100

Mean fish cover total (%): 100
Dominant cover type: SWD
Sub-dom. cover type: LWD/Instr. Veg.
Dominant bed material: Gravel
Sub-dom. bed material: Cobble
Mean canopy cover (%): 100

HABITAT

Spawning: Poor
Overwintering: None
Rearing: Fair
Migration: Poor
Adult Feeding: None

FISH
Sampling methods: EF
Fish captured: none

Known species occurrence: N/A

COMMENTS
Possible habitat use by Finescale Dace and/or Brook Trout. Stream is very closed in by riparian vegetation and tree fall, preventing access.

Murray River Mine Project	Project No.: 0194106-0003	Date: 9-APR-2014	ERM

Stream Name: CS1
Station ID: CS1
Upstream UTM Coordinates: 10U 625954 6096797
Downstream UTM Coordinates: 10U 625930 6096834
Province: BC
Survey Date(s): 24-AUG-2013
Stream Class: N/A
Crew: KE, PH

SITE PHOTO - JUN-2013

SITE PHOTO - AUG-2013

BIOPHYSICAL DATA

Survey distance (m): 43
Transparency: Clear
Flow Conditions: Low
Water temperature (˚C): N/A
Specific cond. (µs/cm): N/A
Oxygen conc. (mg/L): N/A
pH: N/A

Mean bankfull width (m): 8.0
Mean wetted width (m): 6.3
Mean bankfull depth (m): 1.0
Mean wetted depth (m): 0.38
Mean channel gradient (%): 0.0

Left Bank (LB)
Mean LB height (m): 0.60
LB Stability: Stable
Mean LB riparian cover (%): 100

Right Bank (RB)
Mean RB height (m): 0.50
RB Stability: Stable
Mean RB riparian cover (%): 100

Mean fish cover total (%): 100
Dominant cover type: Instream veg.
Sub-dom. cover type: N/A
Dominant bed material: Fines
Sub-dom. bed material: N/A
Mean canopy cover (%): 100

HABITAT

Spawning: Good (for NP)
Overwintering: None
Rearing: Good (for NP and BB)
Migration: Good
Adult Feeding: Fair (for NP)

FISH
Sampling methods: BS, MT
Fish captured: BB; NP

Known species occurrence: N/A

COMMENTS
Site is suitable for fish habitat compensation option for the Project.

Murray River Mine Project	**Project No.:** 0194106-0003	**Date:** 9-APR-2014	ERM

Stream Name: CS5
Station ID: CS5
Upstream UTM Coordinates: 10U 620586 6090577
Downstream UTM Coordinates: 10U 620538 6090655
Province: BC
Survey Date(s): 23-AUG-2013
Stream Class: N/A
Crew: KE, PH

SITE PHOTO - JUN-2013

SITE PHOTO - AUG-2013

BIOPHYSICAL DATA

Survey distance (m): 93
Transparency: Clear
Flow Conditions: Low
Water temperature (˚C): N/A
Specific cond. (µs/cm): N/A
Oxygen conc. (mg/L): N/A
pH: N/A

Mean bankfull width (m): 3.3
Mean wetted width (m): 1.8
Mean bankfull depth (m): 0.49
Mean wetted depth (m): 0.16
Mean channel gradient (%): 1.3

Left Bank (LB)
Mean LB height (m): 0.40
LB Stability: Unstable - Stable
Mean LB riparian cover (%): 0

Right Bank (RB)
Mean RB height (m): 0.29
RB Stability: Unstable - Stable
Mean RB riparian cover (%): 0

Mean fish cover total (%): 72
Dominant cover type: Instream veg.
Sub-dom. cover type: SWD
Dominant bed material: Fines
Sub-dom. bed material: Gravel
Mean canopy cover (%): 0

HABITAT

Spawning: Poor
Overwintering: None
Rearing: Fair
Migration: Poor
Adult Feeding: None

FISH
Sampling methods: EF, MT
Fish captured: CCG, EB, FDC

Known species occurrence: N/A

COMMENTS
Possible habitat use by Finescale Dace and/or Brook Trout.

Murray River Mine Project	Project No.: 0194106-0003	Date: 9-APR-2014	ERM

Stream Name: M20 Creek
Station ID: M20 den
Upstream UTM Coordinates: 10U 626248 6097956
Downstream UTM Coordinates: 10U 626268 6097924
Province: BC
Survey Date(s): 23-SEP-2012
Stream Class: S2, fish-bearing
Crew: KE, JC

hd Mining

SITE PHOTO - SEP-2012

BIOPHYSICAL DATA

Survey distance (m): 25
Transparency: Clear
Flow Conditions: Low
Water temperature (˚C): N/A
Specific cond. (µs/cm): N/A
Oxygen conc. (mg/L): N/A
pH: N/A

Mean bankfull width (m): 8.3
Mean wetted width (m): 3.5
Mean bankfull depth (m): 0.94
Mean wetted depth (m): 0.21
Mean channel gradient (%): 1.6

Left Bank (LB)
Mean LB height (m): 0.75
LB Stability: Unstable - Stable
Mean LB riparian cover (%): 23

Right Bank (RB)
Mean RB height (m): 0.40
RB Stability: Stable
Mean RB riparian cover (%): 0

Mean fish cover total (%): 44
Dominant cover type: Overhang veg.
Sub-dom. cover type: Boulder
Dominant bed material: Cobble
Sub-dom. bed material: Fi/Gr/Bo
Mean canopy cover (%): 23

HABITAT

Spawning: Poor
Overwintering: None
Rearing: Good
Migration: Good
Adult Feeding: Poor

FISH
Sampling methods: EF
Fish captured: BT, CCG, MW

Known species occurrence:
GR, EB, BT, BB, LSU, MW, RB, CCG

COMMENTS
Density survey for fish population/monitoring abundance.

Murray River Mine Project	**Project No.:** 0194106-0003	**Date:** 9-APR-2014	ERM

Stream Name: Twenty Creek
Station ID: Twenty Cr.
Upstream UTM Coordinates: 10U 625380 6096920
Downstream UTM Coordinates: 10U 625500 6096907
Province: BC
Survey Date(s): 4-JUN-2010
Stream Class: S4, fish-bearing
Crew: KE, NA

SITE PHOTO - JUN-2010

SITE PHOTO - JUN-2010

BIOPHYSICAL DATA

Survey distance (m): 200
Transparency: Med/Clear
Flow Conditions: Med
Water temperature (˚C): N/A
Specific cond. (µs/cm): N/A
Oxygen conc. (mg/L): N/A
pH: N/A

Mean bankfull width (m): 3.1
Mean wetted width (m): 2.3
Mean bankfull depth (m): 0.66
Mean wetted depth (m): 0.20
Mean channel gradient (%): 1.3

Left Bank (LB)
Mean LB height (m): 0.56
LB Stability: Stable
Mean LB riparian cover (%): 72

Right Bank (RB)
Mean RB height (m): 0.64
RB Stability: Stable
Mean RB riparian cover (%): 74

Mean fish cover total (%): 64
Dominant cover type: Pool
Sub-dom. cover type: Overhang veg.
Dominant bed material: Gravel
Sub-dom. bed material: Fines
Mean canopy cover (%): 8.4

HABITAT

Spawning: Poor
Overwintering: None
Rearing: Fair
Migration: Fair
Adult Feeding: Poor

FISH
Sampling methods: N/A
Fish captured: N/A

Known species occurrence:
EB, MW, RB

COMMENTS
Site ends at pipeline ROW. Abundant gravel substrate but stream generally too shallow for good spawning and incubation. Abundant rearing cover. No pools > 1 m. No observed barriers from site upstream to Murray River FSR.

Murray River Mine Project	Project No.: 0194106-0003	Date: 9-APR-2014	ERM

Stream Name: M20 Creek
Station ID: M20-FT
Upstream UTM Coordinates: 10U 626195 6097960
Downstream UTM Coordinates: 10U 626195 6098127
Province: BC
Survey Date(s): 3-JUN-2010
Stream Class: S2, fish-bearing
Crew: KE, NA

SITE PHOTO - JUN-2010

BIOPHYSICAL DATA

Survey distance (m): 200
Transparency: Turbid
Flow Conditions: N/A
Water temperature (˚C): N/A
Specific cond. (µs/cm): N/A
Oxygen conc. (mg/L): N/A
pH: N/A

Mean bankfull width (m): 13.1
Mean wetted width (m): 8.3
Mean bankfull depth (m): 1.19
Mean wetted depth (m): 0.38
Mean channel gradient (%): 2.3

Left Bank (LB)
Mean LB height (m): 1.20
LB Stability: Unstable - Stable
Mean LB riparian cover (%): 71

Right Bank (RB)
Mean RB height (m): 1.35
RB Stability: Unstable - Stable
Mean RB riparian cover (%): 90

Mean fish cover total (%): 49
Dominant cover type: LWD
Sub-dom. cover type: Overhang veg.
Dominant bed material: Fines
Sub-dom. bed material: Cobble
Mean canopy cover (%): 18

HABITAT

Spawning: Poor
Overwintering: Poor
Rearing: Fair
Migration: Good
Adult Feeding: Poor

FISH
Sampling methods: N/A
Fish captured: N/A

Known species occurrence:
GR, EB, BT, BB, LSU, MW, RB, CCG

COMMENTS
Few areas of loose gravel, heavy sedimentation. Some areas of shallow pools with abundant cover, some side channel habitat. Little cover for adult fish. No deep pools. No impediments to migration.

Murray River Mine Project	Project No.: 0194106-0003	Date: 9-APR-2014	ERM

Stream Name: Murray River
Station ID: MR4
Upstream UTM Coordinates: 10U 626029 6097474
Downstream UTM Coordinates: 10U 626000 6097330
Province: BC
Survey Date(s): 3-JUN-2010
Stream Class: S1-large river
Crew: KE, NA

SITE PHOTO - JUN-2010

BIOPHYSICAL DATA

Survey distance (m): 200
Transparency: Turbid
Flow Conditions: High
Water temperature (˚C): N/A
Specific cond. (μs/cm): N/A
Oxygen conc. (mg/L): N/A
pH: N/A

Mean bankfull width (m): 1.0
Mean wetted width (m): 0.96
Mean bankfull depth (m): 1.0
Mean wetted depth (m): 1.0
Mean channel gradient (%): 2.0

Left Bank (LB)
Mean LB height (m): Cliff
LB Stability: Unstable
Mean LB riparian cover (%): 0

Right Bank (RB)
Mean RB height (m): 1.00
RB Stability: Highly Stable
Mean RB riparian cover (%): 5

Mean fish cover total (%): 30
Dominant cover type: LWD
Sub-dom. cover type: Pool/OHV/SWD
Dominant bed material: Fi/Gr
Sub-dom. bed material: Cobble
Mean canopy cover (%): 5

HABITAT

Spawning: Poor
Overwintering: Poor
Rearing: Good
Migration: Good
Adult Feeding: Good

FISH
Sampling methods: N/A
Fish captured: N/A

Known species occurrence:
GR, BMC, BSB, EB, BT, BB, FDC, LKC, LNC, LSU, MW, NP, RB, RSC, CCG, WCT

COMMENTS
Poor visibility of substrate. Observed lack of spawning gravel. Abundance rearing and resting areas for fish as LWD jams. Good LWD cover for adult fish. No deep pools but large pool downstream. No impediments to migration.

Stream Name: Murray River
Station ID: MR5A
Upstream UTM Coordinates: N/A
Downstream UTM Coordinates: 10U 626724 6101080
Province: BC
Survey Date(s): 3-JUN-2010
Stream Class: N/A
Crew: KE, NA

hd Mining

SITE PHOTO - JUN-2010

BIOPHYSICAL DATA

Survey distance (m): 200
Transparency: Turbid
Flow Conditions: High
Water temperature (˚C): N/A
Specific cond. (µs/cm): N/A
Oxygen conc. (mg/L): N/A
pH: N/A

Mean bankfull width (m): 105
Mean wetted width (m): 85
Mean bankfull depth (m): 2.5
Mean wetted depth (m): 2.0
Mean channel gradient (%): 2.0

Left Bank (LB)
Mean LB height (m): 1.00
LB Stability: Stable
Mean LB riparian cover (%): 75

Right Bank (RB)
Mean RB height (m): 2.50
RB Stability: Unstable
Mean RB riparian cover (%): 75

Mean fish cover total (%): 40
Dominant cover type: Boulder
Sub-dom. cover type: LWD
Dominant bed material: N/A
Sub-dom. bed material: N/A
Mean canopy cover (%): 0

HABITAT

Spawning: Poor
Overwintering: Good
Rearing: Good
Migration: Good
Adult Feeding: Good

FISH
Sampling methods: N/A
Fish captured: N/A

Known species occurrence:
GR, BMC, BSB, EB, BT, BB, FDC, LKC, LNC, LSU, MW, NP, RB, RSC, CCG, WCT

COMMENTS
Substrate could not be adequately surveyed due to poor visibility from turbidity. No loose gravel. Freshet flow was too fast for spawning. LWD, side channel and pool habitat on LB. Good cover for juveniles, approp. flow and access to pools/side channels. Large mid-channel pool. No impediments to migration.

Murray River Mine Project	Project No.: 0194106-0003	Date: 9-APR-2014	ERM

Stream Name: Murray River
Station ID: MR6
Upstream UTM Coordinates: N/A
Downstream UTM Coordinates: 10U 625364 6109309
Province: BC
Survey Date(s): 4-JUN-2010
Stream Class: S1-large river
Crew: KE, NA

SITE PHOTO - JUN-2010

BIOPHYSICAL DATA

Survey distance (m): 200
Transparency: Turbid
Flow Conditions: High
Water temperature (˚C): N/A
Specific cond. (µs/cm): N/A
Oxygen conc. (mg/L): N/A
pH: N/A

Mean bankfull width (m): 75
Mean wetted width (m): 70
Mean bankfull depth (m): 3.0
Mean wetted depth (m): 2.0
Mean channel gradient (%): 2.0

Left Bank (LB)
Mean LB height (m): 2.00
LB Stability: Stable
Mean LB riparian cover (%): 75

Right Bank (RB)
Mean RB height (m): 2.00
RB Stability: Stable
Mean RB riparian cover (%): 75

Mean fish cover total (%):N/A
Dominant cover type: N/A
Sub-dom. cover type: N/A
Dominant bed material: N/A
Sub-dom. bed material: N/A
Mean canopy cover (%): 0

HABITAT

Spawning: Poor
Overwintering: Good
Rearing: Poor
Migration: Good
Adult Feeding: Good

FISH
Sampling methods: N/A
Fish captured: N/A

Known species occurrence:
GR, BMC, BSB, EB, BT, BB, FDC, LKC, LNC, LSU, MW, NP, RB, RSC, CCG, WCT

COMMENTS
Substrate and cover not surveyed due to poor visibility caused by turbidity. No side channels or pool habitat. Good adult trout habitat. Sufficient depth for all year habitat use. No impediments to migration.

Murray River Mine Project	**Project No.:** 0194106-0003	**Date:** 9-APR-2014	ERM

Stream Name: Murray River
Station ID: MR-REF
Upstream UTM Coordinates: N/A
Downstream UTM Coordinates: 10U 624218 6086910
Province: BC
Survey Date(s): 4-JUN-2010
Stream Class: S1-large river
Crew: KE, NA

SITE PHOTO - JUN-2010

BIOPHYSICAL DATA

Survey distance (m): 200
Transparency: Turbid
Flow Conditions: Med/High
Water temperature (˚C): N/A
Specific cond. (µs/cm): N/A
Oxygen conc. (mg/L): N/A
pH: N/A

Mean bankfull width (m): 70
Mean wetted width (m): 60
Mean bankfull depth (m): 3.5
Mean wetted depth (m): 1.5
Mean channel gradient (%): 2.0

Left Bank (LB)
Mean LB height (m): 0.50
LB Stability: Stable
Mean LB riparian cover (%): 100

Right Bank (RB)
Mean RB height (m): 1.00
RB Stability: Unstable
Mean RB riparian cover (%): 100

Mean fish cover total (%): 55
Dominant cover type: Pool
Sub-dom. cover type: Boulder/OHV
Dominant bed material: Cobble
Sub-dom. bed material: Gravel
Mean canopy cover (%): 10

HABITAT

Spawning: Poor
Overwintering: Poor
Rearing: Good
Migration: Good
Adult Feeding: Good

FISH
Sampling methods: N/A
Fish captured: N/A

Known species occurrence:
GR, BMC, BSB, EB, BT, BB, FDC, LKC, LNC, LSU, MW, NP, RB, RSC, CCG, WCT

COMMENTS
Pool at downstream end of survey site, possible feeding site for adult fish. No side channels. Some loose gravel and cobble. Good cover with LWD and SWD and pool habitat. No deep pools > 1 m. No migration impediments.

Murray River Mine Project	**Project No.:** 0194106-0003	**Date:** 9-APR-2014	ERM

Stream Name: Club Creek
Station ID: REF-ST
Upstream UTM Coordinates: 10U 611594 6080686
Downstream UTM Coordinates: 10U 611518 6080817
Province: BC
Survey Date(s): 4-JUN-2010
Stream Class: S3; fish-bearing
Crew: KE, NA

SITE PHOTO - JUN-2010

BIOPHYSICAL DATA

Survey distance (m): 131
Transparency: Clear
Flow Conditions: Med/High
Water temperature (˚C): N/A
Specific cond. (μs/cm): N/A
Oxygen conc. (mg/L): N/A
pH: N/A

Mean bankfull width (m): 30.0
Mean wetted width (m): 7.3
Mean bankfull depth (m): 1.25
Mean wetted depth (m): 0.43
Mean channel gradient (%): 2.0

Left Bank (LB)
Mean LB height (m): 1.50
LB Stability: Stable
Mean LB riparian cover (%): 38

Right Bank (RB)
Mean RB height (m): 0.50
RB Stability: Stable
Mean RB riparian cover (%): 38

Mean fish cover total (%): 48
Dominant cover type: Boulder/LWD
Sub-dom. cover type: Overhang Veg.
Dominant bed material: Cobble
Sub-dom. bed material: Fi/Gr
Mean canopy cover (%): 5

HABITAT

Spawning: Poor/Good
Overwintering: Poor
Rearing: Good
Migration: Good
Adult Feeding: Good

FISH
Sampling methods: N/A
Fish captured: N/A

Known species occurrence: N/A

COMMENTS
Poor spawning habitat in main channel. Good spawning habitat in side channel. Several side channels with good cover and flow for rearing. Abundant resting sites and insect hatches for adult feeding. No deep pools. No impediments to migration. Good connection downstream to Murray River.

Murray River Mine Project	Project No.:	Date:	
	0194106-0003	9-APR-2014	ERM

Stream Name: Mast Creek
Station ID: Upper Mast
Upstream UTM Coordinates: 10U 619410 6100360
Downstream UTM Coordinates: 10U 619459 6100577
Province: BC
Survey Date(s): 4-JUN-2010
Stream Class: N/A
Crew: KE, NA

SITE PHOTO - JUN-2010

BIOPHYSICAL DATA

Survey distance (m): 200
Transparency: N/A
Flow Conditions: Med/High
Water temperature (˚C): N/A
Specific cond. (µs/cm): N/A
Oxygen conc. (mg/L): N/A
pH: N/A

Mean bankfull width (m): 8.0
Mean wetted width (m): 4.0
Mean bankfull depth (m): 0.70
Mean wetted depth (m): 0.40
Mean channel gradient (%): 2.0

Left Bank (LB)
Mean LB height (m): 1.20
LB Stability: Stable
Mean LB riparian cover (%): 40

Right Bank (RB)
Mean RB height (m): 0.70
RB Stability: Stable
Mean RB riparian cover (%): 40

Mean fish cover total (%): 45
Dominant cover type: LWD
Sub-dom. cover type: Boulder/OHV
Dominant bed material: Cobble
Sub-dom. bed material: Gravel
Mean canopy cover (%): 10

HABITAT

Spawning: Poor
Overwintering: None
Rearing: Good
Migration: Good
Adult Feeding: Poor

FISH
Sampling methods: N/A
Fish captured: N/A

Known species occurrence:
BT, CCG

COMMENTS
Mainly cobble substrate with very little small gravel. Some side channel habitat and some cover from LWD and bank vegetation for rearing fish. Few deep areas for adult fish. No deep pools > 1 m. No impediments to migration.

