August 28, 2013

Jason Shpeley
Department of Fisheries and Oceans Canada
1028 Parsons Road
Edmonton, Alberta
T6X 0J4

Dear Mr. Shpeley:

RE: Robb Trend Project – Fish Compensation Document

In July and September 2012, Alberta Environment and Sustainable Resource Development (ESRD), the Energy Resource and Conservation Board (ERCB) and the Canadian Environmental Assessment Agency (CEAA) completed their initial review of the CVRI mine permit application and each issued a set of Supplemental Information Requests (SIRs). CVRI completed responses to these SIR's and submitted them on December 7, 2013.

On March 26, 2013 CVRI received the final combined version of the second round of SIR's from ESRD, ERCB and CEAA. On June 17th, 2013, CVRI completed responses that addressed all issues and questions raised in this second round of SIR's. CVRI believes that all matters with respect to the completion of the environmental assessment review processes have been completed and that the Project authorizations could now proceed.

Based on the two rounds of SIRs and meetings with DFO, CVRI has developed mining options including minor amendments to satisfy fish habitat compensation concerns. Attached is a report prepared by Pisces Environmental Consulting Services Ltd. titled *Summary of Fish Habitat Impacts, Mitigation and Habitat Compensation Strategies* which highlights the Project in relation to fish habitat, in both disturbance and reclamation. Of particular note to the DFO reviewers, there have been modifications made to the mine reclamation plan wherein some of the previously contemplated reclaimed lakes have been substituted by restored stream channels.

All communications in respect to the fish compensation document should be directed to:

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Yours truly,

COAL VALLEY RESOURCES INC.

<original signed by>

Les, LaFleur
Project Manager
Robb Trend Project

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CVRI Robb Trend Project
Summary of Fish Habitat Impacts, Mitigation and Habitat Compensation Strategies

Prepared for: Coal Valley Resources Inc. Edson, AB

August 2013

PISCES ENVIRONMENTAL CONSULTING SERVICES LTD.

CVRI Robb Trend Project

Summary of Fish Habitat Impacts and Mitigation and Habitat Compensation Strategies

Prepared for:
Coal Valley Resources Inc.
Edson, Alberta

Submitted to:
Fisheries and Oceans Canada (DFO)

Prepared by:
Pisces Environmental Consulting Services Ltd.
Red Deer, Alberta

August 2013

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1.0 INTRODUCTION

Coal Valley Resources Inc. (CVRI) is proposing an extension of the existing Coal Valley Mine (CVM) operation approximately 100 kilometres southwest of Edson, Alberta. Termed the Robb Trend Project (Project), the mine expansion includes development of areas to the northeast of existing operations. The Project mine permit area is approximately two kilometres wide and almost 50 kilometres long, extending in a northwest direction from the Pembina River past the Hamlet of Robb. A Project Application for the proposed expansion entitled *Robb Trend Coal Mine Expansion Project* was submitted to government regulators in April 2012 (CVRI 2012).

This document is intended to address key information requests that have been communicated by Fisheries and Oceans Canada (DFO) to CVRI. Specifically, this document provides:

- A description of updated mine plans and reclamation strategies that have been developed since the Project Application was submitted.
- A summary of direct habitat impacts resulting from the Project based on review of the updated mine plans.
- A discussion of other potential indirect impacts to fish habitat (if it was determined that the updated mine plans had changed the impact assessment scenario presented in the Project Application).
- A discussion of updated mitigation initiatives proposed by CVRI.
- A description of the proposed habitat compensation framework for the Project. It is expected that this conceptual plan will form the basis of agreement from which CVRI and DFO will work in consultation to satisfy the requirements of the federal *Fisheries Act*.
- A discussion of monitoring initiatives proposed by CVRI.

Much of the information provided in this document is summarized from, and makes reference to, sections of the Project Application as well as the responses to Supplemental Information Requests (SIRs) that were submitted as part of the review process. The analysis and conclusions presented in these documents remain applicable and should be referred to if additional details to the points raised in this document are required.

2.0 UPDATED MINE PLANS

To facilitate mine planning, the Project was divided into four areas referred to as Robb West, Robb Main, Robb Centre, and Robb East (Figure 1). The estimated Project lifespan is expected to be approximately 25 years with mine activities expected to progress as indicated below:

- Mining in the Robb West Area: 2032 to 2034
- Mining in the Robb Main Area: 2017 to 2031
- Mining in the Robb Centre Area: 2023 to 2026
- Mining in the Robb East Area: 2027 to 2039

After consultation with stakeholders, CVRI initiated a review of the original mine plan to identify solutions for concerns raised by regulators. Through this process CVRI has produced an updated mine plan that will result in reduced impacts to fish habitat and fewer on-stream/flow-through end pit lakes post reclamation.

The Project will consist of 13 main watercourse diversions; a description of each of the diversions is provided below. The anticipated schedule for development along with the predicted impacts to fish habitat are illustrated in Figure 2.