Murray River Mine Project	Project No.: 0194106-0003	Date: 9-APR-2014	ERM

Appendix 6

Sampling Effort by Gear Type and Year

ERM

Appendix 6a. Electrofishing Sampling Data, 2011 and 2013

Site	Waterbody Name	UTM Location			Date	Sampling Method	Turbidity	Haul or Pass	Effort (s)	Length (m)	Width (m)	Enclosure	Voltage (v)	Frequency (Hz)	Pulse (m/s)	Make	Model	Catch	Total Catch (No. of fish)	CPUE (No. of fish/100 s)	Comments
		Zone	Easting	Northing																	
M17A	M17A Creek	10U	627021	6098288	11-May-13	EF	C	1	954	–	–	Open	–	–	–	–	–	1 BB, 1 CCG, 1 MW	3	0.31	Stantec (2013)
					29-Jul-13	EF	C	1	470	–	–	Open	–	–	–	–	–	1 unidentified salmonid	1	0.21	Stantec (2013)
M19A-1	M19A Creek	10U	627358	6099292	13-Jun-13	EF	C	1	2,216	1,500	0.8	Open	240	30	4	SR	LR 24	0	0	0.00	end of EF site: 10U 626628 E, 6100100 N
M19A-3	M19A Creek	10U	627360	6099292	25-Aug-13	EF	C	1	388	50	0.8	Open	240	30	4	SR	LR 24	0	0	0.00	
CS2	CS2	10U	614908	6088321	13-Jun-13	EF	C	1	344	–	–	Open	240	30	4	SR	LR 24	0	0	0.00	
CS3	CS3	10U	618607	6090967	13-Jun-13	EF	C	1	512	–	–	Open	225	30	4	SR	LR 24	0	0	0.00	
CS5	CS5	10U	620529	6090686	15-Jun-13	EF	C	1	624	–	–	Open	255	30	4	SR	LR 24	0	0	0.00	
					23-Aug-13	EF	C	1	698	93	1.8	Open	225	30	4	SR	LR 24	1 CCG; 3 EB; 4 FDC	8	1.15	
CS6	CS6	10U	626623	6097933	15-Jun-13	EF	C	1	611	–	–	Open	240	30	4	SR	LR 24	0	0	0.00	
M20 DS	M20 Creek	10U	626248	6097956	24-Sep-12	EF	C	1	750	25	4	Stop nets	240	30	4	SR	LR 24	1 BT, 12 CCG, 1 MW	14	1.87	
					24-Sep-12	EF	C	2	400	25	4	Stop nets	240	30	4	SR	LR 24	1 CCG	1	0.25	
					24-Sep-12	EF	C	3	286	25	4	Stop nets	240	30	4	SR	LR 24	0	0	0.00	
OBL 1	Murray River side channel	10U	626910	6098392	22-Sep-12	EF	C	1	1,068	170	–	Open	225	30	4	SR	LR 24	8 CCG, 3 DC	11	1.03	
OBL 2	Murray River side channel	10U	626894	6098325	22-Sep-12	EF	C	1	857	50	10	Open	225	30	4	SR	LR 24	2 BB, 23 CCG	25	2.92	
OBL 3	Murray River side channel	10U	626562	6097863	23-Sep-12	EF	C	1	1,038	25	6	Stop nets	210	30	4	SR	LR 24	1 BB, 6 CCG	7	0.67	
					23-Sep-12	EF	C	2	714	25	6	Stop nets	210	30	4	SR	LR 24	1 CCG	1	0.14	
					23-Sep-12	EF	C	3	404	25	6	Stop nets	210	30	4	SR	LR 24	0	0	0.00	
OBL 4	Murray River side channel	10U	626577	6097888	23-Sep-12	EF	C	1	674	25	5	Stop nets	210	30	4	SR	LR 24	1 CCG	1	0.15	
					23-Sep-12	EF	C	2	423	25	5	Stop nets	210	30	4	SR	LR 24	0	0	0.00	
					23-Sep-12	EF	C	3	266	25	5	Stop nets	210	30	4	SR	LR 24	0	0	0.00	
M19	M19 Creek	10U	626778	6100178	5-Aug-11	EF	M	1	662	200	4.4	Open	250	60	4	Coffelt	Mark X	15 GR, 8 CCG, 1 LNC, 2 EB, 1 BB, 2 MW	29	4.38	DES (2011)
Twenty Cree	Twenty Creek	10U	625474	6096940	5-Aug-11	EF	M	1	331	200	1.85	Open	250	60	4	Coffelt	Mark X	1 RB, 1 MW, 3 EB	5	1.51	DES (2011)

Notes:

Sample Method: EF = backpack electrofisher, SR = Smith-Root™

Turbidity: C = clear, M = moderate

Fish Species Codes: BB = Burbot, BT = Bull Trout, CCG = Slimy Sculpin, EB = Brook Trout, FDC = Finescale Dace, GR = Arctic Grayling, LNC = Longnose Dace, MW = Mountain Whitefish

Dashes (–) indicate data not collected

Appendix 6b. Minnow Trap Sampling Data, 2013

Waterbody	Site	Trap No.	UTM Location Zone	Easting	Northing	Set Date	Time	Retrived Date	Time	Depth (m)	Effort (h)	Catch (No. of fish)	CPUE (No. of fish/trap/24 h)	Comments
M19A Creek	M19A	1	10 U	626603	6100078	13-Jun-13	12:47	14-Jun-13	10:40	0.5	21.88	0	0	No catch
		2	10 U	626600	6100063	13-Jun-13	12:45	14-Jun-13	10:38	0.5	21.88	0	0	No catch
		3	10 U	626655	6099930	13-Jun-13	12:52	14-Jun-13	10:51	0.5	21.98	0	0	No catch
		4	10 U	626588	6099890	13-Jun-13	12:58	14-Jun-13	10:43	0.5	21.75	0	0	No catch
		5	10 U	626658	6100104	13-Jun-13	12:59	14-Jun-13	10:55	0.5	21.93	0	0	No catch
		6	10 U	626662	6100064	13-Jun-13	13:17	14-Jun-13	11:24	0.5	22.12	0	0	No catch
		7	10 U	626618	6100037	13-Jun-13	13:10	14-Jun-13	11:39	0.5	22.48	0	0	No catch
		8	10 U	626621	6100000	13-Jun-13	13:20	14-Jun-13	11:45	0.5	22.42	0	0	No catch
		9	10 U	626606	6099955	13-Jun-13	13:22	14-Jun-13	11:47	0.5	22.42	0	0	No catch
		10	10 U	627067	6099357	13-Jun-13	14:54	14-Jun-13	16:30	0.5	25.60	0	0	No catch
		11	10 U	627110	6099380	13-Jun-13	14:51	14-Jun-13	16:37	0.5	25.77	0	0	No catch
		12	10 U	627129	6099391	13-Jun-13	14:50	14-Jun-13	16:38	0.5	25.80	0	0	No catch
		13	10 U	627149	6099401	13-Jun-13	14:46	14-Jun-13	16:41	0.5	25.92	0	0	No catch
		14	10 U	627176	6099405	13-Jun-13	14:45	14-Jun-13	16:43	0.5	25.97	0	0	No catch
		15	10 U	627190	6099396	13-Jun-13	14:39	14-Jun-13	16:44	0.5	26.08	0	0	No catch
		16	10 U	627207	6099401	13-Jun-13	14:37	14-Jun-13	16:46	0.5	26.15	0	0	No catch
		17	10 U	627260	6099334	13-Jun-13	14:35	14-Jun-13	16:51	0.5	26.27	0	0	No catch
		18	10 U	627303	6099298	13-Jun-13	14:29	14-Jun-13	16:55	0.5	26.43	0	0	No catch
		19	10 U	627349	6099286	13-Jun-13	14:28	14-Jun-13	16:59	0.5	26.52	0	0	No catch
		20	10 U	627358	6099292	13-Jun-13	14:24	14-Jun-13	17:01	0.5	26.62	0	0	No catch
CS3	CS3	1	10 U	618542	6091063	12-Jun-13	14:20	13-Jun-13	16:20	0.5	26.00	0	0	No catch
		2	10 U	618542	6091063	12-Jun-13	14:22	13-Jun-13	16:20	0.5	25.97	0	0	No catch
		3	10 U	618542	6091063	12-Jun-13	14:23	13-Jun-13	16:20	0.5	25.95	0	0	No catch
		4	10 U	618542	6091063	12-Jun-13	14:25	13-Jun-13	16:20	0.5	25.92	0	0	No catch
		5	10 U	618542	6091063	12-Jun-13	14:38	13-Jun-13	16:20	0.5	25.70	0	0	No catch
		6	10 U	618542	6091063	12-Jun-13	14:37	13-Jun-13	16:20	0.5	25.72	0	0	No catch
		7	10 U	618542	6091063	12-Jun-13	14:36	13-Jun-13	16:20	0.5	25.73	0	0	No catch
		8	10 U	618542	6091063	12-Jun-13	14:34	13-Jun-13	16:20	0.5	25.77	0	0	No catch
		9	10 U	618542	6091063	12-Jun-13	14:33	13-Jun-13	16:20	0.5	25.78	0	0	No catch
		10	10 U	618515	6091016	12-Jun-13	14:33	13-Jun-13	16:27	0.5	25.90	0	0	No catch
CS5	CS5	1	10 U	618542	6091063	15-Jun-13	9:07	16-Jun-13	9:48	0.5	24.68	0	0	No catch
		2	10 U	620599	6090495	15-Jun-13	9:10	16-Jun-13	9:49	0.5	24.65	0	0	No catch
		3	10 U	620582	6090524	15-Jun-13	9:12	16-Jun-13	9:52	0.5	24.67	1	0.97	1 FDC juvenile
		4	10 U	620611	6090512	15-Jun-13	9:13	16-Jun-13	10:27	0.5	25.23	0	0	No catch
		5	10 U	620618	6090543	15-Jun-13	9:14	16-Jun-13	10:29	0.5	25.25	0	0	No catch

Appendix 6b. Minnow Trap Sampling Data, 2013

Waterbody	Site	Trap No.	UTM Location Zone	Easting	Northing	Set Date	Time	Retrived Date	Time	Depth (m)	Effort (h)	Catch (No. of fish)	CPUE (No. of fish/trap/24 h)	Comments
CS5 *(cont'd)*	CS5 *(cont'd)*	6	10 U	620602	6090560	15-Jun-13	9:16	16-Jun-13	10:31	0.5	25.25	0	0	No catch
		7	10 U	620599	6090571	15-Jun-13	9:17	16-Jun-13	10:31	0.5	25.23	0	0	No catch
		8	10 U	620588	6090580	15-Jun-13	9:18	16-Jun-13	10:32	0.5	25.23	0	0	No catch
		9	10 U	620578	6090602	15-Jun-13	9:19	16-Jun-13	10:40	0.5	25.35	0	0	No catch
		10	10 U	620565	6090625	15-Jun-13	9:21	16-Jun-13	10:41	0.5	25.33	0	0	No catch
CS6	CS6	1	10 U	616667	6090055	14-Jun-13	9:00	15-Jun-13	10:50	0.5	25.83	0	0	No catch
		2	10 U	616687	6090028	14-Jun-13	9:02	15-Jun-13	10:57	0.5	25.92	0	0	No catch
		3	10 U	616717	6090025	14-Jun-13	9:04	15-Jun-13	11:08	0.5	26.07	0	0	No catch
		4	10 U	616713	6090036	14-Jun-13	9:06	15-Jun-13	11:10	0.5	26.07	0	0	No catch
		5	10 U	616747	6090051	14-Jun-13	9:08	15-Jun-13	11:16	0.5	26.13	0	0	No catch
		6	10 U	616760	6090039	14-Jun-13	9:10	15-Jun-13	11:19	0.5	26.15	0	0	No catch
		7	10 U	616772	6090029	14-Jun-13	9:12	15-Jun-13	11:21	0.5	26.15	0	0	No catch
		8	10 U	616777	6090015	14-Jun-13	9:14	15-Jun-13	11:23	0.5	26.15	0	0	No catch
		9	10 U	616637	6090040	14-Jun-13	9:16	15-Jun-13	11:38	0.5	26.37	0	0	No catch
		10	10 U	616626	6089994	14-Jun-13	9:15	15-Jun-13	11:42	0.5	26.45	0	0	No catch
CS1	CS1	1	10 U	625946	6096808	22-Aug-13	10:30	23-Aug-13	15:45	0.5	29.25	1	0.82	1 NP juveniles
		2	10 U	625948	6096811	22-Aug-13	10:32	23-Aug-13	15:47	0.5	29.25	3	2.46	3 NP juveniles
		3	10 U	625944	6096812	22-Aug-13	10:34	23-Aug-13	15:49	0.5	29.25	0	0	No catch
		4	10 U	625940	6096820	22-Aug-13	10:36	23-Aug-13	15:51	0.5	29.25	0	0	No catch
		5	10 U	625931	6096828	22-Aug-13	10:38	23-Aug-13	15:53	0.5	29.25	0	0	No catch
		6	10 U	625924	6096829	22-Aug-13	10:40	23-Aug-13	15:55	0.5	29.25	0	0	No catch
		7	10 U	625922	6096836	22-Aug-13	10:42	23-Aug-13	15:57	0.5	29.25	0	0	No catch
		8	10 U	625915	6096835	22-Aug-13	10:44	23-Aug-13	15:59	0.5	29.25	0	0	No catch
		9	10 U	625912	6096845	22-Aug-13	10:46	23-Aug-13	16:01	0.5	29.25	0	0	No catch
		10	10 U	625907	6096843	22-Aug-13	10:48	23-Aug-13	16:03	0.5	29.25	0	0	No catch
CS5	CS5	1	10 U	625957	6096783	21-Aug-13	15:15	22-Aug-13	11:00	0.25	19.75	1	1.22	1 FDC juvenile
		2	10 U	620585	6090586	21-Aug-13	15:17	22-Aug-13	11:02	0.25	19.75	3	3.65	2 EB juveniles; 1 FDC juvenile
		3	10 U	620584	6090592	21-Aug-13	15:19	22-Aug-13	11:04	0.25	19.75	2	2.43	2 FDC juveniles
		4	10 U	620582	6090585	21-Aug-13	15:21	22-Aug-13	11:06	0.25	19.75	5	6.08	2 EB juveniles; 3 FDC juveniles
		5	10 U	620570	6090613	21-Aug-13	15:23	22-Aug-13	11:08	0.25	19.75	1	1.22	1 FDC juvenile

Notes:

Fish Species Codes: EB = Brook Trout, FDC = Finescale Dace, NP = Northern Pike

Appendix 6c. Beach Seine Sampling Data, 2013

Site	Seine Pass No.	UTM Location			Length (m)	Width (m)	Area (m^2)	Depth (m)	Catch (No. of fish)	CPUE (No. of fish/seine/m^2)	Comments
		Zone	Easting	Northing							
CS1	1	10 U	626603	6100078	4	3	12	0.5	1	0.08	1 NP
	2	10 U	626600	6100063	4	3	12	0.5	2	0.17	2 NP
	3	10 U	626655	6099930	4	3	12	0.5	2	0.17	2 BB
	4	10 U	626588	6099890	4	3	12	0.5	1	0.08	1 BB
	5	10 U	626658	6100104	3	3	9	0.5	1	0.11	1 BB

Notes:

Fish Species Codes: BB = Burbot, NP = Northern Pike

Appendix 6d. Summary of Electrofishing Sampling Effort and CPUE, 2011

Site	Date	No. of Sampling Events	Total EF Seconds	Total Catch	Total CPUE
M5	29-Jul-11	1	97	0	0.00
M9	29-Jul-11	1	176	0	0.00

EF = backpack electrofishing

CPUE = catch-per-unit-effort; No. of fish captured per 100s.

Appendix 6e. Summary of Electrofishing Sampling Effort and CPUE, 2010

Site	Date	No. of Sampling Events	Total EF Seconds	Total Catch	CPUE
M15	27-Aug-10	1	219	0.00	0.00
M17	28-Aug-10	1	239	0.00	0.00

EF = backpack electrofishing

CPUE = catch-per-unit-effort; No. of fish captured per 100s.

Appendix 6f. Summary of Electrofishing Sampling Effort and CPUE, 2006

Site	Date	Reach	No. of Sampling Events	Total EF Seconds	Total Catch	Total CPUE	Arctic Grayling		Brook Trout		Bull Trout		Burbot		Mountain Whitefish		Rainbow Trout		Slimy Sculpin	
							Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
M20 Creek	10-Jul-06	1	1	110	7	6.36	0	0.00	0	0.00	1	0.91	0	0.00	6	5.45	0	0.00	0	0.00
M20 Creek	10-Jul-06	2	1	607	26	4.28	2	0.33	6	0.99	5	0.82	0	0.00	11	1.81	0	0.00	2	0.33
M20 Creek	1-Sep-06	1	1	414	8	1.93	0	0.00	0	0.00	0	0.00	0	0.00	8	1.93	0	0.00	0	0.00
M20 Creek	5-Sep-06	2	1	993	25	2.52	0	0.00	0	0.00	2	0.20	0	0.00	22	2.22	1	0.10	0	0.00
M20 Creek	16-Sep-06	1	1	351	26	7.41	0	0.00	0	0.00	0	0.00	1	0.28	9	2.56	0	0.00	16	4.56
M20 Creek	5-Oct-06	1	1	415	5	1.20	0	0.00	1	0.24	0	0.00	0	0.00	4	0.96	0	0.00	0	0.00
M20 Creek	5-Oct-06	2	1	880	20	2.27	0	0.00	5	0.57	4	0.45	0	0.00	11	1.25	0	0.00	0	0.00

EF = backpack electrofishing

CPUE = catch-per-unit-effort; No. of fish captured per 100s.

Appendix 6g. Summary of Electrofishing Sampling Effort and CPUE, 2005

Site	Date	Reach	No. of Sampling Events	Total EF Seconds	Total Catch	Total CPUE	Arctic Grayling Catch	Arctic Grayling CPUE	Brook Trout Catch	Brook Trout CPUE	Bull Trout Catch	Bull Trout CPUE	Finescale Dace Catch	Finescale Dace CPUE	Lake Chub Catch	Lake Chub CPUE	Longnose Sucker Catch	Longnose Sucker CPUE	Mountain Whitefish Catch	Mountain Whitefish CPUE	Slimy Sculpin Catch	Slimy Sculpin CPUE
Barbour Creek	29-Jul-05	1	1	538	46.00	8.55	0	0.00	24	4.46	0	0.00	0	0.00	0	0.00	0	0.00	7	1.30	15	2.79
Barbour Creek	29-Jul-05	2	1	276	0.00	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Barbour Creek	29-Jul-05	5	1	257	0.00	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Barbour Creek	21-Sep-05	1	1	555	33.00	5.95	5	0.90	22	3.96	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	6	1.08
Five Cabin Creek	21-Sep-05	1	1	678	15.00	2.21	0	0.00	2	0.29	3	0.44	0	0.00	0	0.00	0	0.00	0	0.00	10	1.47
Five Cabin Creek	21-Sep-05	6	1	235	0.00	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
M14 Creek	11-Aug-05	1	1	203	12.00	5.91	0	0.00	0	0.00	0	0.00	0	0.00	2	0.99	10	4.93	0	0.00	0	0.00
M14 Creek	11-Aug-05	2	1	235	8.00	3.40	0	0.00	0	0.00	0	0.00	8	3.40	0	0.00	0	0.00	0	0.00	0	0.00
Mast Creek	29-Jul-05	3	1	194	9.00	4.64	0	0.00	0	0.00	9	4.64	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Mast Creek	11-Aug-05	4	1	148	1.00	0.68	0	0.00	0	0.00	1	0.68	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Unnamed Tributary to Barbour Creek	29-Jul-05	1	1	420	0.00	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Unnamed Tributary to Barbour Creek	29-Jul-05	2	1	329	0.00	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Waterfall Creek	29-Jul-05	1	1	352	7.00	1.99	0	0.00	6	1.70	0	0.00	0	0.00	0	0.00	0	0.00	1	0.28	0	0.00

EF = backpack electrofishing

CPUE = catch-per-unit-effort; No. of fish captured per 100s.

Appendix 6h. Summary of Electrofishing Sampling Effort and CPUE, 2004

Site	Date	Reach	No. of Sampling Events	Total EF Seconds	Brook Trout	
					Catch	CPUE
Canary Creek	10-Aug-04	3	1	356	0	0.00
M20 Creek	10-Aug-04	4	1	263	0	0.00
South Hermann Creek	16-Sep-04	1	1	359	4	1.11

EF = backpack electrofishing

CPUE = catch-per-unit-effort; No. of fish captured per 100s.

Appendix 6i. Summary of Electrofishing Sampling Effort and CPUE, 2003

Site	Date	Reach	No. of Sampling Events	Total EF Seconds	Total Catch	Total CPUE	Bull Trout		Mountain Whitefish		Slimy Sculpin	
							Catch	CPUE	Catch	CPUE	Catch	CPUE
Babcock Creek	7-Sep-03	1	1	567	0	0.00	0	0.00	0	0.00	0	0.00
Babcock Creek	8-Sep-03	2	1	502	0	0.00	0	0.00	0	0.00	0	0.00
Gordon Creek	8-Sep-03	1	1	780	11	1.41	4	0.51	0	0.00	7	0.90
Babcock Creek	9-Sep-03	3	1	860	20	2.33	3	0.35	9	1.05	8	0.93
Hambler Creek	9-Sep-03	1	1	485	0	0.00	0	0.00	0	0.00	0	0.00
M19 Creek	9-Sep-03	1	1	349	0	0.00	0	0.00	0	0.00	0	0.00

EF = backpack electrofishing

CPUE = catch-per-unit-effort; No. of fish captured per 100s.

Appendix 7

Fish Biological Data

ERM

Appendix 7a. Fish Biological Data, 2013

Waterbody Name	Site	Sample No.	Method	Haul or Pass	Species Code	Length (mm)	Weight (g)	Condition (g/mm^3)	Comment
CS1	CS1	1	MT	1	NP	90	4.9	0.67	–
CS1	CS1	2	MT	2	NP	105	8.3	0.72	–
CS1	CS1	3	MT	2	NP	92	5.1	0.65	–
CS1	CS1	4	MT	2	NP	101	7.7	0.75	–
CS1	CS1	5	BS	1	NP	340	200+	n/a	Exceeded scale maximum weight
CS1	CS1	6	BS	2	NP	94	5.3	0.64	–
CS1	CS1	7	BS	2	NP	110	9.0	0.68	–
CS1	CS1	8	BS	3	BB	63	1.6	0.64	–
CS1	CS1	9	BS	3	BB	62	1.5	0.64	–
CS1	CS1	10	BS	4	BB	65	1.8	0.64	–
CS1	CS1	11	BS	5	BB	65	1.6	0.59	–
CS5	CS5	12	EF	1	FDC	70	3.4	0.99	–
CS5	CS5	13	EF	1	CCG	120	22.0	1.27	–
CS5	CS5	14	EF	1	FDC	76	4.7	1.08	–
CS5	CS5	15	EF	1	EB	80	5.5	1.07	–
CS5	CS5	16	EF	1	EB	78	5.2	1.10	–
CS5	CS5	17	EF	1	FDC	65	2.6	0.96	–
CS5	CS5	18	EF	1	FDC	56	2.3	1.29	–
CS5	CS5	19	EF	1	EB	85	7.5	1.23	–
CS5	CS5	20	MT	1	FDC	73	4.5	1.14	–
CS5	CS5	21	MT	2	FDC	57	2.3	1.22	–
CS5	CS5	22	MT	2	EB	78	5.7	1.21	–
CS5	CS5	23	MT	2	EB	94	8.1	0.98	–
CS5	CS5	24	MT	3	FDC	56	2.4	1.36	–
CS5	CS5	25	MT	3	FDC	64	3.2	1.20	–
CS5	CS5	26	MT	4	FDC	68	3.4	1.09	–
CS5	CS5	27	MT	4	FDC	59	2.4	1.17	–
CS5	CS5	28	MT	4	FDC	56	2.3	1.28	–
CS5	CS5	29	MT	4	EB	78	5.2	1.09	–
CS5	CS5	30	MT	4	EB	76	4.2	0.95	–
CS5	CS5	31	MT	5	FDC	56	2.4	1.34	–

Notes:

Methods: BS = beach seine, EF = backpack electrofisher, MT = minnow trap

Fish Species Codes: BB = Burbot, CCG = Slimy Sculpin, EB = Brook Trout, NP = Northern Pike

Dashes (–) = no data

Appendix 7b. Fish Biological Data, 2012

Waterbody Name	Site	Method	Species Code	Length (mm)	Weight (g)	Condition (g/mm^3)	Comments
Murray River	MR DS	EF	CCG	74	3.8	0.93	–
Murray River	MR DS	EF	CCG	81	4.6	0.86	–
Murray River	MR DS	EF	CCG	77	3.4	0.74	–
Murray River	MR DS	EF	CCG	55	1.5	0.88	–
Murray River	MR DS	EF	CCG	55	1.4	0.84	–
Murray River	MR DS	EF	CCG	67	2.6	0.87	–
Murray River	MR DS	EF	CCG	59	1.9	0.92	–
Murray River	MR DS	EF	CCG	59	1.9	0.91	–
Murray River	MR4	EF	CCG	75	4.6	1.08	–
Murray River	MR4	EF	CCG	66	3.4	1.17	–
Murray River	MR4	EF	CCG	64	2.7	1.03	–
Murray River	MR4	EF	CCG	57	2.3	1.25	–
Murray River	MR4	EF	CCG	64	3.0	1.14	–
Murray River	MR4	EF	CCG	60	2.1	0.99	–
Murray River	MR4	EF	CCG	59	2.0	0.99	–
Murray River	MR4	EF	CCG	52	1.6	1.15	–
Murray River	MR3	EF	CCG	57	1.7	0.93	–
Murray River	MR3	EF	CCG	65	2.8	1.03	–
Murray River	MR3	EF	CCG	52	1.8	1.27	–
Murray River	MR3	EF	CCG	54	1.8	1.15	–
Murray River	MR3	EF	CCG	55	1.8	1.10	–
Murray River	MR3	EF	CCG	50	1.7	1.34	–
Murray River	MR3	EF	CCG	53	1.5	1.00	–
Murray River	MR3	EF	CCG	51 and 45	2.3	2.07	composite sample
Murray River	MR US	EF	CCG	78	4.5	0.94	–
Murray River	MR US	EF	CCG	66	2.6	0.91	–
Murray River	MR US	EF	CCG	70	3.2	0.94	–
Murray River	MR US	EF	CCG	73	3.8	0.96	–
Murray River	MR US	EF	CCG	58	2.4	1.21	–
Murray River	MR US	EF	CCG	63	2.9	1.16	–
Murray River	MR US	EF	CCG	63	2.2	0.86	–
Murray River	MR US	EF	CCG	58	1.9	0.96	–
M20 Creek	M20 US	EF	BT	181	70.2	1.18	–
M20 Creek	M20 US	EF	BT	167	50.5	1.08	–
M20 Creek	M20 US	EF	BT	151	40.3	1.17	–
M20 Creek	M20 US	EF	CCG	92	9.4	1.21	–
M20 Creek	M20 US	EF	CCG	77	5.6	1.22	–
M20 Creek	M20 US	EF	CCG	91	9.5	1.25	–
M20 Creek	M20 US	EF	CCG	105	4.6	0.40	–
M20 Creek	M20 US	EF	CCG	88	7.1	1.04	–
M20 Creek	M20 US	EF	CCG	93	9.3	1.15	–
M20 Creek	M20 US	EF	CCG	80	6.2	1.22	–
M20 Creek	M20 US	EF	CCG	76	4.8	1.10	–
M20 Creek	M20 den	EF	CCG	82	6.2	1.13	–
M20 Creek	M20 den	EF	CCG	98	10.8	1.14	–
M20 Creek	M20 den	EF	CCG	74	4.7	1.15	–
M20 Creek	M20 den	EF	CCG	92	9.6	1.23	–
M20 Creek	M20 den	EF	CCG	56	1.9	1.06	–
M20 Creek	M20 den	EF	CCG	67	3.7	1.23	–
M20 Creek	M20 den	EF	CCG	56	2.0	1.16	–
M20 Creek	M20 den	EF	CCG	51	1.6	1.23	–
M20 Creek	M20 den	EF	CCG	36	0.7	1.41	–
M20 Creek	M20 den	EF	CCG	35	0.5	1.14	–
M20 Creek	M20 den	EF	CCG	55	1.8	1.05	–
M20 Creek	M20 den	EF	CCG	32	0.6	1.74	–
M20 Creek	M20 den	EF	CCG	70	4.4	1.27	–
M20 Creek	M20 den	EF	MW	81	4.2	0.79	–
M20 Creek	M20 den	EF	BT	193	41.2	0.57	–

Appendix 7b. Fish Biological Data, 2012

Waterbody Name	Site	Method	Species Code	Length (mm)	Weight (g)	Condition (g/mm^3)	Comments
Murray River side channel	OBL 1	EF	CCG	73	4.1	1.06	–
Murray River side channel	OBL 1	EF	CCG	74	4.2	1.03	–
Murray River side channel	OBL 1	EF	CCG	85	6.9	1.12	–
Murray River side channel	OBL 1	EF	CCG	57	1.8	0.96	–
Murray River side channel	OBL 1	EF	CCG	51	1.5	1.12	–
Murray River side channel	OBL 1	EF	CCG	47	1.2	1.17	–
Murray River side channel	OBL 1	EF	CCG	41	0.7	0.99	–
Murray River side channel	OBL 1	EF	CCG	53	1.6	1.04	–
Murray River side channel	OBL 1	EF	DC	27	0.1	0.61	Species Uncertain
Murray River side channel	OBL 1	EF	DC	32	0.3	0.95	Species Uncertain
Murray River side channel	OBL 1	EF	DC	31	0.2	0.81	Species Uncertain
Murray River side channel	OBL 2	EF	BB	145	16.2	0.53	–
Murray River side channel	OBL 2	EF	BB	131	11.4	0.51	–
Murray River side channel	OBL 2	EF	CCG	72	4.3	1.15	–
Murray River side channel	OBL 2	EF	CCG	54	1.4	0.91	–
Murray River side channel	OBL 2	EF	CCG	73	4.3	1.11	–
Murray River side channel	OBL 2	EF	CCG	52	1.4	0.97	–
Murray River side channel	OBL 2	EF	CCG	61	2.5	1.08	–
Murray River side channel	OBL 2	EF	CCG	49	1.1	0.89	–
Murray River side channel	OBL 2	EF	CCG	56	1.6	0.93	–
Murray River side channel	OBL 2	EF	CCG	53	1.6	1.07	–
Murray River side channel	OBL 2	EF	CCG	56	2.0	1.13	–
Murray River side channel	OBL 2	EF	CCG	51	1.6	1.17	–
Murray River side channel	OBL 2	EF	CCG	50	1.4	1.14	–
Murray River side channel	OBL 2	EF	CCG	61	2.7	1.20	–
Murray River side channel	OBL 2	EF	CCG	51	1.5	1.11	–
Murray River side channel	OBL 2	EF	CCG	51	1.3	1.01	–
Murray River side channel	OBL 2	EF	CCG	56	2.0	1.13	–
Murray River side channel	OBL 2	EF	CCG	56	1.7	0.97	–
Murray River side channel	OBL 2	EF	CCG	66	3.2	1.10	–
Murray River side channel	OBL 2	EF	CCG	57	2.4	1.27	–
Murray River side channel	OBL 2	EF	CCG	55	1.5	0.90	–
Murray River side channel	OBL 2	EF	CCG	58	2.2	1.13	–
Murray River side channel	OBL 2	EF	CCG	37	0.7	1.30	–
Murray River side channel	OBL 2	EF	CCG	23	0.1	0.90	–
Murray River side channel	OBL 2	EF	CCG	22	0.1	0.94	–
Murray River side channel	OBL 3	EF	CCG	67	3.0	1.01	–
Murray River side channel	OBL 3	EF	CCG	54	1.5	0.97	–
Murray River side channel	OBL 3	EF	CCG	66	3.1	1.07	–
Murray River side channel	OBL 3	EF	CCG	57	1.7	0.92	–
Murray River side channel	OBL 3	EF	CCG	59	2.1	1.03	–
Murray River side channel	OBL 3	EF	CCG	41	0.7	1.03	–
Murray River side channel	OBL 3	EF	CCG	56	1.9	1.07	–
Murray River side channel	OBL 3	EF	BB	111	6.8	0.50	–
Murray River side channel	OBL 4	EF	CCG	56	2.1	1.17	–

Notes:

Methods: EF = backpack electrofisher

Fish Species Codes: BB = Burbot, BT = Bull Trout, CCG = Slimy Sculpin, DC = Dace spp., MW = Mountain Whitefish

Dashes (–) = no data

Appendix 7c. Fish Biological Data, 2011

Waterbody Name	Site	Method	Species Code	Length (mm)	Weight (g)	Condition (g/mm^3)	Comments
Murray River	Murray RB	EF	CCG	70	3.5	1.01	–
Murray River	Murray RB	EF	CCG	50	1.1	0.84	–
Murray River	Murray RB	EF	CCG	45	0.8	0.84	–
Murray River	Murray RB	EF	CCG	38	0.5	0.91	–
Murray River	Murray RB	EF	CCG	42	0.5	0.63	–
Murray River	Murray RB	EF	CCG	42	0.7	0.93	–
Murray River	Murray RB	EF	CCG	38	0.5	0.95	–
Murray River	Murray RB	EF	CCG	46	0.8	0.82	–
Murray River	Murray RB	EF	CCG	48	0.8	0.70	–
Murray River	Murray RB	EF	CCG	52	1.0	0.71	–
Murray River	Murray RB	EF	CCG	45	0.8	0.84	–
Murray River	Murray RB	EF	CCG	40	0.6	0.97	–
Murray River	Murray RB	EF	CCG	37	0.6	1.13	–
Murray River	Murray RB	EF	CCG	48	0.9	0.82	–
Murray River	Murray RB	EF	CCG	55	1.6	0.99	–
Murray River	Murray RB	EF	CCG	60	1.6	0.72	–
Murray River	Murray RB	EF	CCG	40	0.6	0.94	–
Murray River	Murray RB	EF	CCG	42	0.7	0.99	–
Murray River	Murray RB	EF	CCG	47	1.0	0.92	–
Murray River	Murray RB	EF	CCG	48	0.8	0.74	–
Murray River	Murray RB	EF	CCG	43	0.6	0.78	–
Murray River	Murray RB	EF	CCG	45	0.6	0.61	–
Murray River	Murray RB	EF	CCG	43	0.7	0.84	–
Murray River	Murray RB	EF	CCG	35	0.4	0.91	–
Murray River	Murray RB	EF	CCG	63	2.4	0.95	–
Murray River	Murray RB	EF	CCG	66	2.6	0.91	–
Murray River	Murray RB	EF	CCG	70	2.2	0.65	–
Murray River	Murray RB	EF	CCG	64	2.2	0.82	–
Murray River	Murray RB	EF	CCG	56	1.1	0.64	–
Murray River	Murray RB	EF	CCG	60	2.1	0.99	–
Murray River	Murray RB	EF	CCG	70	3.6	1.04	–
Murray River	Murray RB	EF	CCG	75	4.4	1.03	–
Murray River	Murray RB	EF	CCG	50	1.1	0.86	–
Murray River	Murray DS	EF	CCG	73	3.7	0.95	–
Murray River	Murray DS	EF	CCG	65	2.9	1.04	–
Murray River	Murray DS	EF	CCG	65	2.8	1.00	–
Murray River	Murray DS	EF	CCG	69	2.8	0.85	–
Murray River	Murray DS	EF	CCG	89	5.3	0.75	–
Murray River	Murray DS	EF	CCG	55	1.5	0.89	–
Murray River	Murray DS	EF	CCG	68	2.9	0.92	–
Murray River	Murray DS	EF	CCG	50	1.1	0.86	–
Murray River	Murray DS	EF	CCG	53	1.4	0.96	–
Murray River	Murray DS	EF	CCG	61	2.1	0.93	–
Murray River	Murray DS	EF	CCG	45	0.4	0.38	–
Murray River	Murray DS	EF	CCG	44	0.6	0.69	–
Murray River	Murray DS	EF	CCG	42	0.8	1.11	–
Murray River	Murray DS	EF	CCG	60	1.9	0.88	–
Murray River	Murray DS	EF	CCG	72	3.8	1.02	–
Murray River	Murray DS	EF	CCG	41	0.7	1.02	–
Murray River	Murray DS	EF	CCG	41	0.7	0.96	–

Appendix 7c. Fish Biological Data, 2011

Waterbody Name	Site	Method	Species Code	Length (mm)	Weight (g)	Condition (g/mm^3)	Comments
Murray River	Murray DS	EF	CCG	38	0.6	1.02	–
Murray River	Murray DS	EF	CCG	44	0.7	0.83	–
Murray River	Murray DS	EF	CCG	40	0.5	0.75	–
Murray River	Murray DS	EF	CCG	39	0.3	0.54	–
Murray River	Murray DS	EF	CCG	65	2.8	1.03	–
Murray River	Murray DS	EF	CCG	80	4.2	0.83	–
Murray River	Murray DS	EF	CCG	42	3.5	4.70	–
Murray River	Murray DS	EF	CCG	36	0.5	1.11	–
Murray River	Murray DS	EF	CCG	40	0.6	0.91	–
Murray River	Murray DS	EF	CCG	41	0.5	0.75	–
Murray River	Murray DS	EF	CCG	42	0.5	0.61	–
Murray River	Murray DS	EF	CCG	36	0.5	1.07	–
Murray River	Murray DS	EF	CCG	28	0.3	1.32	–
Murray River	Murray US	EF	CCG	76	4.0	0.90	–
Murray River	Murray US	EF	CCG	58	1.8	0.91	–
Murray River	Murray US	EF	CCG	50	1.2	0.92	–
Murray River	Murray US	EF	CCG	39	0.6	1.01	–
Murray River	Murray US	EF	CCG	98	6.0	0.64	–
Murray River	Murray US	EF	CCG	83	3.6	0.63	–
Murray River	Murray US	EF	CCG	67	1.9	0.62	–
Murray River	Murray US	EF	CCG	81	4.2	0.80	–
Murray River	Murray US	EF	CCG	46	0.8	0.81	–
Murray River	Murray US	EF	CCG	79	3.0	0.62	–
Murray River	Murray US	EF	CCG	64	1.5	0.56	–
Murray River	Murray US	EF	CCG	47	0.5	0.47	–
Murray River	Murray US	EF	CCG	77	3.0	0.66	–
Murray River	Murray US	EF	CCG	49	0.6	0.47	–
Murray River	Murray US	EF	CCG	49	0.6	0.51	–
Murray River	Murray US	EF	CCG	49	0.6	0.54	–
Murray River	Murray US	EF	CCG	44	0.4	0.42	–
Murray River	Murray US	EF	CCG	48	0.5	0.46	–
Murray River	Murray US	EF	CCG	76	2.9	0.65	–
Murray River	Murray US	EF	CCG	67	1.7	0.56	–
Murray River	Murray US	EF	CCG	49	0.6	0.52	–
Murray River	Murray US	EF	CCG	71	2.0	0.56	–
Waterfall Creek	Waterfall Creek	EF	EB	208	114.4	1.27	–
Waterfall Creek	Waterfall Creek	EF	EB	172	47.3	0.93	–
Waterfall Creek	Waterfall Creek	EF	EB	160	47.0	1.15	–
M17 Creek	M17 Creek	EF	EB	77	4.3	0.93	–
M17 Creek	M17 Creek	EF	EB	63	2.2	0.89	–
Murray River Wetland	B2 Wetland	EF	FDC	72	3.5	0.92	–
Murray River Wetland	B2 Wetland	EF	FDC	65	2.8	1.01	–
Murray River Wetland	B2 Wetland	EF	FDC	77	4.7	1.03	–
Murray River Wetland	B2 Wetland	EF	FDC	65	2.5	0.92	–
Murray River Wetland	B2 Wetland	EF	FDC	55	1.3	0.75	–
Murray River Wetland	B2 Wetland	EF	FDC	63	2.3	0.91	–
Murray River Wetland	B2 Wetland	EF	FDC	54	1.4	0.89	–
Murray River Wetland	B2 Wetland	EF	FDC	70	3.3	0.97	–