Erith River Diversion

Diversion of the Erith River involves several phases as illustrated on Figure 5.

Short sections of stream channel to route the Erith River out of the proposed McPherson Pit area will be constructed. These sections would be short, cutting off small meanders of the river and forcing the river toward the south. Once construction is completed the flow would be moved into the new channels. This diversion would last approximately three years while the McPherson Pit is mined and a new channel built in the floor of the McPherson Pit. The river would then be moved to the new McPherson Pit channel, which would be constructed to provide habitat for fish. This diversion would be in place for approximately five years while the Mynheer Pit was mined and reclaimed with a new channel in the base of the Mynheer Pit. Once the Mynheer Pit is complete, the Erith River would be moved into the new channel routed through the Mynheer Pit. This channel replaces Lake 4 (previously proposed in the Project Application). Mining of the Val d'Or Pit will also require movement of the Erith River channel to accommodate mining beneath the river. This will be accomplished by moving the river to the east into a constructed channel so that mining can be conducted on the west side of the river. Once mining is completed, a land bridge will be backfilled to the west and a new channel constructed on the land bridge as the final reclaimed river channel. All channels will be constructed to provide fish habitat. The 'switch' will take approximately four years to accomplish. Lake 5 (West and East) will outlet into the new channel.

ERT1 Diversion

Plans involving ERT1 have been revised to reduce direct impacts to fish habitat (Figure 5).

A short portion (~500 m) of the Mynheer Pit is being excluded from development in order to maintain spawning habitat in ERT1. Flows in ERT1 will be maintained to flow into the Erith River. A short diversion channel on the north side of the Mynheer Pit (highwall side) will be used to direct flows below sensitive habitat (spawning sites) that was identified during baseline investigations. This diversion will be in place approximately two years before it is discontinued as it is replaced by a new channel in the pit floor of Mynheer Pit. All channels will be constructed to provide fish habitat.

Bacon Creek Diversion

Plans involving Bacon Creek have been revised to reduce direct impacts to fish habitat (Figures 5 and 6).

A short section of the Mynheer Pit will be excluded from development in order to maintain certain sections of the existing Bacon Creek channel. However mining of the Val d'Or Pit will require that portions of Bacon Creek be moved to accommodate mining beneath the creek. This will be accomplished moving the creek to the east into a constructed channel so that mining can be conducted on the west side of the river. Once mining is completed a land bridge will be backfilled to the west and a new channel constructed on the land bridge as the final reclaimed river channel. All channels will be constructed to provide fish habitat. The 'switch' will take approximately four years to accomplish. The new channel will be located between Lake 5 and 6. Lakes will outlet into the creek.

Halpenny Creek Diversion

Plans involving Halpenny Creek have been revised to reduce direct impacts to fish impact. (Figure 6).

Two short sections of the Mynheer Pit will be excluded from development in order to ensure continued flow in the Halpenny Creek basin. Mining which directly impacted HLT1 will no longer be completed and HLT1 will continue to flow into Halpenny Creek (Main). Mining which interrupted HLT2 will no longer be completed and HLT2 will continue to flow into Halpenny Creek (Main). Mining which interrupted Halpenny Creek (Main) in the Mynheer Pit area will no longer be completed. Mining of the Val d'Or Pit will require movement of Halpenny Creek to accommodate mining beneath the creek. This will be accomplished by moving the creek to the east into a constructed channel so that mining can be conducted on the west side of the river. Once mining is completed a land bridge will be backfilled to the west and a new channel constructed on the land bridge as the final reclaimed creek channel. All channels will be constructed to provide fish habitat. The 'switch' will take approximately four years to accomplish. Lake 6 will not outlet into Halpenny Creek as it will flow westward into Bacon Creek.

Lendrum Creek Diversions

Plans involving Lendrum Creek have been revised to reduce direct impact to fish habitat (Figures 7 and 8).

Flow in LET1 will be ditched or pumped to LET3 during mining of the Mynheer Pit. This transfer is expected to be in place for approximately one year. Afterwards, the flow can be accommodated in the pit floor.

Flow in LET3 will be handled with a diversion ditch or pumping during mining of the Mynheer Pit. This transfer is expected to be in place for approximately one year. Afterward a constructed channel will be put in place as part of reclamation to handle LET1 and LET3. Flow in LET3 will be handled with a diversion ditch or channel during mining of the Val d'Or Pit. This transfer is expected to be in place for approximately two years. Further mining to the east can be isolated from LET3. Final flow of LET3 will be through Lake 7. This diversion is expected to be in place for approximately three years.

Upper Lendrum Creek will be handled by ditching during the mining of the Mynheer Pit. This transfer is expected to be in place for approximately three years until the Mynheer Pit is reclaimed. Flow would then be moved into a new channel established in the pit floor and connected to LET3. The ditching is expected to be in place for approximately three years.

Hay Creek Diversion

Mining in the Mynheer Pit will intercept drainage of the upper portion of this creek. Water caught by the mining area will be collected, treated and returned to Hay Creek. This transfer is expected to be in place for approximately four years. Lake 3 will outlet to Hay Creek (Figure 4).