Appendix 7c. Fish Biological Data, 2011

Waterbody Name	Site	Method	Species Code	Length (mm)	Weight (g)	Condition (g/mm^3)	Comments
Murray River Wetland	B2 Wetland	EF	FDC	68	2.7	0.86	–
Murray River Wetland	B2 Wetland	EF	FDC	66	2.9	0.99	–
Murray River Wetland	B2 Wetland	EF	FDC	66	2.2	0.76	–
Murray River Wetland	B2 Wetland	EF	FDC	64	2.5	0.93	–
Murray River Wetland	B2 Wetland	EF	FDC	69	2.8	0.86	–
Murray River Wetland	B2 Wetland	EF	FDC	51	1.0	0.75	–
Murray River Wetland	B2 Wetland	EF	FDC	48	1.1	0.99	–
Murray River Wetland	B2 Wetland	EF	FDC	55	1.4	0.83	–
Murray River Wetland	B2 Wetland	EF	FDC	53	1.3	0.85	–
Murray River Wetland	B2 Wetland	EF	FDC	49	0.9	0.80	–
Murray River Wetland	B2 Wetland	EF	FDC	68	2.6	0.82	–
Murray River Wetland	B2 Wetland	EF	FDC	70	2.9	0.84	–
Murray River Wetland	B2 Wetland	EF	FDC	67	2.6	0.85	–
Murray River Wetland	B2 Wetland	EF	FDC	68	2.6	0.83	–
Murray River Wetland	B2 Wetland	EF	FDC	63	2.2	0.88	–
Murray River Wetland	B2 Wetland	EF	FDC	64	2.1	0.82	–
Murray River Wetland	B2 Wetland	EF	FDC	67	2.0	0.66	–
Murray River Wetland	B2 Wetland	EF	FDC	69	3.1	0.93	–
Murray River Wetland	B2 Wetland	EF	FDC	53	1.3	0.86	–
Murray River Wetland	B2 Wetland	EF	FDC	63	2.4	0.95	–
Murray River Wetland	B2 Wetland	EF	FDC	53	1.2	0.79	–
Murray River Wetland	B2 Wetland	EF	FDC	55	1.4	0.85	–
Murray River Wetland	B2 Wetland	EF	FDC	55	1.4	0.86	–
Murray River Wetland	B2 Wetland	EF	FDC	52	1.2	0.88	–
Murray River Wetland	B2 Wetland	EF	FDC	51	1.06	0.8	–
Murray River Wetland	B2 Wetland	EF	FDC	57	1.56	0.84	–
Murray River Wetland	B2 Wetland	EF	FDC	56	1.48	0.84	–
Murray River Wetland	B2 Wetland	EF	FDC	71	3.43	0.96	–
Murray River Wetland	B2 Wetland	EF	FDC	53	1.35	0.91	–
Murray River Wetland	B2 Wetland	EF	FDC	53	1.4	0.94	–
Murray River Wetland	B2 Wetland	EF	FDC	60	1.86	0.86	–
Murray River Wetland	B2 Wetland	EF	FDC	50	1.1	0.84	–
Murray River Wetland	B2 Wetland	EF	FDC	56	1.4	0.81	–
Murray River Wetland	B2 Wetland	EF	FDC	53	1.3	0.84	–
Murray River Wetland	B2 Wetland	EF	FDC	55	1.4	0.84	–
Murray River Wetland	B2 Wetland	EF	FDC	49	1.0	0.88	–
Murray River Wetland	B2 Wetland	EF	FDC	55	1.5	0.90	–
Murray River Wetland	B2 Wetland	EF	FDC	51	1.1	0.86	–
Murray River Wetland	B2 Wetland	EF	FDC	52	1.1	0.75	–
Murray River Wetland	B2 Wetland	EF	FDC	53	1.2	0.83	–
Murray River Wetland	B2 Wetland	EF	FDC	54	1.4	0.86	–
Murray River Wetland	B2 Wetland	EF	FDC	51	1.2	0.90	–
Murray River Wetland	B2 Wetland	EF	FDC	53	1.2	0.82	–
Murray River Wetland	B2 Wetland	EF	FDC	51	1.1	0.84	–
Murray River Wetland	B2 Wetland	EF	FDC	53	1.2	0.83	–
Murray River Wetland	B2 Wetland	EF	FDC	53	1.2	0.81	–
Murray River Wetland	B2 Wetland	EF	FDC	53	1.3	0.84	–

Appendix 7c. Fish Biological Data, 2011

Waterbody Name	Site	Method	Species Code	Length (mm)	Weight (g)	Condition (g/mm^3)	Comments
Murray River Wetland	B2 Wetland	EF	FDC	48	1.0	0.88	–
Murray River Wetland	B2 Wetland	EF	FDC	51	1.0	0.78	–
Murray River Wetland	B2 Wetland	EF	FDC	51	0.9	0.69	–
Murray River Wetland	B2 Wetland	EF	FDC	49	1.0	0.83	–
Murray River Wetland	B2 Wetland	EF	FDC	48	0.9	0.80	–
Murray River Wetland	B2 Wetland	EF	FDC	51	1.2	0.87	–
Murray River Wetland	B2 Wetland	EF	FDC	52	1.2	0.85	–
Murray River Wetland	B2 Wetland	EF	FDC	52	1.2	0.83	–
Murray River Wetland	B2 Wetland	EF	FDC	53	1.3	0.89	–
Murray River Wetland	B2 Wetland	EF	FDC	48	1.0	0.87	–
Murray River Wetland	B2 Wetland	EF	FDC	49	1.0	0.86	–
Murray River Wetland	B2 Wetland	EF	FDC	50	1.0	0.79	–
Murray River Wetland	B2 Wetland	EF	FDC	50	1.0	0.83	–
Murray River Wetland	B2 Wetland	EF	FDC	48	0.8	0.74	–
Murray River Wetland	B2 Wetland	EF	FDC	49	0.9	0.79	–
Murray River Wetland	B2 Wetland	EF	FDC	45	0.8	0.83	–
Murray River Wetland	B2 Wetland	EF	FDC	47	0.9	0.84	–
Murray River Wetland	B2 Wetland	EF	FDC	50	1.0	0.82	–
Murray River Wetland	B2 Wetland	EF	FDC	46	0.9	0.87	–
Murray River Wetland	B2 Wetland	EF	FDC	49	0.9	0.78	–
Murray River Wetland	M20 Wetland	EF	FDC	98	9.1	0.97	–
Murray River Wetland	M20 Wetland	EF	FDC	72	3.3	0.89	–
Murray River Wetland	M20 Wetland	EF	FDC	69	3.2	0.97	–
Murray River Wetland	M20 Wetland	EF	FDC	72	3.5	0.94	–
Murray River Wetland	M20 Wetland	EF	FDC	71	3.6	1.00	–
Murray River Wetland	M20 Wetland	EF	FDC	70	2.8	0.82	–
Murray River Wetland	M20 Wetland	EF	FDC	69	3.0	0.92	–
Murray River Wetland	M20 Wetland	EF	FDC	70	3.4	1.00	–
Murray River Wetland	M20 Wetland	EF	FDC	71	3.2	0.89	–
Murray River Wetland	M20 Wetland	EF	FDC	72	3.6	0.95	–
Murray River Wetland	M20 Wetland	EF	FDC	77	4.2	0.92	–
Murray River Wetland	M20 Wetland	EF	FDC	68	3.2	1.00	–
Murray River Wetland	M20 Wetland	EF	FDC	76	4.1	0.93	–
Murray River Wetland	M20 Wetland	EF	FDC	69	3.3	1.01	–
Murray River Wetland	M20 Wetland	EF	FDC	71	3.5	0.98	–
Murray River Wetland	M20 Wetland	EF	FDC	72	3.7	1.00	–
Murray River Wetland	M20 Wetland	EF	FDC	63	2.6	1.02	–
Murray River Wetland	M20 Wetland	EF	FDC	68	2.9	0.92	–
Murray River Wetland	M20 Wetland	EF	FDC	68	3.4	1.08	–
Murray River Wetland	M14 Wetland	EF	FDC	84	5.6	0.95	–
Murray River Wetland	M14 Wetland	EF	FDC	55	1.8	1.08	–
Murray River Wetland	M14 Wetland	EF	FDC	82	5.4	0.98	–
Murray River Wetland	M14 Wetland	EF	FDC	54	1.6	1.00	–
Murray River Wetland	M14 Wetland	EF	FDC	57	1.8	0.98	–
Murray River Wetland	M14 Wetland	EF	FDC	75	4.3	1.03	–
Murray River Wetland	M14 Wetland	EF	FDC	65	3.0	1.10	–
Murray River Wetland	M14 Wetland	EF	FDC	71	3.7	1.04	–

Appendix 7c. Fish Biological Data, 2011

Waterbody Name	Site	Method	Species Code	Length (mm)	Weight (g)	Condition (g/mm³)	Comments
Murray River Wetland	M14 Wetland	EF	FDC	68	3.0	0.97	–
Murray River Wetland	M14 Wetland	EF	FDC	57	1.7	0.94	–
Murray River Wetland	M14 Wetland	EF	FDC	74	4.1	1.01	–
Murray River Wetland	M14 Wetland	EF	FDC	76	3.8	0.85	–
Murray River Wetland	M14 Wetland	EF	FDC	76	3.8	0.86	–
Murray River Wetland	M14 Wetland	EF	FDC	67	3.2	1.05	–
Murray River Wetland	M14 Wetland	EF	FDC	68	3.3	1.05	–
Murray River Wetland	M14 Wetland	EF	FDC	62	2.3	0.97	–
Murray River Wetland	M14 Wetland	EF	FDC	71	3.7	1.04	–
Murray River Wetland	M14 Wetland	EF	FDC	71	3.6	1.00	–
Murray River Wetland	M14 Wetland	EF	FDC	74	3.7	0.91	–
Murray River Wetland	Barbour Wetland	EF	FDC	87	5.7	0.86	–
Murray River Wetland	Barbour Wetland	EF	FDC	73	3.8	0.96	–
Murray River Wetland	Barbour Wetland	EF	FDC	62	1.9	0.78	–
Murray River Wetland	Barbour Wetland	EF	FDC	87	5.2	0.78	–
Murray River Wetland	Barbour Wetland	EF	FDC	77	3.8	0.83	–
Murray River Wetland	Barbour Wetland	EF	FDC	59	1.7	0.84	–
Murray River Wetland	Barbour Wetland	EF	FDC	88	5.6	0.82	–
Murray River Wetland	Barbour Wetland	EF	FDC	76	4.2	0.95	–
Murray River Wetland	Barbour Wetland	EF	FDC	87	5.7	0.87	–
Murray River Wetland	Barbour Wetland	EF	FDC	71	3.0	0.84	–
Murray River Wetland	Barbour Wetland	EF	FDC	81	4.0	0.75	–
Murray River Wetland	Barbour Wetland	EF	FDC	63	2.1	0.85	–
Murray River Wetland	Barbour Wetland	EF	FDC	69	2.4	0.74	–
Murray River Wetland	Barbour Wetland	EF	FDC	69	2.6	0.79	–
Murray River Wetland	Barbour Wetland	EF	FDC	83	4.7	0.83	–
Murray River Wetland	Barbour Wetland	EF	FDC	73	3.1	0.80	–
Murray River Wetland	Barbour Wetland	EF	FDC	67	2.5	0.84	–
Murray River Wetland	Barbour Wetland	EF	FDC	75	3.4	0.82	–
Murray River Wetland	Barbour Wetland	EF	FDC	66	2.2	0.77	–
Murray River Wetland	Barbour Wetland	EF	FDC	62	2.0	0.85	–
Murray River Wetland	Barbour Wetland	EF	FDC	59	1.2	0.57	–
Murray River Wetland	Barbour Wetland	EF	FDC	73	3.2	0.82	–
Murray River Wetland	Barbour Wetland	EF	FDC	70	2.9	0.85	–
Murray River Wetland	Barbour Wetland	EF	FDC	61	1.8	0.81	–
M20 Creek	M20 Creek	EF	CCG	82	6.9	1.25	–
M20 Creek	M20 Creek	EF	CCG	95	8.5	0.99	–
M20 Creek	M20 Creek	EF	CCG	82	6.4	1.16	–
M20 Creek	M20 Creek	EF	CCG	80	5.3	1.04	–
M20 Creek	M20 Creek	EF	CCG	86	7.2	1.13	–
M20 Creek	M20 Creek	EF	CCG	83	6.8	1.19	–
M20 Creek	M20 Creek	EF	CCG	91	8.7	1.15	–
M20 Creek	M20 Creek	EF	CCG	77	5.1	1.12	–
Murray River Wetland	Wetland 00313	EF	FDC	69	3.4	1.03	–
Murray River Wetland	Wetland 00313	EF	FDC	63	3.0	1.20	–
Murray River Wetland	Wetland 00313	EF	FDC	65	3.7	1.35	–
Murray River Wetland	Wetland 00313	EF	FDC	68	3.2	1.02	–

Appendix 7c. Fish Biological Data, 2011

Waterbody Name	Site	Method	Species Code	Length (mm)	Weight (g)	Condition (g/mm^3)	Comments
Murray River Wetland	Wetland 00313	EF	FDC	63	3.1	1.24	–
Murray River Wetland	Wetland 00313	EF	FDC	69	3.7	1.13	–
Murray River Wetland	Wetland 00313	EF	FDC	64	3.1	1.18	–
Murray River Wetland	Wetland 00313	EF	FDC	67	3.2	1.06	–
Murray River Wetland	Wetland 00313	EF	FDC	64	3.0	1.14	–
Murray River Wetland	Wetland 00313	EF	FDC	65	2.8	1.02	–
Murray River Wetland	Wetland 00313	EF	FDC	69	2.5	0.76	–
Murray River Wetland	Wetland 00313	EF	FDC	52	1.4	1.00	–
Murray River Wetland	Wetland 00313	EF	FDC	47	1.2	1.16	–
Murray River Wetland	Wetland 00313	EF	FDC	62	2.6	1.09	–
Murray River Wetland	Wetland 00313	EF	FDC	61	2.8	1.23	–
Murray River Wetland	Wetland 00313	EF	FDC	62	3.4	1.43	–
Murray River Wetland	Wetland 00313	EF	FDC	65	3.3	1.20	–

Notes:

Methods: EF = backpack electrofisher

Fish Species Codes: CCG = Slimy Sculpin, EB = Brook Trout, FDC = Finescale Dace

Dashes (–) = no data

Appendix 7d. Fish Biological Data, 2005

Waterbody Name	Site	Method	Species Code	Length (mm)	Weight (g)	Condition (g/mm^3)	Comments
Murray River	Murray US	EF	CCG	63	2.2	0.88	–
Murray River	Murray US	EF	CCG	63	2.8	1.12	–
Murray River	Murray US	EF	CCG	80	6.4	1.25	–
Murray River	Murray US	EF	CCG	60	2.4	1.11	–
Murray River	Murray US	EF	CCG	62	2.5	1.05	–
Murray River	Murray US	EF	CCG	64	2.6	0.99	–
Murray River	Murray US	EF	CCG	64	2.9	1.11	–
Murray River	Murray US	EF	CCG	60	2.3	1.06	–
Murray River	Murray US	EF	CCG	65	2.6	0.95	–
Murray River	Murray US	EF	CCG	74	4.0	0.99	–
Murray River	Murray US	EF	CCG	55	2.0	1.20	–
Murray River	Murray US	EF	CCG	57	1.9	1.03	–
Murray River	Murray US	EF	CCG	57	2.1	1.13	–
Murray River	Murray US	EF	CCG	63	2.2	0.88	–
Murray River	Murray US	EF	CCG	64	2.7	1.03	–
Murray River	Murray US	EF	CCG	67	3.0	1.00	–
Murray River	Murray US	EF	CCG	68	3.2	1.02	–
Murray River	Murray US	EF	CCG	75	5.3	1.26	–
Murray River	Murray US	EF	MW	68	3.1	0.99	–
Murray River	Murray US	EF	MW	72	3.8	1.02	–
Murray River	Murray US	EF	MW	64	2.3	0.88	–
Murray River	Murray US	EF	MW	67	3.1	1.03	–
Murray River	Murray US	EF	MW	68	2.8	0.89	–
Murray River	Murray US	EF	MW	60	2.1	0.97	–
Murray River	Murray US	EF	MW	65	2.3	0.84	–
Murray River	Murray US	EF	MW	66	2.6	0.90	–
Murray River	Murray DS	EF	CCG	71	4.3	1.20	–
Murray River	Murray DS	EF	CCG	73	5.2	1.34	–
Murray River	Murray DS	EF	CCG	73	5.2	1.34	–
Murray River	Murray DS	EF	CCG	75	5.1	1.21	–
Murray River	Murray DS	EF	CCG	73	4.9	1.26	–
Murray River	Murray DS	EF	CCG	74	5.1	1.26	–
Murray River	Murray DS	EF	CCG	65	3.0	1.09	–
Murray River	Murray DS	EF	CCG	65	3.3	1.20	–
Murray River	Murray DS	EF	CCG	68	3.8	1.21	–
Murray River	Murray DS	EF	CCG	63	3.0	1.20	–
Murray River	Murray DS	EF	CCG	66	2.0	0.70	–
Murray River	Murray DS	EF	CCG	67	3.3	1.10	–
Murray River	Murray DS	EF	MW	61	1.8	0.79	–
Murray River	Murray DS	EF	MW	70	2.9	0.85	–
Murray River	Murray DS	EF	MW	76	3.7	0.84	–
Murray River	Murray RB	EF	CCG	72	4.5	1.21	–
Murray River	Murray RB	EF	CCG	74	4.5	1.11	–
Murray River	Murray RB	EF	CCG	70	3.8	1.11	–
Murray River	Murray RB	EF	CCG	72	3.6	0.96	–
Murray River	Murray RB	EF	CCG	62	2.3	0.97	–
Murray River	Murray RB	EF	CCG	62	2.4	1.01	–
Murray River	Murray RB	EF	CCG	63	2.6	1.04	–
Murray River	Murray RB	EF	CCG	50	1.4	1.12	–
Murray River	Murray RB	EF	CCG	51	1.8	1.36	–
Murray River	Murray RB	EF	CCG	62	2.4	1.01	–
Murray River	Murray RB	EF	CCG	63	2.5	1.00	–
Murray River	Murray RB	EF	CCG	43	0.8	1.01	–
Murray River	Murray RB	EF	CCG	44	0.9	1.06	–
Murray River	Murray RB	EF	CCG	46	0.9	0.92	–