Lund Creek Diversions

LDT1 will be intercepted by mining in both Mynheer and Val d'Or Pits. Land bridges provided in both pits will provide uninterrupted flow during mining. Lakes 8 and 9 will be developed as part of the reclaimed profile (Figures 8 and 9). LDT1 will flow through both Lakes 8 and 9 with a short channel between the two lakes. These relocations are expected to last approximately four years and may be completed concurrently.

LDT3 will be intercepted by mining in both Mynheer and Val d'Or Pits. Flows in both pits will be handled by pumping. Alternatives for ditching flows either to the east or west could also be considered. Lakes 10 and 11 will be developed as part of the reclaimed profile. LDT3 will flow through both Lake 10 and 11 with a short channel between the two lakes. Lake 12 will outlet into Lake 10. This interruption is expected to extend over approximately two years.

Bryan Creek Diversion

Plans involving Bryan Creek have been revised to provide restored channel on the final reclamation landscape rather than a flow-through end pit lake (Figure 3).

Short sections of stream channel to route Bryan Creek out of the proposed Mynheer Pit area will be constructed. These sections would be short, cutting off small meanders of the creek and forcing the creek toward the north. Channels would be constructed to provide fish habitat. Once construction is completed the flow will be directed into the new channels. This diversion would last approximately three years while the Mynheer Pit was completed and reclaimed with a stream channel in the base of the pit. Flow will be routed through the Mynheer Pit channel. This will be the final, reclaimed channel for the creek and would be constructed to provide fish habitat. Lake 2 will outlet into Bryan Creek below the new channel.

PET1 Diversion

Plans involving PET1 have been revised to provide restored channel on the final reclamation landscape rather than a flow-through end pit lake (Figure 9).

The easternmost end of the Val d'Or Pit nearest the Pembina River is being excluded from development. This provides an increased buffer between development and the Pembina floodplain. This revision allows for diversion of PET1 around the eastern end of the proposed Val d'Or Pit. This diversion can be accomplished prior to mining. The channel will be constructed to provide fish habitat.

3.0 SUMMARY OF EXISTING CONDITIONS

Baseline fish and fish habitat conditions within the Project area were described in detail in the Project Application (CVRI 2012). A brief summary of the information gathered during the baseline investigations is provided below.

3.1 FISH POPULATIONS

During baseline field investigations fish presence was confirmed at 53 of the 84 sites sampled (electrofishing and angling sites) in 42 waterbodies in and adjacent to the Project. Overall, 15 fish species were captured and identified (Table 1).

Rainbow Trout were the most common and widespread species within the Local Study Area (LSA) and Regional Study Area (RSA), captured in 38 of the 42 waterbodies sampled. Bull Trout, Burbot, Lake Chub, Longnose Sucker, and Spoonhead Sculpin were encountered much less frequently than Rainbow Trout but were still found at a number of different locations. Other species, including Arctic Grayling, Brook Stickleback, Brook Trout, Longnose Dace, Mountain Whitefish, Northern Pike, Pearl Dace, Trout-perch, and White Sucker were rare and found in one or two waterbodies. Rainbow Trout densities and catch-per-unit-effort (CPUE) for all sport fish captured in streams sampled during baseline investigations are presented in Figures 10 and 11 respectively.

3.2 FISH HABITAT

Habitat inventories were conducted on all streams within the LSA that exhibited habitat potential (i.e. exhibited a defined channel, did not have an excessive gradient (>12%)). Information obtained from the habitat inventories and fish sampling (local field data) was used to provide a conservative ranking of study streams in terms of their overall habitat potential/ability to support various life cycle phases of fish. The rating system was designed to provide a general understanding of habitat potential of subject watercourses based on local field data but should not be considered as a habitat suitability (HSI) ranking system. Photos depicting typical habitat conditions within Low, Moderate, and High habitat potential ranked watercourses are provided in Figure 12.

Preliminary scoping identified a total of 42 potential study streams in or immediately adjacent to the Project. A list of watercourses and general habitat characteristics is provided in Table 2.

A summary of habitat potential/utilization information and a habitat potential/utility ranking for watercourses that exhibited fish habitat potential are provided in Table 3 and Figure 13.

Table 1. Fish species distribution in watercourses in and adjacent to the Robb Trend Project.

Mine Area	Water Body	Reach	Arctic Grayling	Brook Stickleback	Brook Trout	Bull Trout	Burbot	Lake Chub	Longnose Dace	Longnose Sucker	Mountain Whitefish	Northern Pike	Pearl Dace	Rainbow Trout	Spoonhead Sculpin	Trout-perch	White Sucker
Robb West	Bryan Creek (BR-1 to BR-3)													✔✖			
	BRT2													✔✖			
	Embarras River (EM-1 & EM-2)		✔✖		✔✖	✖	✖	✔		✔	✔✖			✔✖	✔✖	✔✖	
	EMT1											✔					
	Jackson Creek				✔									✖			
Robb Main	Hay Creek (HA-1 to HA-4)	1 2 3					✔							✔✖ ✔ ✔			
	Erith River (ER-3, ER-4, & ER-5)	1 2 3	✖ ✖			✔✖	 ✖	✔ ✔	✔	✔ ✔✖	 ✔✖			✔ ✔✖ ✔	✔ ✔✖	✔	✔ ✖
	Erith River (ER-7)					✔								✔			
	ERT1					✔								✔✖	✔		
	ERT2													✔✖	✔		
	ERT3													✔			
	ERT4													✔			
	ERT5									✔✖				✔✖			
	ERT6					✖								✔✖			
	ERT7													✔✖			
	ERT10					✖								✔✖			
	ERT12													✔✖			
	Bacon Creek (BA-2)					✖								✔✖			
Robb Centre	Halpenny Creek (HL-2 & HL-3)	1 2				✖				✖	✖		✔	✔✖ ✔	✖		
	Halpenny Creek (HL-5)													✔			
	Halpenny Creek (HL-6)													✔			
	HLT1													✔✖			
	HLT2			✔													
	HLT5													✔			
	Lendrum Creek (LE-2 & LE-3)						✔							✔			
	LET1						✔							✔✖			
	LET1B													✔			
	LET3													✔			
Robb East	Lund Creek (LD-5 & LD-7)													✔			
	LDT1					✖								✔✖			
	LDT3													✔			
	PET1				✔		✔										

✔Pisces baseline investigations (2005-2013)
✖Historical Reference (FWMIS)

Table 2. Summary of watercourses identified in the Project area.

Mine Area	Watercourse	Code	Scoping Results	Stream Class[1]
Robb West	Bryan Creek	BR	• Defined channel (3.6 m wide), perennial flow	P
	Bryan tributary #1	BRT1	• Poorly defined channel, limited discharge	E
	Bryan tributary #2	BRT2	• Defined channel (1.2 m wide), perennial flow likely	P
	Embarras tributary #1	EMT1	• Poorly defined channel that transitions to quantifiable habitat downstream near mine permit boundaries, limited discharge	I
	Jackson Creek	JA	• Defined channel (0.8 m wide), perennial flow	P
Robb Main	Bacon Creek	BA	• Defined channel (2.0 m wide), perennial flow	P
	Erith River	ER	• Defined channel (6.2 m wide), perennial flow	P
	Erith tributary #1	ERT1	• Defined channel (2.6 m wide), perennial flow likely	P
	Erith tributary #2	ERT2	• Defined channel (1.4 m wide), limited discharge, Class 3 (<0.5 m deep) habitat only	I
	Erith tributary #3	ERT3	• Defined channel (1.0 m wide), limited flows	I
	Erith tributary #4	ERT4	• Defined channel (0.7 m wide), high gradient, natural impediments to fish movement	I
	Erith tributary #5	ERT5	• Defined channel (1.4 m wide), perennial flow likely	P
	Erith tributary #6	ERT6	• Defined channel (1.8 m wide), perennial flow likely	P
	Erith tributary #7	ERT7	• Defined channel (1.7 m wide), perennial flow likely	P
	Erith tributary #8	ERT8	• Defined channel (1.3 m wide), perennial flow likely	P
	Erith tributary #10	ERT10	• Defined channel (2.2 m wide), perennial flow likely	P
	Erith tributary #12	ERT12	• Defined channel (1.3 m wide), perennial flow likely	P
	Hay Creek	HA	• Defined channel (2.5 m wide), perennial flow	P
	Hay tributary #1	HAT1	• Poorly defined channel, limited discharge, Class 3 habitat only, natural impediments to fish movement	I
	Mitchell tributary #1	MIT1	• Small channel to poorly defined channel, limited discharge, high gradient, natural impediments to fish movement	E
	Mitchell tributary #2	MIT2	• Small channel to poorly defined channel, limited discharge, high gradient, natural impediments to fish movement	E
Robb Centre	Halpenny Creek	HL	• Defined channel (4.0 m wide), perennial flow	P
	Halpenny tributary #1	HLT1	• Defined channel (1.8 m wide), perennial flow likely	P
	Halpenny tributary #2	HLT2	• Defined channel (0.9 m wide), limited discharge, natural barrier to fish movement	I
	Halpenny tributary #3	HLT3	• No defined channel	E
	Halpenny tributary #4	HLT4	• Defined channel (1.1 m wide), limited discharge, Class 3 habitat only, natural impediments to fish movement	I
	Halpenny tributary #5	HLT5	• Defined channel (0.8 m wide), limited discharge, Class 3 habitat only	I
	Halpenny tributary #8	HLT8	• Poorly defined to undefined channel	E
	Halpenny tributary #9	HLT9	• Defined channel (1.3 m wide), perennial flow likely	P
	Lendrum Creek	LE	• Defined channel (3.3 m wide), perennial flow	P
	Lendrum tributary #1	LET1	• Defined channel (2.0 m wide), perennial flow likely	P
	Lendrum tributary #2	LET2	• Poorly defined, limited discharge	E
	Lendrum tributary #3	LET3	• Defined channel (3.2 m wide), perennial flow likely	P
Robb East	Lund Creek	LD	• Defined channel (2.5 m wide), perennial flow	P
	Lund tributary #1	LDT1	• Defined channel (2.4 m wide), perennial flow likely	P
	Lund tributary #2	LDT2	• Defined channel (1.0 m wide), limited discharge, Class 3 habitat only	I
	Lund tributary #3	LDT3	• Defined channel (2.1 m wide), perennial flow likely	P
	Lund tributary #4	LDT4	• Defined channel (0.8 m wide), limited discharge, Class 3 habitat only	I
	Lund tributary #5	LDT5	• Defined channel (0.9 m wide), limited discharge, Class 3 habitat only	I
	Lund tributary #6	LDT6	• Poorly defined to undefined channel	E
	Lund tributary#7	LDT7	• Defined channel (1.3 m wide), limited discharge, Class 3 habitat only	I
	Pembina tributary #1	PET1	• Defined channel (2.5 m wide), perennial flow likely	P