Appendix 7d. Fish Biological Data, 2005

Waterbody Name	Site	Method	Species Code	Length (mm)	Weight (g)	Condition (g/mm^3)	Comments
Murray River	Murray RB	EF	CCG	49	1.2	1.02	–
Murray River	Murray RB	EF	CCG	49	1.4	1.19	–
Murray River	Murray RB	EF	CCG	52	1.3	0.92	–
Murray River	Murray RB	EF	CCG	54	1.6	1.02	–
Wolverine River Tributary	Mast Creek	EF	CCG	70	3.7	1.08	–
Wolverine River Tributary	Mast Creek	EF	CCG	83	7.7	1.35	–
Wolverine River Tributary	Mast Creek	EF	CCG	66	3.7	1.29	–
Wolverine River Tributary	Mast Creek	EF	CCG	83	7.6	1.33	–
Wolverine River Tributary	Mast Creek	EF	CCG	81	8.4	1.58	–
Wolverine River Tributary	Mast Creek	EF	CCG	68	3.9	1.24	–
Wolverine River Tributary	Mast Creek	EF	CCG	68	5.1	1.62	–
Wolverine River Tributary	Mast Creek	EF	CCG	75	5.8	1.37	–
Wolverine River Tributary	Mast Creek	EF	CCG	76	5.3	1.21	–

Notes:

Methods: EF = backpack electrofisher

Fish Species Codes: CCG = Slimy Sculpin, MW = Mountain Whitefish

Dashes (–) = no data

Appendix 7e. Fish Biological Data, 2004

Waterbody Name	Site	Method	Species Code	Length (mm)	Weight (g)	Condition (g/mm^3)	Comments
M20 Creek	M20 DS	EF	CCG	111	17.8	1.30	–
M20 Creek	M20 DS	EF	CCG	109	10.0	0.77	–
M20 Creek	M20 DS	EF	CCG	94	6.8	0.82	–
M20 Creek	M20 DS	EF	CCG	76	14.5	–	Composite Weight
M20 Creek	M20 DS	EF	CCG	57	14.5	–	Composite Weight
M20 Creek	M20 DS	EF	CCG	55	14.5	–	Composite Weight
M20 Creek	M20 DS	EF	CCG	64	14.5	–	Composite Weight
M20 Creek	M20 DS	EF	CCG	55	14.5	–	Composite Weight
M20 Creek	M20 DS	EF	CCG	47	14.5	–	Composite Weight
M20 Creek	M20 DS	EF	CCG	46	14.5	–	Composite Weight
M20 Creek	M20 DS	EF	CCG	49	14.5	–	Composite Weight
M20 Creek	M20 DS	EF	CCG	70	11.7	–	Composite Weight
M20 Creek	M20 DS	EF	CCG	50	11.7	–	Composite Weight
M20 Creek	M20 DS	EF	CCG	53	11.7	–	Composite Weight
M20 Creek	M20 DS	EF	CCG	57	11.7	–	Composite Weight
M20 Creek	M20 DS	EF	CCG	48	11.7	–	Composite Weight
M20 Creek	M20 DS	EF	CCG	44	11.7	–	Composite Weight
M20 Creek	M20 DS	EF	CCG	55	11.7	–	Composite Weight
Murray River	Sesyncline	EF	CCG	72	13.3	–	Composite Weight
Murray River	Sesyncline	EF	CCG	62	13.3	–	Composite Weight
Murray River	Sesyncline	EF	CCG	66	13.3	–	Composite Weight
Murray River	Sesyncline	EF	CCG	59	13.3	–	Composite Weight
Murray River	Sesyncline	EF	CCG	41	13.3	–	Composite Weight
Murray River	Sesyncline	EF	CCG	60	13.3	–	Composite Weight
Murray River	Sesyncline	EF	CCG	69	13.1	–	Composite Weight
Murray River	Sesyncline	EF	CCG	42	13.1	–	Composite Weight
Murray River	Sesyncline	EF	CCG	52	13.1	–	Composite Weight
Murray River	Sesyncline	EF	CCG	41	13.1	–	Composite Weight
Murray River	Sesyncline	EF	CCG	71	13.1	–	Composite Weight
Murray River	Sesyncline	EF	CCG	57	13.1	–	Composite Weight
Murray River	Sesyncline	EF	CCG	42	13.1	–	Composite Weight
Murray River	Sesyncline	EF	CCG	47	13.1	–	Composite Weight
Murray River	Sesyncline	EF	CCG	43	13.1	–	Composite Weight
Murray River	Sesyncline	EF	CCG	66	12.3	–	Composite Weight
Murray River	Sesyncline	EF	CCG	54	12.3	–	Composite Weight
Murray River	Sesyncline	EF	CCG	61	12.3	–	Composite Weight
Murray River	Sesyncline	EF	CCG	50	12.3	–	Composite Weight
Murray River	Sesyncline	EF	CCG	51	12.3	–	Composite Weight
Murray River	Sesyncline	EF	CCG	59	12.3	–	Composite Weight
Murray River	Sesyncline	EF	CCG	49	12.3	–	Composite Weight
Murray River	Sesyncline	EF	CCG	68	19.1	–	Composite Weight
Murray River	Sesyncline	EF	CCG	64	19.1	–	Composite Weight
Murray River	Sesyncline	EF	CCG	82	19.1	–	Composite Weight
Murray River	Sesyncline	EF	CCG	57	19.1	–	Composite Weight
Murray River	Sesyncline	EF	CCG	80	19.1	–	Composite Weight
Murray River	Sesyncline	EF	CCG	78	18.2	–	Composite Weight
Murray River	Sesyncline	EF	CCG	65	18.2	–	Composite Weight
Murray River	Sesyncline	EF	CCG	55	18.2	–	Composite Weight
Murray River	Sesyncline	EF	CCG	76	18.2	–	Composite Weight
Murray River	Sesyncline	EF	CCG	51	18.2	–	Composite Weight
Murray River	Sesyncline	EF	CCG	70	18.2	–	Composite Weight

Notes:

Methods: EF = backpack electrofisher

Fish Species Codes: CCG = Slimy Sculpin

Dashes (–) = no data

Appendix 8
Tissue Metals Analytical Data

ERM

Appendix 8a. Tissue Metals Analytical Data, 2012

Project	0791-007-36-11
Report To	RESCAN ENVIRONMENTAL SERVICES
ALS File No.	L1220862
Date Received	09-Oct-12 23:03
Date	21-Nov-12

RESULTS OF ANALYSIS										
Sample ID	MR D/S, CCG TISSUE 1	MR D/S, CCG TISSUE 2	MR D/S, CCG TISSUE 3	MR D/S, CCG TISSUE 4	MR D/S, CCG TISSUE 5	MR D/S, CCG TISSUE 6	MR D/S, CCG TISSUE 7	MR D/S, CCG TISSUE 8	MR 3, CCG TISSUE 1	MR 3, CCG TISSUE 2
Date Sampled	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12
Time Sampled	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID	L1220862-1	L1220862-2	L1220862-3	L1220862-4	L1220862-5	L1220862-6	L1220862-7	L1220862-8	L1220862-9	L1220862-10
Sample Type	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests										
% Moisture	74.9	73.1	77.2	76.3	74.6	75.6	73.4	76.3	71.6	73.2
Metals										
Aluminum (Al)-Total	12.4	38.0	6.2	44.9	41.7	87.8	16	23.4	15.2	18.2
Antimony (Sb)-Total	<0.010	<0.020	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	0.045	0.073	0.046	0.060	0.069	0.072	0.042	0.051	0.070	0.048
Barium (Ba)-Total	3.260	9.990	5.160	4.130	5.530	4.460	4.840	3.730	4.220	3.720
Beryllium (Be)-Total	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth (Bi)-Total	<0.030	<0.060	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Cadmium (Cd)-Total	0.102	0.119	0.11	0.119	0.145	0.155	0.0862	0.11	0.0796	0.168
Calcium (Ca)-Total	11300	32200	17700	13100	16600	13100	17400	15300	15800	14800
Chromium (Cr)-Total	0.19	<0.20	0.1	<0.10	<0.10	0.17	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total	0.061	0.057	0.043	0.084	0.074	0.087	0.030	0.067	0.077	0.075
Copper (Cu)-Total	0.711	0.735	0.559	0.682	0.860	0.856	0.556	0.783	0.568	0.538
Iron (Fe)-Total	18.6	40.7	16.1	51.7	48.000	70.900	30.9	35.3	22.5	22.200
Lead (Pb)-Total	0.051	0.076	0.044	0.042	0.057	0.057	0.041	0.035	0.046	0.044
Lithium (Li)-Total	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-Total	371	672	407	378	453	381	436	392	450	448
Manganese (Mn)-Total	4.3100	6.3600	3.7100	6.930	6.3000	6.3200	5.3300	4.360	5.940	4.200
Mercury (Hg)-Total	0.0434	0.0564	0.0865	0.0227	0.0332	0.071	0.0246	0.027	0.0227	0.0549
Molybdenum (Mo)-Total	0.018	0.026	0.022	0.029	0.039	0.025	0.025	0.027	0.018	0.016
Nickel (Ni)-Total	0.16	<0.20	0.24	<0.10	0.11	0.28	<0.10	<0.10	<0.10	<0.10
Phosphorus (P)-Total	7340	17400	10300	8060	10100	7920	9940	9690	9250	8850
Potassium (K)-Total	2870	2810	2610	2790	2780	2690	2530	2960	3220	2870
Selenium (Se)-Total	0.92	0.72	0.64	1.17	1.1	0.91	0.89	0.99	1.34	0.78
Sodium (Na)-Total	1130	1550	1320	1130	1140	1140	1090	1260	1290	1260
Strontium (Sr)-Total	7.89	23.4	12.8	8.88	13	9.21	13.6	9.28	11.4	10.3
Thallium (Tl)-Total	<0.010	<0.020	<0.010	<0.010	<0.010	0.01	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total	<0.050	<0.10	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Titanium (Ti)-Total	1.6	2.8	1.8	2.2	2.3	2.1	2.1	2	1.9	1.9
Uranium (U)-Total	0.0037	0.0161	0.0055	0.0067	0.0058	0.0162	0.0036	0.0031	0.0036	0.0048
Vanadium (V)-Total	0.13	0.52	0.25	0.33	0.26	2.31	0.18	0.26	0.22	0.17
Zinc (Zn)-Total	26	35.8	38.2	18	27.2	23.1	29.7	25.4	24.4	23.1
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt

Appendix 8a. Tissue Metals Analytical Data, 2012

Project 0791-007-36-11
Report To RESCAN ENVIRONMENTAL SERVICES
ALS File No. L1220862
Date Received 09-Oct-12 23:03
Date 21-Nov-12

RESULTS OF ANALYSIS										
Sample ID	MR 3, CCG TISSUE 3	MR 3, CCG TISSUE 4	MR 3, CCG TISSUE 5	MR 3, CCG TISSUE 6	MR 3, CCG TISSUE 7	MR 3, CCG TISSUE 8	MR 4, CCG TISSUE 1	MR 4, CCG TISSUE 2	MR 4, CCG TISSUE 3	MR 4, CCG TISSUE 4
Date Sampled	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12
Time Sampled	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID	L1220862-11	L1220862-12	L1220862-13	L1220862-14	L1220862-15	L1220862-16	L1220862-17	L1220862-18	L1220862-19	L1220862-20
Sample Type	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests										
% Moisture	73.6	72.7	71.2	74.7	73.2	74.0	75.9	70.7	76.5	74.8
Metals										
Aluminum (Al)-Total	80.9	36.3	9.2	5.4	15.3	18.4	77.5	61.7	46.5	191
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.016	<0.010	<0.010
Arsenic (As)-Total	0.077	0.073	0.048	0.060	0.062	0.062	0.072	0.043	0.074	0.103
Barium (Ba)-Total	4.960	3.92	3	2.530	3.93	3.02	2.360	4.83	2.550	4.620
Beryllium (Be)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth (Bi)-Total	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Cadmium (Cd)-Total	0.146	0.103	0.0763	0.105	0.119	0.116	0.17	0.106	0.126	0.176
Calcium (Ca)-Total	18300	16800	14800	12400	19700	11900	7620	18400	8790	7880
Chromium (Cr)-Total	0.12	<0.10	<0.10	<0.10	<0.10	<0.10	0.13	0.52	0.18	0.38
Cobalt (Co)-Total	0.088	0.063	0.035	0.06	0.057	0.071	0.164	0.062	0.118	0.187
Copper (Cu)-Total	0.902	0.764	0.628	0.565	0.648	0.676	1.670	0.986	1.200	2.460
Iron (Fe)-Total	75.400	45.3	18.4	16.9	24.3	26	81.9	70.3	59	151
Lead (Pb)-Total	0.05	0.036	<0.020	0.021	0.031	0.033	0.042	0.069	0.038	0.084
Lithium (Li)-Total	000	<0.10	<0.10	<0.10	<0.10	<0.10	000	<0.10	<0.10	000
Magnesium (Mg)-Total	525	439	414	370	455	358	310	525	335	435
Manganese (Mn)-Total	6.8300	4.190	3.830	4.3600	3.780	3.430	3.3400	7.920	6.3400	6.620
Mercury (Hg)-Total	0.0206	0.0196	0.0267	0.0252	0.0234	0.024	0.0261	0.0226	0.0285	0.0322
Molybdenum (Mo)-Total	0.023	0.025	0.018	0.024	0.023	0.02	0.024	0.031	0.019	0.033
Nickel (Ni)-Total	0.12	<0.10	<0.10	<0.10	<0.10	<0.10	0.20	0.13	0.11	0.22
Phosphorus (P)-Total	10500	11000	8870	8010	11100	7550	4950	11400	6480	6020
Potassium (K)-Total	2890	3260	3340	3160	2990	2910	2570	3190	2960	2930
Selenium (Se)-Total	1.64	1.24	1.47	1.35	1.14	1.55	1.06	1.92	1.42	1.08
Sodium (Na)-Total	1240	1300	1270	1320	1210	1070	1000	1300	1140	1220
Strontium (Sr)-Total	13.1	10.8	9.53	7.77	12.6	7.98	4.96	14.3	6.05	5.64
Thallium (Tl)-Total	0.01	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	0.02	<0.010	0.01
Tin (Sn)-Total	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Titanium (Ti)-Total	3.2	2.4	1.8	1.6	2.3	1.8	2	2.7	2	3.5
Uranium (U)-Total	0.0051	0.0029	0.0027	<0.0020	0.003	<0.0020	0.0039	0.0058	0.0035	0.0088
Vanadium (V)-Total	0.37	0.21	0.19	0.12	0.18	0.15	0.35	0.36	0.23	0.73
Zinc (Zn)-Total	27	23	24.5	20.7	25.5	19.6	21.1	27.4	20.4	21.8
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt

Appendix 8a. Tissue Metals Analytical Data, 2012

Project	0791-007-36-11
Report To	RESCAN ENVIRONMENTAL SERVICES
ALS File No.	L1220862
Date Received	09-Oct-12 23:03
Date	21-Nov-12

RESULTS OF ANALYSIS										
Sample ID	MR 4, CCG TISSUE 5	MR 4, CCG TISSUE 6	MR 4, CCG TISSUE 7	MR 4, CCG TISSUE 8	MR U/S, CCG TISSUE 1	MR U/S, CCG TISSUE 2	MR U/S, CCG TISSUE 3	MR U/S, CCG TISSUE 4	MR U/S, CCG TISSUE 5	MR U/S, CCG TISSUE 6
Date Sampled	20-SEP-12	20-SEP-12	20-SEP-12	20-SEP-12	21-SEP-12	21-SEP-12	21-SEP-12	21-SEP-12	21-SEP-12	21-SEP-12
Time Sampled	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID	L1220862-21	L1220862-22	L1220862-23	L1220862-24	L1220862-25	L1220862-26	L1220862-27	L1220862-28	L1220862-29	L1220862-30
Sample Type	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests										
% Moisture	73.9	75.2	74.3	72	74.9	70.9	73.9	74.7	73.7	74.6
Metals										
Aluminum (Al)-Total	22.7	83.8	139	18.2	29.1	17.6	22.8	4.4	25.4	20
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	0.058	0.082	0.084	0.077	0.068	0.058	0.069	0.053	0.067	0.054
Barium (Ba)-Total	2	5.57	4.98	3.32	6.490	4.550	4.230	1.07	3.07	2.790
Beryllium (Be)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth (Bi)-Total	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Cadmium (Cd)-Total	0.0758	0.0987	0.141	0.108	0.152	0.115	0.103	0.0749	0.0792	0.137
Calcium (Ca)-Total	6560	10800	12200	11100	21400	17600	17000	5130	16000	12200
Chromium (Cr)-Total	<0.10	0.25	0.3	<0.10	0.18	<0.10	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total	0.098	0.078	0.128	0.094	0.067	0.049	0.084	0.034	0.039	0.053
Copper (Cu)-Total	0.985	0.812	1.15	0.957	0.579	0.816	1.170	0.567	0.601	0.679
Iron (Fe)-Total	31.9	71.1	145	26.4	43.9	26.700	28.900	11.5	28.9	30.8
Lead (Pb)-Total	0.025	0.054	0.085	0.024	0.031	0.021	0.032	<0.020	0.022	<0.020
Lithium (Li)-Total	<0.10	<0.10	0.17	<0.10	000	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-Total	355	441	423	441	494	434	472	257	507	380
Manganese (Mn)-Total	4.860	6.53	9.01	4.05	7.900	6.540	4.9000	2.710	4.110	4.7300
Mercury (Hg)-Total	0.0416	0.0347	0.0258	0.0424	0.0806	0.0245	0.0368	0.0348	0.0229	0.0308
Molybdenum (Mo)-Total	0.021	0.041	0.037	0.021	0.025	0.027	0.029	<0.010	0.015	0.013
Nickel (Ni)-Total	<0.10	0.16	0.19	<0.10	0.14	<0.10	0.10	<0.10	<0.10	<0.10
Phosphorus (P)-Total	5200	7150	8680	8080	13500	11400	11000	4390	10000	9150
Potassium (K)-Total	3220	3070	3510	3190	2990	3020	2830	3040	2900	3170
Selenium (Se)-Total	1.34	1.21	1.87	1.25	0.78	1.34	1.3	1.04	1.35	0.96
Sodium (Na)-Total	1170	1170	1300	1210	1720	1260	1280	1170	1120	1420
Strontium (Sr)-Total	4.46	7.96	10.1	7.08	16.2	12	10.4	3.08	10.5	7.93
Thallium (Tl)-Total	<0.010	0.013	<0.010	<0.010	0.01	0.01	0.01	<0.010	<0.010	<0.010
Tin (Sn)-Total	<0.050	<0.050	<0.050	<0.050	<0.050	0.075	0.097	0.062	0.111	0.068
Titanium (Ti)-Total	1.4	2.4	3.6	1.8	2.7	2	2.1	<1.0	2.2	2
Uranium (U)-Total	0.0026	0.005	0.0081	0.0028	0.0089	0.0051	0.0036	<0.0020	0.005	0.0026
Vanadium (V)-Total	0.16	0.52	0.51	0.17	0.36	0.16	0.53	<0.10	0.22	0.17
Zinc (Zn)-Total	21.1	24.5	22.7	21.2	41.8	28.8	29.3	20.9	24.3	19.3
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt

Appendix 8a. Tissue Metals Analytical Data, 2012

Project 0791-007-36-11

Report To RESCAN ENVIRONMENTAL SERVICES

ALS File No. L1220862

Date Received 09-Oct-12 23:03

Date 21-Nov-12

RESULTS OF ANALYSIS									
Sample ID	MR U/S, CCG TISSUE 7	MR U/S, CCG TISSUE 8	M20 U/S, CCG TISSUE 1	M20 U/S, CCG TISSUE 2	M20 U/S, CCG TISSUE 3	M20 U/S, CCG TISSUE 4	M20 U/S, CCG TISSUE 5	M20 U/S, CCG TISSUE 6	M20 U/S, CCG TISSUE 7
Date Sampled	21-SEP-12	21-SEP-12	21-SEP-12	21-SEP-12	21-SEP-12	21-SEP-12	21-SEP-12	21-SEP-12	21-SEP-12
Time Sampled	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID	L1220862-31	L1220862-32	L1220862-33	L1220862-34	L1220862-35	L1220862-36	L1220862-37	L1220862-38	L1220862-39
Sample Type	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests									
% Moisture	74.0	74.3	74.1	77.7	73.9	76.0	72.9	75.5	76.0
Metals									
Aluminum (Al)-Total	61.5	9	19.5	36.7	56.0	22.4	149	32.3	5.6
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	0.076	0.061	0.055	0.046	0.058	0.050	0.113	0.057	0.037
Barium (Ba)-Total	4.2	1.96	5.570	2.960	6.820	5.37	6.03	5.380	1.47
Beryllium (Be)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth (Bi)-Total	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Cadmium (Cd)-Total	0.149	0.0854	0.0789	0.0439	0.0698	0.0412	0.0695	0.0671	0.0408
Calcium (Ca)-Total	17100	8510	11900	4660	15000	9990	7200	14100	4660
Chromium (Cr)-Total	0.15	<0.10	<0.10	<0.10	<0.10	<0.10	0.25	<0.10	<0.10
Cobalt (Co)-Total	0.079	0.049	0.250	0.155	0.207	0.177	0.184	0.171	0.091
Copper (Cu)-Total	0.589	0.605	0.718	0.536	0.677	0.617	0.622	0.733	0.573
Iron (Fe)-Total	67.3	14.9	33.3	31.700	60.300	23.2	144	22.6	12.1
Lead (Pb)-Total	0.036	<0.020	0.022	<0.020	0.031	0.027	0.088	0.024	<0.020
Lithium (Li)-Total	000	<0.10	<0.10	<0.10	<0.10	<0.10	000	<0.10	<0.10
Magnesium (Mg)-Total	463	421	358	310	437	359	349	468	245
Manganese (Mn)-Total	7.630	5.120	3.260	1.650	3.0700	1.950	2.770	3.6600	0.750
Mercury (Hg)-Total	0.021	0.0514	0.0287	0.0247	0.0233	0.0193	0.0229	0.0221	0.0524
Molybdenum (Mo)-Total	0.022	0.012	0.013	0.011	0.016	0.012	0.02	0.014	0.011
Nickel (Ni)-Total	0.13	<0.10	0.12	<0.10	0.13	0.10	0.15	<0.10	<0.10
Phosphorus (P)-Total	11000	6820	8560	4600	8760	5990	6030	7000	3650
Potassium (K)-Total	3170	3160	2970	3100	2660	2270	3420	2320	3000
Selenium (Se)-Total	1.28	1.29	2.02	2.07	2.13	2.59	2.79	2.65	2.39
Sodium (Na)-Total	1380	1320	1290	970	1030	921	1160	875	1110
Strontium (Sr)-Total	11.2	5.81	9.94	4.25	11.8	9.2	6.58	11.6	4.31
Thallium (Tl)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total	0.103	0.122	0.107	0.083	0.057	0.07	0.057	0.051	0.051
Titanium (Ti)-Total	2.7	1.5	1.9	1.2	0.39	0.51	2.7	<0.20	<1.0
Uranium (U)-Total	0.0035	0.0027	0.0021	<0.0020	0.004	0.0021	0.0047	0.0023	<0.0020
Vanadium (V)-Total	0.32	0.11	0.11	0.15	0.26	0.1	0.58	0.15	<0.10
Zinc (Zn)-Total	30.4	18.5	24.2	15.8	28	21.3	19.8	26.7	18.9
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt

Appendix 8a. Tissue Metals Analytical Data, 2012

Project	0791-007-36-11
Report To	RESCAN ENVIRONMENTAL SERVICES
ALS File No.	L1220862
Date Received	09-Oct-12 23:03
Date	21-Nov-12

RESULTS OF ANALYSIS				
Sample ID	M20 U/S, CCG TISSUE 8	M20 U/S, BT TISSUE 1	M20 U/S, BT TISSUE 2	M20 U/S, BT TISSUE 3
Date Sampled	21-SEP-12	21-SEP-12	21-SEP-12	21-SEP-12
Time Sampled	00:00	00:00	00:00	00:00
ALS Sample ID	L1220862-40	L1220862-41	L1220862-42	L1220862-43
Sample Type	Whole body	Whole body	Whole body	Whole body
Matrix	Tissue	Tissue	Tissue	Tissue
Physical Tests				
% Moisture	71.9	76.9	77.8	75.5
Metals				
Aluminum (Al)-Total	26.7	15.5	4.2	21.3
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	0.049	0.014	<0.010	0.015
Barium (Ba)-Total	7.08	1.850	0.733	1.400
Beryllium (Be)-Total	<0.10	<0.10	<0.10	<0.10
Bismuth (Bi)-Total	<0.030	<0.030	<0.030	<0.030
Cadmium (Cd)-Total	0.0376	0.0503	0.0694	0.0744
Calcium (Ca)-Total	18100	5400	2540	2850
Chromium (Cr)-Total	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total	0.1	0.045	0.034	0.037
Copper (Cu)-Total	0.520	0.629	0.624	0.807
Iron (Fe)-Total	32.4	18.9	9.110	21.400
Lead (Pb)-Total	0.033	<0.020	<0.020	<0.020
Lithium (Li)-Total	<0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-Total	476	344	293	285
Manganese (Mn)-Total	3.320	1.170	0.721	1.0400
Mercury (Hg)-Total	0.0195	0.0181	0.0184	0.0136
Molybdenum (Mo)-Total	0.011	0.015	<0.010	0.02
Nickel (Ni)-Total	<0.10	<0.10	<0.10	<0.10
Phosphorus (P)-Total	11300	4300	3070	3080
Potassium (K)-Total	3010	2890	2990	2740
Selenium (Se)-Total	2.32	1.04	0.83	0.8
Sodium (Na)-Total	1080	838	878	856
Strontium (Sr)-Total	17.3	3.92	1.65	2.18
Thallium (Tl)-Total	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total	0.068	<0.050	<0.050	<0.050
Titanium (Ti)-Total	2.2	0.53	0.29	0.63
Uranium (U)-Total	0.0022	<0.0020	<0.0020	<0.0020
Vanadium (V)-Total	0.15	<0.10	<0.10	<0.10
Zinc (Zn)-Total	25.1	22.6	19.7	16.9
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt

Appendix 8b. Tissue Metals Analytical Data, 2011

Project	DEHUA MURRAY RIVER
Report To	DIVERSIFIED ENVIRONMENTAL SERVICES
ALS File No.	L1111173
Date Received	06-Feb-12 13:15
Date	02-Apr-12

RESULTS OF ANALYSIS

Sample ID	M20-11-CCG-01	M20-11-CCG-02	M20-11-CCG-03	M20-11-CCG-04	M20-11-CCG-05	M20-11-CCG-06	M20-11-CCG-07	M20-11-CCG-08	MUR-11-FDC-01	MUR-11-FDC-02	MUR-11-FDC-03	MUR-11-FDC-04	MUR-11-FDC-05	MUR-11-FDC-06	MUR-11-FDC-07	MUR-11-FDC-08
Date Sampled	26-SEP-11	26-SEP-11	26-SEP-11	26-SEP-11	26-SEP-11	26-SEP-11	26-SEP-11	26-SEP-11	26-SEP-11	26-SEP-11	26-SEP-11	26-SEP-11	26-SEP-11	26-SEP-11	26-SEP-11	26-SEP-11
Time Sampled	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID	L1111173-7	L1111173-8	L1111173-9	L1111173-10	L1111173-11	L1111173-12	L1111173-13	L1111173-14	L1111173-18	L1111173-19	L1111173-20	L1111173-21	L1111173-22	L1111173-23	L1111173-24	L1111173-25
Sample Type	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests																
% Moisture	70.3	72.0	69.2	70.1	72.8	71.2	72.1	70.1	73.0	74.3	73.0	74.2	73.6	79.3	77.4	78.6
Metals																
Aluminum (Al)-Total	40.4	21.8	94.6	14.1	8.93	76.3	23.8	19.1	1.01	1.5	01.2	3.03	1.24	1.14	1.16	1.05
Antimony (Sb)-Total	0.0048	0.0028	0.0041	0.0033	0.0028	0.0026	0.0026	0.003	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Arsenic (As)-Total	0.060	0.043	0.069	0.044	0.040	0.058	0.034	0.054	0.017	0.013	0.025	0.025	0.019	0.015	0.012	0.017
Barium (Ba)-Total	6.320	4.910	5.390	6.320	4.970	4.740	6.820	4.740	11.200	10.400	10.700	10.9	10.8	13.400	16.2	10
Beryllium (Be)-Total	0.0025	<0.0020	0.0042	<0.0020	<0.0020	0.0033	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Bismuth (Bi)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Boron (B)-Total	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)-Total	0	0	0	0	0	0	0	0	0	0	<0.0020	0	0	<0.0020	<0.0020	<0.0020
Calcium (Ca)-Total	18300	14600	10700	19100	15200	15100	18800	13400	15000	9360	12700	10900	13500	9740	15900	11000
Cesium (Cs)-Total	0.009	0.006	0.014	0.005	0.004	0.011	0.006	0.006	0.001	0.001	<0.0010	0.0014	0.0011	<0.0010	<0.0010	<0.0010
Chromium (Cr)-Total	0.114	0.209	0.183	0.051	0.065	0.197	0.090	0.140	0.035	0.037	0.019	0.034	0.029	0.038	0.027	0.058
Cobalt (Co)-Total	0.0831	0.101	0.102	0.0663	0.071	0.190	0.0982	0.0552	0.0058	0.008	0.005	0.0071	0.0051	0.0054	0.0046	0.0053
Copper (Cu)-Total	0.881	0.742	0.78	0.697	0.55	0.918	0.698	0.758	1	0.963	1.45	1.41	1.09	0.812	0.641	0.759
Gallium (Ga)-Total	000	000	000	<0.0040	<0.0040	000	000	000	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Iron (Fe)-Total	41	<30	81	<25	<15	54	<30	<25	<32	<30	<30	<32	36	<25	<20	<20
Lead (Pb)-Total	0.0325	0.0235	0.0525	0.027	<0.020	0.0398	<0.024	0.024	<0.016	<0.012	<0.012	<0.016	<0.012	<0.024	<0.012	<0.016
Lithium (Li)-Total	0.113	0.087	0.152	0.088	0.085	0.249	0.097	0.103	0.068	0.065	0.072	0.075	0.06	0.062	0.084	0.057
Magnesium (Mg)-Total	507	418	441	505	441	437	483	441	419	320	378	376	401	282	380	303
Manganese (Mn)-Total	5.66	2.64	4.04	3.58	2.13	5.15	2.76	3.33	9.59	7.66	7.88	8.57	8.17	8.91	11.20	9.95
Mercury (Hg)-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)-Total	0.173	0.211	0.199	<0.10	<0.090	0.314	0.128	0.152	<0.040	<0.050	<0.040	<0.050	<0.040	<0.050	<0.040	<0.070
Phosphorus (P)-Total	11000	9110	7480	11300	9530	9470	11400	8770	8100	5450	7020	6650	7580	5050	8070	5370
Potassium (K)-Total	3300	3290	3400	3030	2850	2820	2990	3190	2020	1620	1520	1810	1770	420	340	300
Rhenium (Re)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Rubidium (Rb)-Total	1.06	0.836	0.916	0.934	0.942	1.03	1.01	0.937	1.87	1.42	1.49	1.77	1.32	0.298	0.257	0.243
Selenium (Se)-Total	1.26	2.65	2.57	2.49	2.11	1.97	2.51	2.83	0.499	0.537	0.463	0.517	0.4	0.31	0.347	0.259
Sodium (Na)-Total	1230	1290	1050	1060	1110	1160	1200	1160	660	510	520	560	570	200	220	<200
Strontium (Sr)-Total	15	11.4	7.28	15	12.5	10.7	15.4	10.7	10.1	7.68	8.9	7.64	9.73	9.55	12.8	8.14
Tellurium (Te)-Total	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Thallium (Tl)-Total	0.0107	0.00676	0.00875	0.0076	0.0079	0.00862	0.00873	0.00724	0.00155	0.00113	0.00141	0.00129	0.0013	0.00081	0.00091	0.00071
Thorium (Th)-Total	0.005	0.0033	0.0093	0.0041	0.003	0.0055	0.0034	0.0034	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Tin (Sn)-Total	0.0077	0.0121	0.0131	0.0382	0.0136	0.0075	0.0105	0.005	0.0048	0.0233	0.0048	<0.0040	<0.0040	0.0086	0.0055	0.0072
Titanium (Ti)-Total	0.391	0.221	0.994	0.219	0.106	0.358	0.273	0.225	0.029	0.038	0.02	0.047	0.033	0.027	0.016	0.042
Uranium (U)-Total	0.00519	0.00185	0.00436	0.00288	0.0014	0.00605	0.00224	0.00238	0.00062	0.00067	0.0009	0.00099	0.00099	0.00157	0.00155	0.00147
Vanadium (V)-Total	0.224	0.128	0.409	0.106	0.0611	0.335	0.131	0.119	0.006	0.0089	0.005	0.0168	0.0073	0.0066	0.0059	0.0046
Yttrium (Y)-Total	0.0296	0.0173	0.0459	0.0104	0.0049	0.0337	0.0147	0.0168	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Zinc (Zn)-Total	23	28.9	22.4	24.1	19.4	26.7	25.2	25.3	51.2	41.8	44.1	48.5	54.1	43.3	48.5	46.7
Zirconium (Zr)-Total	<0.040	<0.040	0.047	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt

Appendix 8b. Tissue Metals Analytical Data, 2011

Project	DEHUA MURRAY RIVER
Report To	DIVERSIFIED ENVIRONMENTAL SERVICES
ALS File No.	L1111173
Date Received	06-Feb-12 13:15
Date	02-Apr-12

RESULTS OF ANALYSIS									
Sample ID	M20-11-BT-01	M20-11-BT-02	M20-11-BT-03	FEL-11-BT-01	FEL-11-BT-02	FEL-11-BT-03	M20-11-EB -01	M20-11-EB -02	M20-11-EB-03
Date Sampled	26-SEP-11	26-SEP-11	26-SEP-11	06-SEP-11	06-SEP-11	06-SEP-11	26-SEP-11	26-SEP-11	26-SEP-11
Time Sampled	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID	L1111173-1	L1111173-2	L1111173-3	L1111173-4	L1111173-5	L1111173-6	L1111173-15	L1111173-16	L1111173-17
Sample Type	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests									
% Moisture	76.6	78.8	77.3	73.5	76.9	76.8	75.3	77.0	75.1
Metals									
Aluminum (Al)-Total	25.2	5.66	5.44	1.99	3.05	9.06	7.94	54.6	13.4
Antimony (Sb)-Total	<0.0020	<0.0020	<0.0020	0.0026	<0.0020	0.0023	<0.0020	0.0021	<0.0020
Arsenic (As)-Total	0.019	0.009	0.013	0.055	0.027	0.049	0.010	0.025	0.024
Barium (Ba)-Total	1.180	1.03	0.715	0.378	0.403	0.422	1.590	3.070	1.440
Beryllium (Be)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0026	<0.0020
Bismuth (Bi)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Boron (B)-Total	0.23	<0.20	<0.20	<0.20	0.27	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)-Total	0	0	0	0	0	0	0	0	0
Calcium (Ca)-Total	11200	2990	2140	4780	5910	4810	4670	5370	4480
Cesium (Cs)-Total	0.0089	0.0044	0.0036	0.0025	0.0027	0.0036	0.003	0.009	0.003
Chromium (Cr)-Total	0.174	0.171	0.090	0.034	0.055	0.044	0.032	0.100	0.218
Cobalt (Co)-Total	0.0523	0.0363	0.0376	0.0281	0.0313	0.0367	0.0607	0.071	0.043
Copper (Cu)-Total	0.521	0.595	0.568	0.576	0.771	0.725	0.685	0.889	0.869
Gallium (Ga)-Total	000	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	000	<0.0040
Iron (Fe)-Total	<40	<25	<20	<10	<15	<25	<20	59	<25
Lead (Pb)-Total	<0.020	<0.0080	<0.016	<0.012	<0.0080	<0.020	<0.0080	0.036	<0.020
Lithium (Li)-Total	0.074	0.054	0.044	0.084	0.088	0.088	0.07	0.106	<0.020
Magnesium (Mg)-Total	402	254	280	307	331	318	297	312	291
Manganese (Mn)-Total	1.50	0.56	0.71	0.45	1.05	1.13	1.36	2.24	2.03
Mercury (Hg)-Total	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)-Total	0	0	0	0	0	0	0	0	0
Nickel (Ni)-Total	0.116	0.117	<0.090	<0.050	<0.060	<0.10	<0.050	0.11	0.13
Phosphorus (P)-Total	7570	3120	3270	4700	5090	4530	4560	4750	4500
Potassium (K)-Total	3840	3900	3910	3540	3610	3560	3730	3800	3780
Rhenium (Re)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Rubidium (Rb)-Total	1.66	1.04	1.05	1.37	1.34	1.36	1.19	1.06	0.977
Selenium (Se)-Total	1.01	0.869	0.754	1.35	0.941	1.22	0.767	0.787	0.503
Sodium (Na)-Total	1210	1160	1050	940	990	970	980	1030	950
Strontium (Sr)-Total	5.82	2.28	1.49	1.84	2.13	1.94	3.94	4.58	3.76
Tellurium (Te)-Total	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Thallium (Tl)-Total	0.0147	0.00909	0.00434	0.0265	0.0244	0.0254	0.00382	0.00444	0.00317
Thorium (Th)-Total	0.0063	0.0046	0.0032	0.0026	<0.0020	<0.0020	<0.0020	0.005	0.0039
Tin (Sn)-Total	0.0144	0.014	0.0146	0.0076	0.0057	0.0067	<0.0040	0.0057	0.0131
Titanium (Ti)-Total	0.313	0.062	0.049	0.041	0.089	0.113	0.084	0.473	0.136
Uranium (U)-Total	0.00168	0.00062	0.00055	0.0008	0.00093	0.0016	0.00128	0.0045	0.00126
Vanadium (V)-Total	0.106	0.0286	0.0234	0.0193	0.0249	0.0583	0.0329	0.202	0.0603
Yttrium (Y)-Total	0.0134	0.004	0.0039	<0.0020	<0.0020	0.0072	0.0061	0.0423	0.0093
Zinc (Zn)-Total	31.8	23.4	20.1	18	26.6	23.9	21.7	20.2	23.9
Zirconium (Zr)-Total	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.054
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt

Appendix 8c. Tissue Metals Analytical Data, 2011

Project	Quintette
Report To	Stantec
ALS File No.	L1092391
Date Received	06-Dec-11 11:26
Date	27-Jan-12