[1] Stream Classification:
E = Ephemeral, not fish habitat, no defined channel or discontinuous channel over length of survey reach
I = Intermittent, marginal fish habitat, defined channel over length of survey reach, flow present only seasonally
P = Permanent, fish habitat, flowing most or all of the year

Table 3. Habitat potential/utilization, limiting factors, and overall ranking for watercourses in the Project area.

Waterbody	Habitat Potential/Utilization					Limiting Factors	Overall Rank
	Spawning		Rearing	Overwintering	Feeding		
Robb West							
Bryan Creek Reach 1	High	RNTR	High	Moderate	High	- limited cover, presence of beaver dams, absence of Class 1 (>1m deep) habitat	High
Bryan Creek Reach 2	None		Low	Moderate	Moderate	- limited cover, presence of beaver dams, lack of gravel/cobble, low pool frequency	Low
Bryan Creek Reach 3	High	RNTR	High	Low	Moderate	- limited cover, beaver dams, limited Class 1 habitat, low pool frequency	High
Bryan Creek Reach 4	None		Low	Moderate	Moderate	- beaver dams, lack of gravel/cobble, absence of pool habitat	Low
BRT2	Low	RNTR	Low	None	Low	- limited flows, absence of Class 1 habitat, absence of pool habitat	Low
Embarras River	Moderate	ARGR BKTR MNWH RNTR	Moderate	High	High	- low pool frequency, limited cover	High
EMT1	Low	NRPK	Low	None	Moderate	- absence of Class 1 habitat, low pool frequency, lack of gravel/cobble, low winter dissolved oxygen	Low
Jackson Creek	None		Low	None	Low	- limited flows, absence of Class 1 habitat, low pool frequency	Low
Robb Main							
Hay Creek Reach 1	None		Moderate	None	Low	- absence of Class1 habitat, absence of pool habitat, no winter flow	Low
Hay Creek Reach 2	None		Low	None	Low	- limited Class 1 habitat, low pool frequency, beaver dams, no winter flow	Low
Hay Creek Reach 3	None		None	None	Low	- beaver dams, absence of pool habitat, lack of gravel/cobble, no winter flow	Low
Erith River Reach 1	Moderate	MNWH RNTR	High	Moderate	High	- limited cover, beaver dams, low pool frequency	High
Erith River Reach 2	Low	MNWH RNTR	Moderate	Moderate	High	- limited cover, beaver dams, low pool frequency, limited Class 1 habitat	High
Erith River Reach 3	Moderate	RNTR	High	Moderate	High	- limited cover, beaver dams, absence of pool habitat, limited Class 1 habitat	High
Erith River (ER-7)	Low	RNTR	Moderate	Low	Moderate	- limited Class 1 habitat, low pool frequency	Moderate
ERT1	High	RNTR	High	None	High	- absence of Class 1 habitat, limited flows	High
ERT2	Low	RNTR	Low	None	Low	- limited flows, absence of Class 1 habitat, low pool frequency, lack of gravel	Low
ERT3	None		None	Low	Low	- beaver dams, low winter dissolved O_2, lack of gravel/cobble, limited flows	Low
ERT4	Low	RNTR	Low	None	Low	- absence of Class 1 habitat, steep gradient	Low
ERT5	Low	RNTR	Moderate	None	Moderate	- absence of Class 1 habitat	Low
ERT6	Moderate	BLTR RNTR	Moderate	None	Moderate	- absence of Class 1 habitat	Moderate
ERT7	Moderate	RNTR	Low	None	Low	- limited flows, absence of Class 1 habitat	Low
ERT8	None		Low	None	Low	- limited flows, absence of Class 1 habitat, low pool frequency	Low
ERT10	None		Moderate	None	Moderate	- absence of Class 1 habitat, lack of gravel	Low
ERT12	Low	RNTR	Low	None	Moderate	- limited flows, absence of Class 1 habitat, absence of pool habitat	Low
Bacon Creek	High	RNTR	High	Low	Moderate	- absence of Class 1 habitat, limited pool frequency, limited cover	High
Robb Centre							
Halpenny Creek Reach 1	Moderate	RNTR	Moderate	Moderate	Moderate	- absence of Class 1 habitat, low pool frequency	High