RESULTS OF ANALYSIS																
Sample ID	MURRAY RB CCG-1	MURRAY RB CCG-2	MURRAY RB CCG-3	MURRAY RB CCG-4	MURRAY RB CCG-5	MURRAY RB CCG-6	MURRAY RB CCG-7	MURRAY RB CCG-8	MURRAY D/S CCG-1	MURRAY D/S CCG-2	MURRAY D/S CCG-3	MURRAY D/S CCG-4	MURRAY D/S CCG-5	MURRAY D/S CCG-6	MURRAY D/S CCG-7	MURRAY D/S CCG-8
Date Sampled	20-SEP-11	20-SEP-11	20-SEP-11	20-SEP-11	20-SEP-11	20-SEP-11	20-SEP-11	20-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11
Time Sampled	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID	L1092391-1	L1092391-2	L1092391-3	L1092391-4	L1092391-5	L1092391-6	L1092391-7	L1092391-8	L1092391-9	L1092391-10	L1092391-11	L1092391-12	L1092391-13	L1092391-14	L1092391-15	L1092391-16
Sample Type	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests																
% Moisture	73.6	72.3	74.2	75.8	71.9	72.5	72.2	73.3	76.3	72.7	72.4	71.9	75.3	74.5	74.7	75.2
Metals																
Aluminum (Al)-Total	80.7	138.0	47.1	35.1	66.3	124	140	109.0	83.5	38.4	46.3	193	122	43.5	180	83.6
Antimony (Sb)-Total	0.0043	0.0045	0.0036	0.0024	0.0024	0.0032	0.0105	0.0128	0.003	0.0021	0.0029	0.0071	0.004	0.0113	0.0025	0.0044
Arsenic (As)-Total	0.070	0.084	0.067	0.063	0.075	0.078	0.073	0.081	0.064	0.056	0.044	0.115	0.065	0.054	0.061	0.059
Barium (Ba)-Total	3.210	4.830	4.150	3.210	4.830	5.080	4.350	4.870	4.160	5.030	5.410	7.8	3.86	4.250	4.69	5.35
Beryllium (Be)-Total	0.0036	0.0053	0.0021	<0.0020	0.0024	0.0047	0.0059	0.004	0.0026	<0.0020	0.0021	0.0078	0.0044	<0.0020	0.006	0.0031
Bismuth (Bi)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Boron (B)-Total	0.21	0.35	0.33	<0.70	<0.20	0.75	0.81	0.26	<0.40	<0.30	0.65	0.43	0.73	<0.20	0.21	<0.20
Cadmium (Cd)-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)-Total	12800	13200	14900	11000	19300	17000	15100	19800	15200	19800	20500	23500	11100	16900	12500	17700
Cesium (Cs)-Total	0.013	0.019	0.011	0.010	0.012	0.022	0.020	0.015	0.012	0.009	0.011	0.021	0.0156	0.0089	0.0217	0.011
Chromium (Cr)-Total	0.415	0.362	0.225	0.140	0.754	0.529	0.438	0.516	0.220	0.096	0.460	0.427	0.399	0.121	0.415	0.342
Cobalt (Co)-Total	0.0719	0.11	0.0908	0.0964	0.111	0.101	0.103	0.108	0.108	0.112	0.055	0.155	0.106	0.0791	0.11	0.104
Copper (Cu)-Total	0.892	0.974	1.1	0.852	0.92	0.886	1.01	0.906	1.35	0.89	0.774	0.964	1.2	1.12	1.02	1.06
Gallium (Ga)-Total	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
Iron (Fe)-Total	73	100	56	46	62	73	104	100	81	48	52	212	112	43	104	83
Lead (Pb)-Total	0.0416	0.0540	0.0404	0.021	0.0508	0.0380	0.0545	0.043	0.043	0.031	0.0346	0.076	0.054	0.0294	0.059	0.048
Lithium (Li)-Total	<0.20	<0.20	<0.20	<0.020	<0.20	<0.20	<0.20	<0.25	0.123	0.091	<0.20	<0.30	<0.20	<0.10	<0.20	<0.20
Magnesium (Mg)-Total	421	443	451	392	489	462	492	482	406	474	510	806	422	426	402	480
Manganese (Mn)-Total	5.54	7.47	7.25	6.42	7.99	8.94	5.73	8.53	7.65	7.95	8.08	13.50	5.99	5.10	7.97	10.80
Mercury (Hg)-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)-Total	0.243	0.197	0.141	0.108	0.174	0.257	0.18	0.276	0.19	0.115	0.344	0.345	0.251	0.126	0.275	0.269
Phosphorus (P)-Total	8340	8040	8980	7210	11400	9710	9050	10600	8450	11400	11900	13200	6870	9080	7720	10100
Potassium (K)-Total	3150	3440	3120	3210	2860	3070	3070	2660	3190	3240	3030	2830	3010	2770	2960	2760
Rhenium (Re)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Rubidium (Rb)-Total	1.6	1.84	1.65	1.66	1.57	1.83	1.68	1.63	1.34	1.47	1.68	1.68	1.63	1.35	1.63	1.38
Selenium (Se)-Total	1.31	1.53	1.59	1.74	1.62	1.47	1.48	1.27	0.933	1.13	1.07	1.11	0.949	0.855	1.01	0.935
Sodium (Na)-Total	1220	1220	1190	1110	1320	1250	1290	1250	1270	1300	1400	1240	1080	1210	990	1130
Strontium (Sr)-Total	7.88	8.53	10.3	8.39	12.1	11.6	10.5	13.6	9.67	12.2	13	15.3	7.47	12	8.48	11.9
Tellurium (Te)-Total	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Thallium (Tl)-Total	0.0104	0.0109	0.00972	0.00999	0.0118	0.0117	0.0114	0.0111	0.00922	0.013	0.00734	0.0139	0.0117	0.0122	0.0123	0.0101
Thorium (Th)-Total	0.0117	0.0213	0.0163	0.0085	0.0123	0.0177	0.0198	0.0167	0.0151	0.0129	0.0097	0.0278	0.0225	0.0093	0.0224	0.014
Tin (Sn)-Total	0.0051	0.0156	0.0055	<0.0040	0.0054	0.0054	0.0066	0.0049	0.0061	0.0046	0.0057	0.0083	0.005	0.0075	0.006	0.0046
Titanium (Ti)-Total	0.949	1.14	0.641	0.574	0.608	0.846	1.15	1.04	1.03	0.575	0.651	1.82	1.5	0.587	1.01	1.21
Uranium (U)-Total	0.00373	0.00465	0.00348	0.00229	0.00358	0.00931	0.00576	0.00897	0.00528	0.00486	0.00507	0.021	0.0059	0.00488	0.00556	0.0091
Vanadium (V)-Total	0.614	0.674	0.31	0.176	0.455	0.673	0.6	0.429	0.329	0.224	0.289	1.77	0.468	0.287	0.772	0.409
Yttrium (Y)-Total	0.0244	0.0423	0.0186	0.0148	0.0212	0.0509	0.0447	0.0495	0.0294	0.0151	0.0209	0.0904	0.0492	0.0173	0.039	0.0381
Zinc (Zn)-Total	23.4	25.7	25.6	24.1	23.8	24.4	27.9	29.1	24.9	27.8	32.2	32.8	22.2	24.7	24.7	31
Zirconium (Zr)-Total	0.054	0.058	<0.040	<0.040	<0.040	0.05	0.057	0.05	0.044	<0.040	<0.040	0.088	0.056	<0.040	0.062	0.043
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt

Appendix 8c. Tissue Metals Analytical Data, 2011

Project	Quintette
Report To	Stantec
ALS File No.	L1092391
Date Received	06-Dec-11 11:26
Date	27-Jan-12

RESULTS OF ANALYSIS																	
Sample ID	B2 WETLAND FDC-1	B2 WETLAND FDC-2	B2 WETLAND FDC-3	B2 WETLAND FDC-4	B2 WETLAND FDC-5	B2 WETLAND FDC-6	B2 WETLAND FDC-7	B2 WETLAND FDC-8	M20 WETLAND FDC-1	M20 WETLAND FDC-2	M20 WETLAND FDC-3	M20 WETLAND FDC-4	M20 WETLAND FDC-5	M20 WETLAND FDC-6	M20 WETLAND FDC-7	M20 WETLAND FDC-8	M14 WET;AND FDC-1
Date Sampled	22-SEP-11	22-SEP-11	22-SEP-11	22-SEP-11	22-SEP-11	22-SEP-11	22-SEP-11	22-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11
Time Sampled	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID	L1092391-17	L1092391-18	L1092391-19	L1092391-20	L1092391-21	L1092391-22	L1092391-23	L1092391-24	L1092391-25	L1092391-26	L1092391-27	L1092391-28	L1092391-29	L1092391-30	L1092391-31	L1092391-32	L1092391-33
Sample Type	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests																	
% Moisture	73.6	75.3	77.9	74.7	75.4	76.4	76.7	77.5	74.7	72.7	74.4	74.7	73.5	72.0	73.8	73.7	74.8
Metals																	
Aluminum (Al)-Total	58	19.3	79.2	47.2	11.2	12.1	22.8	11.2	0.72	1.2	00.7	1.89	1.58	0.92	4.62	1.61	23.1
Antimony (Sb)-Total	0.0021	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Arsenic (As)-Total	0.047	0.035	0.046	0.055	0.049	0.046	0.057	0.045	0.013	0.011	0.024	0.021	0.021	0.012	0.015	0.030	0.049
Barium (Ba)-Total	17.100	10.600	11.500	20.1	10.5	7.580	8.3	8.38	9.720	7.350	6.780	7.05	8.19	10.600	6.99	7.42	7.980
Beryllium (Be)-Total	0.002	<0.0020	0.0028	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Bismuth (Bi)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Boron (B)-Total	<0.30	<0.20	<0.20	<0.20	<0.20	0.69	<0.20	<0.60	<0.20	<0.20	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)-Total	0	0	0	0	0	0	0	0	<0.0020	0	0	0	0	0	0	0	0
Calcium (Ca)-Total	12600	7410	9130	12800	11500	7220	9090	8530	6090	11200	7510	6760	10000	11100	10600	8740	9880
Cesium (Cs)-Total	0.009	0.004	0.011	0.0068	0.003	0.0032	0.0046	0.0033	0.002	0.002	0.002	0.0024	0.0016	0.0022	0.0024	0.0019	0.003
Chromium (Cr)-Total	0.186	0.065	0.141	0.155	0.056	0.049	0.091	0.078	0.040	0.041	0.038	0.040	0.032	0.136	0.071	0.078	0.080
Cobalt (Co)-Total	0.0375	0.022	0.030	0.0321	0.0157	0.0145	0.0174	0.0129	0.0071	0.007	0.006	0.0082	0.0067	0.0075	0.0087	0.0069	0.0187
Copper (Cu)-Total	1.8	1.33	1.3	1.27	1.44	1.66	1.59	1.48	2.97	1.18	1.29	1.58	0.939	1.42	0.946	1.02	3.07
Gallium (Ga)-Total	000	000	000	000	<0.0040	<0.0040	000	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	000
Iron (Fe)-Total	56	37	59	50	36	28	35	29	35	33	36	39	32	34	35	37	55
Lead (Pb)-Total	0.025	0.008	0.0287	0.020	0.006	0.0052	0.009	0.006	0.009	0.004	0.0159	0.041	0.008	0.0073	0.012	0.007	0.013
Lithium (Li)-Total	0.097	<0.10	0.086	<0.10	0.046	<0.10	<0.10	0.035	0.024	0.022	<0.020	<0.020	0.021	0.025	0.025	<0.020	<0.10
Magnesium (Mg)-Total	445	352	362	447	417	330	367	352	317	403	353	335	355	392	390	356	350
Manganese (Mn)-Total	6.38	5.23	3.89	6.97	4.01	3.52	3.57	3.25	5.66	6.30	4.67	6.14	6.29	6.22	6.56	4.49	5.94
Mercury (Hg)-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)-Total	0.106	<0.050	0.087	0.073	0.064	0.097	<0.10	0.035	0.017	0.026	0.018	0.012	0.024	0.058	0.03	0.035	<0.10
Phosphorus (P)-Total	7850	5430	5720	8090	7550	5010	6070	5670	4720	7010	5610	5220	6210	6850	6320	5860	5880
Potassium (K)-Total	3070	3070	3130	3010	3000	3090	2990	3050	3320	3540	3510	3380	2870	3380	3460	3340	3070
Rhenium (Re)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Rubidium (Rb)-Total	1.49	1.21	1.36	1.25	1.44	1.5	1.49	1.42	3.13	2.51	2.95	3.04	2.27	3.42	2.83	2.56	1.09
Selenium (Se)-Total	0.693	0.706	0.557	0.546	0.605	0.552	0.542	0.505	0.548	0.752	0.591	0.634	0.6	0.65	0.691	0.547	0.939
Sodium (Na)-Total	990	870	930	930	940	840	810	830	830	860	820	790	740	800	840	800	880
Strontium (Sr)-Total	11.6	7.47	8.59	13.5	12.3	8.15	9.67	8.25	4.07	6.32	4.72	4.43	6.3	7.28	6.55	5.65	12.1
Tellurium (Te)-Total	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Thallium (Tl)-Total	0.00197	0.0012	0.00193	0.00159	0.00116	0.00132	0.00168	0.00139	0.00115	0.00139	0.00172	0.00154	0.00144	0.00169	0.0016	0.00145	0.00188
Thorium (Th)-Total	0.0067	0.0031	0.0099	0.0056	<0.0020	<0.0020	0.0028	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0038
Tin (Sn)-Total	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Titanium (Ti)-Total	0.961	0.243	0.556	1.66	0.219	0.088	0.162	0.092	0.032	0.013	0.034	0.038	0.034	0.033	0.08	0.025	0.269
Uranium (U)-Total	0.00209	0.00089	0.00231	0.00188	0.00072	0.0005	0.00096	0.00059	<0.00040	<0.00040	<0.00040	0.00042	0.00044	<0.00040	0.00057	<0.00040	0.00088
Vanadium (V)-Total	0.214	0.0674	0.276	0.168	0.0395	0.042	0.0786	0.0397	<0.0040	0.0051	<0.0040	0.0075	0.0078	0.0048	0.0208	0.0056	0.0866
Yttrium (Y)-Total	0.0212	0.006	0.0251	0.0138	0.0038	0.0036	0.0057	0.0031	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0021	<0.0020	0.0071
Zinc (Zn)-Total	55.8	54.6	63	78.5	65.1	55.2	67.1	62.4	30.2	48.7	54.4	53.2	48.5	47.7	50	48	50.8
Zirconium (Zr)-Total	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt

Appendix 8c. Tissue Metals Analytical Data, 2011

Project	Quintette
Report To	Stantec
ALS File No.	L1092391
Date Received	06-Dec-11 11:26
Date	27-Jan-12

RESULTS OF ANALYSIS																	
Sample ID	M14 WETLAND FDC-2	M14 WETLAND FDC-3	M14 WETLAND FDC-4	M14 WETLAND FDC-5	M14 WETLAND FDC-6	M14 WETLAND FDC-7	M14 WETLAND FDC-8	BARBOUR WETLAND FDC-1	BARBOUR WETLAND FDC-2	BARBOUR WETLAND FDC-3	BARBOUR WETLAND FDC-4	BARBOUR WETLAND FDC-5	BARBOUR WETLAND FDC-6	BARBOUR WETLAND FDC-7	BARBOUR WETLAND FDC-8	MURRAY U/S CCG-1	MURRAY U/S CCG-2
Date Sampled	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	23-SEP-11	25-SEP-11
Time Sampled	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID	L1092391-34	L1092391-35	L1092391-36	L1092391-37	L1092391-38	L1092391-39	L1092391-40	L1092391-41	L1092391-42	L1092391-43	L1092391-44	L1092391-45	L1092391-46	L1092391-47	L1092391-48	L1092391-49	L1092391-50
Sample Type	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests																	
% Moisture	73.8	73.8	75.0	74.7	75.6	75.1	75.2	74.2	74.7	73.6	74.0	75.1	75.0	76.0	74.8	74.4	75.4
Metals																	
Aluminum (Al)-Total	1.5	07.2	10.5	9.75	5.67	27.7	4.82	1.64	4.1	03.2	6.03	1.88	3.9	3.23	1.54	52.6	10.0
Antimony (Sb)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0026	0.0027	0.0025	0.0023	0.0028	0.0029	0.0024	0.0022	0.0048	<0.0020
Arsenic (As)-Total	0.037	0.044	0.036	0.033	0.024	0.042	0.040	0.011	0.030	0.013	0.014	0.012	0.012	0.014	0.017	0.069	0.039
Barium (Ba)-Total	6.330	8.570	6.6	8.17	6.320	7.99	6.75	7.180	11.500	10.300	10.7	11	10.100	10.8	13.1	6.850	5.370
Beryllium (Be)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Bismuth (Bi)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Boron (B)-Total	0.69	0.51	<0.20	<0.30	<0.20	<0.20	<0.30	<0.20	<0.40	<0.20	<0.20	<0.20	<0.40	<0.20	<0.20	0.37	<0.20
Cadmium (Cd)-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)-Total	9860	11900	8710	12500	7200	14200	8260	6300	10100	9750	8150	9860	8540	10800	10300	25200	25200
Cesium (Cs)-Total	<0.0010	0.002	0.0018	0.0022	0.0014	0.0033	0.0014	0.002	0.003	0.002	0.0022	0.002	0.0019	0.0018	0.0018	0.015	0.019
Chromium (Cr)-Total	0.029	0.105	0.058	0.136	0.065	0.212	0.028	0.031	0.057	0.044	0.053	0.033	0.055	0.038	0.075	0.198	0.099
Cobalt (Co)-Total	0.012	0.030	0.0139	0.0155	0.0126	0.0205	0.0152	0.0079	0.009	0.009	0.011	0.0081	0.0115	0.009	0.0111	0.0933	0.079
Copper (Cu)-Total	2.09	2.06	1.62	2.18	1.72	2.08	1.93	2.19	1.2	2.32	1.65	2.01	2.34	1.44	2.16	0.978	0.657
Gallium (Ga)-Total	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	000	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	000	<0.0040
Iron (Fe)-Total	31	37	43	44	30	61	36	29	37	36	38	36	41	29	27	57	34
Lead (Pb)-Total	0.006	0.0117	0.009	0.010	0.0059	0.019	0.006	0.007	0.006	0.0065	0.009	0.007	0.0129	0.010	0.006	0.035	0.025
Lithium (Li)-Total	<0.040	<0.10	0.036	0.042	<0.040	0.053	0.029	0.024	0.029	0.035	0.03	0.027	0.031	0.031	0.022	<0.20	0.086
Magnesium (Mg)-Total	370	426	371	403	333	421	361	305	351	368	348	354	344	379	374	542	497
Manganese (Mn)-Total	5.60	10.30	5.51	8.28	5.15	7.07	5.70	2.09	2.92	3.28	2.78	3.34	3.03	3.08	2.39	7.84	7.90
Mercury (Hg)-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)-Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)-Total	<0.050	<0.10	0.029	0.07	<0.050	0.101	0.017	0.02	0.031	0.032	0.043	0.024	0.034	0.031	0.051	0.166	0.142
Phosphorus (P)-Total	6490	7720	5910	7360	5440	7690	5800	4740	5960	6370	5700	6100	5690	6580	5940	13300	13400
Potassium (K)-Total	3050	3210	3390	3070	2970	3100	3370	3150	3280	3360	3280	3190	3320	3250	3570	2630	2550
Rhenium (Re)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Rubidium (Rb)-Total	1.07	1.23	1.1	1.17	1.01	1.01	1.11	0.937	0.938	1.08	1.03	1.07	0.965	0.968	1.08	1.27	1.73
Selenium (Se)-Total	0.909	0.928	0.928	0.851	0.8	0.835	1.06	1.7	2.12	2.17	2.08	1.95	2.05	1.77	1.73	0.919	0.846
Sodium (Na)-Total	860	900	900	890	780	910	870	790	900	990	870	830	930	900	910	1360	1670
Strontium (Sr)-Total	12.1	16.4	10.4	14.8	9.42	16.8	9.56	4.17	6.87	6.62	5.96	7.19	6.21	7.54	8.93	16.8	14.7
Tellurium (Te)-Total	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Thallium (Tl)-Total	0.00204	0.00235	0.00164	0.0024	0.0016	0.00204	0.00233	0.00268	0.00264	0.00297	0.00352	0.00284	0.00326	0.00315	0.00419	0.0109	0.0117
Thorium (Th)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0036	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0082	<0.0020
Tin (Sn)-Total	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Titanium (Ti)-Total	0.021	0.093	0.752	0.197	1.12	19.6	0.118	13	1.45	15.5	5.48	0.587	19.8	9.85	0.345	0.866	0.274
Uranium (U)-Total	0.0004	0.0013	0.00071	0.00072	0.00066	0.002	0.00046	0.00088	0.00118	0.00154	0.0014	0.00091	0.00246	0.00079	0.0008	0.00944	0.00446
Vanadium (V)-Total	0.037	0.0428	0.0471	0.0463	0.0333	0.101	0.0302	0.011	0.0326	0.0197	0.0377	0.0149	0.0275	0.0191	0.0149	0.349	0.204
Yttrium (Y)-Total	<0.0020	0.0021	0.0029	0.0028	0.003	0.0088	<0.0020	<0.0020	<0.0020	<0.0020	0.0022	<0.0020	0.0031	<0.0020	<0.0020	0.0286	0.0097
Zinc (Zn)-Total	54.1	60.7	53.1	47.8	46.5	58.9	48.9	50.9	63.8	60.8	67.6	68.4	72.1	78.1	79.6	34.1	41.8
Zirconium (Zr)-Total	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.075	<0.040
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt

Appendix 8c. Tissue Metals Analytical Data, 2011

Project	Quintette
Report To	Stantec
ALS File No.	L1092391
Date Received	06-Dec-11 11:26
Date	27-Jan-12

RESULTS OF ANALYSIS											
Sample ID	MURRAY U/S CCG-3	MURRAY U/S CCG-4	MURRAY U/S CCG-5	MURRAY U/S CCG-6	MURRAY U/S CCG-7	WATERFALL EB-1 (MUSCLE ONLY)	WATERFALL EB-2 (MUSCLE ONLY)	WATERFALL EB-3 (MUSCLE ONLY)	WATERFALL EB-1 (WHOLE BODY)	WATERFALL EB-2 (WHOLE BODY)	WATERFALL EB-3 (WHOLE BODY)
Date Sampled	25-SEP-11	25-SEP-11	25-SEP-11	25-SEP-11	25-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11	21-SEP-11
Time Sampled	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID	L1092391-51	L1092391-52	L1092391-53	L1092391-54	L1092391-55	L1092391-56	L1092391-57	L1092391-58	L1092391-59	L1092391-60	L1092391-61
Sample Type	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests											
% Moisture	78.0	74.1	72.9	75.2	73.2	77.8	76.9	74.1	75.1	72.2	68.3
Metals											
Aluminum (Al)-Total	122.0	162	9.55	16.3	26.2	0.73	1.1	00.4	63	4.7	16.1
Antimony (Sb)-Total	0.0045	0.0058	0.0028	0.0023	0.003	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Arsenic (As)-Total	0.069	0.095	0.041	0.048	0.056	0.007	0.013	0.018	0.016	0.029	0.039
Barium (Ba)-Total	2.740	4.48	4.21	2.390	3.61	0.101	0.230	0.059	2.330	0.951	1.110
Beryllium (Be)-Total	0.0042	0.0053	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Bismuth (Bi)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Boron (B)-Total	<0.20	<0.40	<0.60	0.55	0.59	<0.70	<0.20	<0.20	<0.20	<0.20	<0.50
Cadmium (Cd)-Total	0	0	0	0	0	<0.0020	<0.0020	<0.0020	0	0	0
Calcium (Ca)-Total	9500	14600	18200	11700	16700	392	567	201	6790	3580	2640
Cesium (Cs)-Total	0.021	0.0239	0.0094	0.0109	0.0128	0.007	0.007	0.007	0.013	0.007	0.008
Chromium (Cr)-Total	0.407	0.336	0.435	0.345	0.427	0.023	0.034	0.019	0.172	0.040	0.045
Cobalt (Co)-Total	0.061	0.0948	0.0401	0.0533	0.0578	0.0563	0.042	0.033	0.119	0.121	0.075
Copper (Cu)-Total	0.665	0.927	0.799	0.76	0.787	0.365	0.343	0.343	0.672	0.711	1.1
Gallium (Ga)-Total	000	000	<0.0040	<0.0040	000	<0.0040	<0.0040	<0.0040	000	<0.0040	000
Iron (Fe)-Total	104	131	22	26	35	4	4	3	37	15	19
Lead (Pb)-Total	0.0532	0.071	0.017	0.0142	0.018	<0.0040	<0.0040	<0.0040	0.016	0.007	0.0073
Lithium (Li)-Total	0.125	0.162	0.059	<0.10	<0.10	<0.020	<0.020	<0.020	0.055	<0.020	<0.020
Magnesium (Mg)-Total	398	564	450	385	453	274	291	289	329	279	306
Manganese (Mn)-Total	4.08	9.45	6.05	4.19	5.93	0.16	0.22	0.11	1.19	0.66	0.80
Mercury (Hg)-Total	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)-Total	0	0	0	0	0	0	<0.0040	<0.0040	0	0	0
Nickel (Ni)-Total	0.204	0.226	0.225	0.17	0.244	0.025	<0.010	<0.010	0.063	0.022	0.043
Phosphorus (P)-Total	6070	8460	10400	7730	9920	2380	2620	2530	5390	3850	3830
Potassium (K)-Total	3060	3070	3000	3030	2950	4430	4500	4380	3730	3760	3970
Rhenium (Re)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Rubidium (Rb)-Total	1.34	1.47	1.36	1.48	1.52	1.67	2.31	2.65	1.58	1.97	2.3
Selenium (Se)-Total	1	1.03	1.05	1.38	1.34	1.01	1.05	1.17	1.36	1.71	1.7
Sodium (Na)-Total	1170	1080	1210	1070	1170	590	480	500	1040	840	770
Strontium (Sr)-Total	5.36	8.53	11	7.14	11.1	0.279	0.484	0.144	5.1	2.98	1.88
Tellurium (Te)-Total	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Thallium (Tl)-Total	0.0107	0.0138	0.0135	0.00937	0.0128	0.00635	0.00683	0.00637	0.00932	0.00853	0.00925
Thorium (Th)-Total	0.0191	0.0313	0.0035	0.0034	0.005	<0.0020	<0.0020	<0.0020	0.0055	<0.0020	0.0021
Tin (Sn)-Total	0.0044	0.0048	<0.0040	<0.0040	0.0048	<0.0040	<0.0040	<0.0040	0.0097	0.0065	0.0054
Titanium (Ti)-Total	1.18	1.7	0.337	0.318	0.416	0.077	0.022	0.087	0.323	0.202	0.262
Uranium (U)-Total	0.00997	0.0106	0.00428	0.00257	0.00386	<0.00040	<0.00040	<0.00040	0.00237	0.00052	0.00131
Vanadium (V)-Total	0.623	0.863	0.19	0.123	0.242	<0.0040	<0.0040	<0.0040	0.23	0.0159	0.0525
Yttrium (Y)-Total	0.0607	0.0789	0.0053	0.0089	0.0099	<0.0020	<0.0020	<0.0020	0.013	0.0024	0.0085
Zinc (Zn)-Total	22	28.7	29.8	25.2	25.6	6.05	7.52	7.03	19.8	20.1	24.6
Zirconium (Zr)-Total	0.072	0.091	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.041	<0.040	<0.040
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt

Appendix 8d. Tissue Metals Analytical Data, 2005

Project
Report To EVS- Golder
ALS File No. W6868
Date Received 2-Nov-05
Date 14-Dec-05

RESULTS OF ANALYSIS									
Sample ID	Murray DS CCG-1	Murray DS CCG-2	Murray DS CCG-3	Murray DS CCG-4	Murray DS CCG-5	Murray DS MW-1	Murray US CCG- 1	Murray US CCG- 2	Murray US CCG- 3
Date Sampled	E206323-01	E206323-02	E206323-03	E206323-04	E206323-05	E206323-06	E206322-01	E206322-02	E206322-03
Time Sampled	38617	38617	38617	38617	38617	38617	38616	38616	38616
ALS Sample ID									
Sample Type	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests									
% Moisture	76.9	79.4	77.0	77.6	76.1	73.2	73.9	75.5	72.2
Metals									
Aluminum (Al)-Total	49.2	43.3	60.7	32.3	58.8	22.3	35	16.5	12.4
Antimony (Sb)-Total	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02
Arsenic (As)-Total	0.055	0.056	0.055	0.046	0.053	0.030	0.065	0.059	0.054
Barium (Ba)-Total	4.690	5.170	5.610	3.860	4.930	0.933	4.450	3.710	3.500
Beryllium (Be)-Total	<0.2	<0.2	<0.2	<0.02	<0.02	<0.01	<0.2	<0.2	<0.2
Bismuth (Bi)-Total	<0.2	<0.2	<0.2	<0.02	<0.02	<0.01	<0.2	<0.2	<0.2
Cadmium (Cd)-Total	0.181	0.127	0.141	0.088	0.123	0.0619	0.196	0.104	0.104
Calcium (Ca)-Total	15500	16400	16000	13000	16200	6100	20000	14300	13100
Chromium (Cr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.20	<0.20	<0.02
Cobalt (Co)-Total	0.063	0.052	0.069	0.045	0.048	0.055	0.069	0.048	0.047
Copper (Cu)-Total	0.725	0.641	0.673	0.587	0.718	0.788	0.860	0.759	0.722
Lead (Pb)-Total	<0.04	<0.04	0.051	<0.04	0.040	<0.02	<0.04	<0.04	<0.04
Lithium (Li)-Total	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.2	<0.2	<0.2
Magnesium (Mg)-Total	419	412	394	366	458	345	462	385	376
Manganese (Mn)-Total	6	5	6	4	5	2	8	5	5
Molybdenum (Mo)-Total	0.0210	<0.02	0.0240	<0.02	0.0210	0.0130	<0.02	<0.02	<0.02
Nickel (Ni)-Total	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.2	<0.2	<0.2
Selenium (Se)-Total	0.84	0.8	0.65	0.78	0.85	1.08	0.91	1.08	0.92
Strontium (Sr)-Total	11.10	11.10	10.90	22.50	20.30	25.70	13.70	9.80	9.07
Thallium (Tl)-Total	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02
Tin (Sn)-Total	<0.1	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1
Uranium (U)-Total	0.0064	0.0056	0.0061	<0.004	0.0063	<0.002	0.0056	<0.004	<0.004
Vanadium (V)-Total	0.29	0.3	0.35	<0.2	0.35	<0.1	0.31	<0.2	<0.2
Zinc (Zn)-Total	28	27.6	31.1	22.5	20.3	25.7	29.9	22	24.2
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt

Appendix 8d. Tissue Metals Analytical Data, 2005

Project

Report To	EVS- Golder
ALS File No.	W6868
Date Received	2-Nov-05
Date	14-Dec-05

RESULTS OF ANALYSIS									
Sample ID	Murray US CCG- 4	Murray US CCG- 5	Murray US MW- 1	Murray US MW- 2	Murray US MW- 3	Murray RB CCG- 1	Murray RB CCG- 2	Murray RB CCG- 3	Murray RB CCG- 4
Date Sampled	E206322-04	E206322-05	E206322-06	E206322-07	E206322-08	E206972-01	E206972-02	E206972-03	E206972-04
Time Sampled	38616	38616	38616	38616	38616	38616	38616	38616	38616
ALS Sample ID									
Sample Type	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests									
% Moisture	72.0	73.9	74.3	75.8	71.0	73.2	68.9	71.9	71.7
Metals									
Aluminum (Al)-Total	44.8	39.4	11.6	17.2	41.8	71	129.0	75.1	64.1
Antimony (Sb)-Total	<0.02	<0.02	<0.01	<0.01	<0.01	<0.02	<0.02	<0.01	<0.02
Arsenic (As)-Total	0.088	0.072	0.042	0.044	0.060	0.066	0.095	0.061	0.067
Barium (Ba)-Total	4.46	4.2	0.989	2.77	1.09	4.630	5.120	5.190	4.02
Beryllium (Be)-Total	<0.2	<0.2	<0.1	<0.1	<0.1	<0.2	<0.2	<0.10	<0.2
Bismuth (Bi)-Total	<0.2	<0.2	<0.1	<0.1	<0.1	<0.2	<0.2	<0.10	<0.2
Cadmium (Cd)-Total	0.092	0.163	0.0537	0.0531	0.0684	0.1	0.121	0.108	0.142
Calcium (Ca)-Total	15800	15300	6710	7940	8750	15100	13500	12400	13000
Chromium (Cr)-Total	<0.02	<0.02	<0.01	<0.01	<0.1	<0.2	0.27	0.16	<0.2
Cobalt (Co)-Total	0.066	0.074	0.075	0.041	0.086	0.056	0.087	0.066	0.072
Copper (Cu)-Total	0.823	0.937	0.702	0.793	0.821	0.909	1.060	1.000	0.860
Lead (Pb)-Total	<0.04	<0.04	<0.02	0.023	0.037	0.042	0.074	0.050	0.042
Lithium (Li)-Total	<0.2	<0.2	<0.1	<0.1	<0.1	<0.2	<0.2	0.11	<0.2
Magnesium (Mg)-Total	433	419	360	392	437	436	456	418	407
Manganese (Mn)-Total	6	6	2	4	3	7	6	6	7
Molybdenum (Mo)-Total	0.027	0.022	0.0110	0.012	0.015	0.026	0.034	0.0230	0.021
Nickel (Ni)-Total	<0.2	<0.2	<0.1	<0.1	0.34	<0.2	0.25	0.11	<0.2
Selenium (Se)-Total	0.95	0.68	1.13	1.15	1.49	1.24	1.08	0.93	1.18
Strontium (Sr)-Total	11.10	10.30	3.92	4.21	4.06	10.50	9.83	8.39	9.46
Thallium (Tl)-Total	<0.02	<0.02	<0.01	<0.01	0	<0.02	<0.02	<0.01	<0.02
Tin (Sn)-Total	<0.1	<0.1	<0.05	<0.05	<0.05	<0.1	<0.1	<0.05	<0.1
Uranium (U)-Total	<0.004	0.0046	<0.002	<0.002	0.0022	0.0084	0.0166	0.0057	0.0047
Vanadium (V)-Total	0.25	0.27	<0.1	<0.1	0.13	0.45	0.9	0.39	0.28
Zinc (Zn)-Total	24	30.8	26.8	33.9	33.7	21	21.3	21	19.2
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt

Appendix 8d. Tissue Metals Analytical Data, 2005

Project
Report To EVS- Golder
ALS File No. W6868
Date Received 2-Nov-05
Date 14-Dec-05

RESULTS OF ANALYSIS						
Sample ID	Murray RB CCG- 5	Mast Ck CCG- 1	Mast Ck CCG- 2	Mast Ck CCG- 3	Mast Ck CCG- 4	Mast Ck CCG- 5
Date Sampled	E206972-05	E206526-01	E206526-02	E206526-03	E206526-04	E206526-05
Time Sampled	38616	38617	38617	38617	38617	38617
ALS Sample ID						
Sample Type	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests						
% Moisture	72.3	75.7	74.2	74.5	74.7	72.8
Metals						
Aluminum (Al)-Total	94	17.2	20.0	17.5	36.2	47.4
Antimony (Sb)-Total	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic (As)-Total	0.085	0.043	0.043	0.032	0.053	0.058
Barium (Ba)-Total	6.07	4.070	4.200	2.540	5.25	4.81
Beryllium (Be)-Total	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1
Bismuth (Bi)-Total	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium (Cd)-Total	0.139	0.0527	0.0486	0.0703	0.0528	0.0695
Calcium (Ca)-Total	15000	10900	10000	8460	9660	12200
Chromium (Cr)-Total	<0.2	<0.1	<0.1	0.47	<0.1	0.15
Cobalt (Co)-Total	0.069	0.034	0.026	0.029	0.022	0.036
Copper (Cu)-Total	0.936	0.734	0.652	0.596	0.709	0.726
Lead (Pb)-Total	0.058	<0.02	<0.02	<0.02	<0.02	0.024
Lithium (Li)-Total	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1
Magnesium (Mg)-Total	445	345	329	301	349	356
Manganese (Mn)-Total	7	5	6	5	3	6
Molybdenum (Mo)-Total	0.029	0.016	0.019	0.0140	0.017	0.019
Nickel (Ni)-Total	0.25	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium (Se)-Total	1.06	0.97	1.11	1.19	1.23	1.25
Strontium (Sr)-Total	10.50	13.80	12.00	9.68	11.60	14.60
Thallium (Tl)-Total	<0.02	<0.01	0	<0.01	<0.01	0
Tin (Sn)-Total	<0.1	<0.05	<0.05	<0.05	<0.05	<0.05
Uranium (U)-Total	0.0068	0.0022	0.0029	0.005	0.004	0.0033
Vanadium (V)-Total	0.53	0.21	0.23	0.2	0.25	0.34
Zinc (Zn)-Total	21.4	19.4	20.1	17.6	19.7	20.4
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt

Appendix 8e. Tissue Metals Analytical Data, 2004

Project Western Coal, Herman Project Tissue Analysis 04-1421-094-3000
Report To EVS-Golder Associates Ltd.
ALS File No. U9390
Date Received 10/13/2004
Date 10/26/2004

RESULTS OF ANALYSIS										
Sample ID	SESYN- CLINE-1	SESYN- CLINE-2	SESYN- CLINE-3	SESYN- CLINE-4	SESYN- CLINE-5	M20 d/s-1	M20 d/s-2	M20 d/s-3	M20 d/s-4	M20 d/s-5
Date Sampled										
Time Sampled										
ALS Sample ID	1	2	3	4	5	6	7	8	9	10
Sample Type	Composite	Composite	Composite	Composite	Composite	Composite	Composite	Composite	Composite	Composite
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests										
% Moisture	76.3	75.6	76.7	76.8	77.5	77.4	76.1	79.2	76.1	76.4
Metals										
Aluminum (Al)-Total	14.22	28.1	23.067	16.008	22.275	10.848	25.6	30.0	45.888	67.968
Antimony (Sb)-Total	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Arsenic (As)-Total	0.050	0.073	0.049	0.049	<0.02	<0.02	0.050	0.046	0.069	0.071
Barium (Ba)-Total	3.247	3.514	3.052	2.506	2.790	5.537	7.983	5.803	5.4253	5.9708
Beryllium (Be)-Total	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bismuth (Bi)-Total	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cadmium (Cd)-Total	0.1185	0.11712	0.08854	0.1044	0.108	0.03164	0.08843	0.052	0.06453	0.059
Calcium (Ca)-Total	14220	12273	11114	10858	12218	15662	23542	17410	12787	10998
Chromium (Cr)-Total	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cobalt (Co)-Total	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.141	0.094	0.12906	0.11092
Copper (Cu)-Total	0.751	0.752	0.708	0.640	0.729	0.506	0.734	0.607	0.863	0.793
Lead (Pb)-Total	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Lithium (Li)-Total	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Magnesium (Mg)-Total	422	403	373	387	383	396	509	422	394	389
Manganese (Mn)-Total	3	4	4	3	4	2	4	2	4	4
Mercury (Hg)-Total	0.0419	0.0339	0.0277	0.032	0.0266	0.019	0.034	0.0231	0.015	0.015
Molybdenum (Mo)-Total	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel (Ni)-Total	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Selenium (Se)-Total	0.73	1.02	0.96	0.91	0.88	1.28	0.93	0.97	1.34	1.31
Strontium (Sr)-Total	10	9	8	7	8	13	15	12	10	9
Thallium (Tl)-Total	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tin (Sn)-Total	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Uranium (U)-Total	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)-Total	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Zinc (Zn)-Total	23.6052	23.8388	20.0147	23.432	23.175	27.12	30.353	23.088	26.768	25.252
Units	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt	mg/kg wwt