Halpenny Creek Reach 2	None		Low	High	Low	- absence of gravel/cobble, lack of cover, beaver dams	Low
Halpenny Creek Reach 3	High	RNTR	High	Low	High	-absence of Class 1 habitat, low pool frequency, low winter flows	High
HLT1	High	RNTR	Moderate	None	Moderate	- fish passage issues, low pool frequency, absence of Class 1 habitat	Moderate
HLT2	None		Low	Moderate	Low	- limited flows, low pool frequency, lack of gravel/cobble	Low
HLT4	None		Low	None	Low	- limited flows, absence of Class 1 habitat, absence of pool habitat, lack of gravel/cobble	Low
HLT5	None		Low	None	Low	- limited flows, absence of Class 1 habitat, absence of pool habitat, lack of gravel	Low
HLT9	Low	RNTR	Low	None	Low	- limited flows, absence of Class 1 habitat, lack of cover	Low
Lendrum Creek Reach 1	Moderate	RNTR	High	High	Moderate	- low pool frequency, lack of gravel/cobble, limited cover, beaver dams, low winter dissolved O_2	High
Lendrum Creek Reach 2	Low	RNTR	Moderate	Low	Moderate	- absence of Class 1 habitat, low pool frequency, lack of gravel/cobble, limited cover, beaver dams	Moderate
LET1	Moderate	RNTR BURB	Moderate	Low	Moderate	- limited flows, absence of Class 1 habitat, low pool frequency, limited cover, beaver dams	Moderate
LET3	High	RNTR	High	Moderate	Moderate	- low pool frequency, limited cover, lack of gravel/cobble	High
Robb East							
Lund Creek	High	RNTR	Moderate	None	Moderate	- absence of Class 1 habitat, low pool frequency	Moderate
LDT1	Low	RNTR	Low	Low	Moderate	- limited flows, absence of Class 1 habitat, limited cover	Low
LDT1A	None		Low	None	Low	- limited flows, absence of Class 1 habitat, low pool frequency	Low
LDT1C	None		Low	None	Low	- limited flows, absence of Class 1 habitat, low pool frequency	Low
LDT1D	None		None	None	Low	- limited flows, absence of Class 1 habitat, low pool frequency, steep gradient, fish passage issues	Low
LDT2	None		None	None	Low	- limited flows, absence of Class 1 habitat, low pool frequency, lack of gravel	Low
LDT3	Low	RNTR	Low	None	Moderate	- limited flows, absence of Class 1 habitat	Low
LDT3A	None		None	None	Low	- limited flows, absence of Class 1 habitat, lack of gravel, steep gradient, limited cover	Low
LDT4	None		None	None	Low	- limited flows, absence of Class 1 habitat, lack of gravel, limited cover	Low
LDT5	None		None	None	Low	- limited flows, absence of Class 1 habitat, lack of gravel	Low
LDT7	None		None	None	Low	- limited flows, absence of Class 1 habitat, lack of gravel	Low
PET1	High	BKTR	Moderate	Moderate	Moderate	- limited cover, lack of gravel/cobble	High
PET1A	None		None	None	Low	- limited flows, discontinuous channel	Low
PET1B	None		None	None	Low	- limited flows, discontinuous channel	Low

4.0 IMPACTS TO FISH HABITAT

The potential impacts to fisheries resources as a result of the Project are addressed in the Project Application (CVRI 2012). For the assessment presented in this document, the most recent information regarding mine planning, surface water management, and reclamation was reviewed to determine if there are resultant changes to the impact assessment scenario in terms of direct and indirect impacts to fish habitat.

4.1 DIRECT HABITAT IMPACTS

Components of the Project with the potential to result in direct habitat loss/alteration are summarized in Table 4.

Table 4. Summary of project components potentially resulting in direct habitat loss/alteration in waterbodies within the Robb Trend Project area.

Mine Area	Project Phase	Waterbody	Project Component Potentially Impacting Habitat
Robb West	Construction	Bryan Creek	• Watercourse crossing construction
		BRT2	• Watercourse crossing construction
		Jackson Creek	• Watercourse crossing construction
	Operation	Bryan Creek	• Temporary diversion to maintain downstream flows during mining • Development of mine pit
	Reclamation	Bryan Creek	• Reclamation of watercourse crossing • Reclamation of aquatic ecosystem to include end pit lake and stream reconstruction
		BRT2	• Reclamation of watercourse crossings
		Jackson Creek	• Reclamation of watercourse crossing
Robb Main	Construction	Erith River	• Watercourse crossing construction
		ERT4,5,6,8,10	• Watercourse crossing construction
	Operation	Erith River	• Temporary diversion to maintain downstream flows during mining • Development of mine pits
		ERT1,2,3	• Temporary diversion to maintain downstream flows during mining • Development of mine pit
		Bacon Creek	• Temporary diversion to maintain downstream flows during mining • Development of mine pit
		Hay Creek	• Temporary diversion to maintain downstream flows during mining • Development of mine pit
	Reclamation	Erith River	• Reclamation of watercourse crossing • Permanent diversion • Reclamation of aquatic ecosystem to include end pit lake and stream reconstruction
		ERT4,5,6,8,10	• Reclamation of watercourse crossings
		ERT1,2,3	• Reclamation of aquatic ecosystem to include end pit lake and stream reconstruction
		Bacon Creek	• Reclamation of aquatic ecosystem to include stream reconstruction
		Hay Creek	• Reclamation of aquatic ecosystem to include end pit lake and stream reconstruction

Note: Table 4 continues on next page.

Table 4 continued.

Robb Centre	Construction	HLT1,9	• Watercourse crossing construction
	Operation	Halpenny Creek	• Temporary diversion to maintain downstream flows during mining • Development of mine pit
		Lendrum Creek	• Temporary diversion to maintain downstream flows during mining • Development of mine pit
		LET1,3	• Temporary diversion to maintain downstream flows during mining • Development of mine pit
	Reclamation	Halpenny Creek	• Reclamation of aquatic ecosystem to include end pit lake and stream reconstruction
		HLT1,9	• Reclamation of watercourse crossings • Reclamation of aquatic ecosystem to include end pit lake and stream reconstruction
		Lendrum Creek	• Reclamation of aquatic ecosystem to include end pit lake and stream reconstruction
		LET1,3	• Reclamation of aquatic ecosystem to include end pit lake and stream reconstruction
Robb East	Construction	None	• No haulroad watercourse crossing construction in this area
	Operation	Lund Creek	• Temporary diversion to maintain downstream flows during mining • Development of mine pit
		LDT1,3	• Temporary diversion to maintain downstream flows during mining • Development of mine pit
		PET1	• Diversion to maintain downstream flows during mining • Development of mine pit
	Reclamation	Lund Creek	• Reclamation of aquatic ecosystem to include end pit lake and stream reconstruction
		LDT1,3	• Reclamation of aquatic ecosystem to include end pit lake and stream reconstruction
		PET1	• Reclamation of aquatic ecosystem to include stream reconstruction

4.1.1 HAULROAD CROSSINGS

In total there will be 12 haulroad crossings located on watercourses that provide fish habitat (Table 5). All of the watercourse crossings will be designed to provide for fish passage and to maintain habitat connectivity. Clear span arch structures or large culverts that are sized to accommodate fish passage will be constructed on watercourses that are fish bearing. Numerous additional culverts (minimum 0.6 m diameter) will be required in ephemeral draws to maintain natural drainage patterns (Matrix 2012).

Table 5. Description of habitat and analysis of direct habitat impacts for the haulroad crossings.

Watercourse	Culvert Diameter (m)[1]	Fish Habitat Present (overall rank)	Habitat Impact[2]
Bryan Creek	3.0	• Low habitat potential/utilization in this section of Bryan Creek	• Low since culvert will be designed to accommodate fish passage and will likely be sized to exceed bankfull width
BRT2	2.4	• Low habitat potential/utilization	• Low since culvert will be designed to accommodate fish passage and will likely be sized to exceed bankfull width
Jackson Creek	2.0	• Low habitat potential/utilization	• Low since culvert will be designed to accommodate fish passage and will likely be sized to exceed bankfull width
Erith River	3.6	• High habitat potential/utilization	• Low since structure will be designed to accommodate fish passage and will likely be sized to exceed bankfull width
ERT4	2.2	• Low habitat potential/utilization	• Low since culvert will be designed to accommodate fish passage and will likely be sized to exceed bankfull width
ERT5	3.0	• Low habitat potential/utilization	• Low since culvert will be designed to accommodate fish passage and will likely be sized to exceed bankfull width
ERT6	1.4	• Moderate habitat potential/utilization	• Low since culvert will be designed to accommodate fish passage and will likely be sized to exceed bankfull width
ERT8	2.2	• Low habitat potential/utilization	• Low since culvert will be designed to accommodate fish passage and will likely be sized to exceed bankfull width
ERT10	2.6	• Low habitat potential/utilization	• Low since culvert will be designed to accommodate fish passage and will likely be sized to exceed bankfull width
HLT1	3.0	• Moderate habitat potential/utilization	• Low since culvert will be designed to accommodate fish passage and will likely be sized to exceed bankfull width
HLT9	2.2	• Low habitat potential/utilization	• Low since culvert will be designed to accommodate fish passage and will likely be sized to exceed bankfull width
HLT9A	2.2	• Low habitat potential/utilization	• Low since culvert will be designed to accommodate fish passage and will likely be sized to exceed bankfull width

[1] Subject to change based on final design
[2] A detailed assessment of the direct impacts to habitat will be completed once final design plans have been determined

4.1.2 Watercourse Diversions and Pit Development

As previously described there will be a total of 13 main watercourse diversions required for the Project. A comparison of habitat impacts resulting from watercourse diversions for the original Project Application and the proposed updated mine plan is provided in Table 6.

Table 6. Planned diversions and the associated potential habitat impacts in the Robb Trend Project area.

Mine Area	Watercourse	Diversion #/ Pit Development	Fish Habitat Impacted				
			Application		Revision		
			Length (m)	Area (m²)	Length (m)	Area (m²)	Habitat Present (overall rank)
Robb West	Bryan Creek	13 Pit Dev.	4,244 TBD	14,208 TBD	4,244 1,382	14,208 1,480	• High habitat potential/utilization in Reach's 1 and 3 and low habitat potential/utilization in Reach 2 • Low habitat potential/utilization in upper Bryan Creek
Robb Main	Erith River	1	10,500	67,485	10,500	67,485	• High habitat potential/utilization • Most of Reach 1, all of Reach 2 and the lower part of Reach 3 will be impacted
	ERT1 ERT1A	2 Pit Dev.	2,315 157	5,834 102	400 0	1,000 0	• High habitat potential/utilization in ERT1 • Low habitat potential/utilization in ERT1A, no disturbances planned
	ERT2	Pit Dev.	264	406	264	406	• Low habitat potential/utilization
	ERT3	Pit Dev.	507	7,751	507	7,751	• Low habitat potential/utilization, habitat considered sub-marginal further upstream
	Bacon Creek	3	1,424	2,777 TBD	1,424	2,777	• High habitat potential/utilization • Originally was being diverted into Lake 4/5 but now flows will be maintained
	Hay Creek	10	1,368	1,804 TBD	1,368	2,325	• Low habitat potential/utilization
Robb Centre	Halpenny Creek	5	1,563	7,601	295	4,129	• Low habitat potential/utilization in Reach 2 • Mynheer Pit diversion no longer occurring
	HLT1	4	1,237	2,239	0	0	• Moderate habitat potential/utilization • No diversion planned
	HLT2	6	246	219	0	0	• Low habitat potential/utilization • No diversion planned
	Lendrum Creek	9/Pit Dev.	4,335	17,468	4,335	17,468	• Moderate habitat potential/utilization in Reach 2
	LET1	7	1,534	1,923	1,534	3,282	• Moderate habitat potential/utilization
	LET3	8	1,167	22,161	1,167	7,959	• High habitat potential/utilization
Robb East	Lund Creek	14 Pit Dev.	2,762	11,026	2,762	7,319	• Moderate habitat potential/utilization
	LDT1 LDT1A	11 Pit Dev.	909 785	2,991 1,091	909 785	2,991 1,091	• Low habitat potential/utilization
	LDT2	Pit Dev.	TBD	TBD	200	209	• Low habitat potential/utilization
	LDT3	12	1,194	2,507	1,194	3,831	• Low habitat potential/utilization
	LDT4	Pit Dev.	TBD	TBD	686	542	• Low habitat potential/utilization
	LDT5	Pit Dev.	198	154	198	154	• Low habitat potential/utilization, habitat considered sub-marginal further upstream
	PET1	15	1,587	5,236	200	660	• High habitat potential/utilization in PET1
Total			38,296	174,983	34,354	147,067	

4.2 CHANGES IN FLOW REGIME

The Project Application included a description of Project components that have potential to affect surface flows and provided discussion of the potential for these surface flow impacts to affect fish habitat availability. Table 7 provides an updated description of the anticipated changes in flow regime and the corresponding impacts to fish habitat.

Table 7. Summary of surface flow impacts and corresponding effects on fish habitat in major watercourses.

Mine Area	Watercourse	Potential Change to Flow Regime		Potential Impacts to Fish Habitat
		Application	Revision [1]	
Robb West	Bryan Creek	• Moderation of peak flows • Increase in low flows • Mean annual runoff may temporarily increase by as much as 20% during pit, groundwater dewatering	• Revised mine plan will allow for natural flow regime through the Project area	• Negligible, no significant impact to fish habitat expected • Impacted habitat has high and low potential/utilization ranking
Robb Main	Bacon Creek	• Approximately 70% of lower basin lost due to diversion • 2.4 km long channel remaining with ~30% of flow	• Revised mine plan will allow for natural flow regime through the Project area	• Negligible, no significant impact to fish habitat expected • Impacted habitat has high potential/utilization ranking
	Embarras River	• Small footprint upstream of Robb, impacts during mining expected to be negligible • Maximum estimated impacts downstream of Robb equate to: 3% decrease in high flows, 10% increase in low flows, and negligible change in mean annual flows	• No change to original impact scenario expected	• Negligible, no significant impact to fish habitat expected • Impacted habitat has high potential/utilization ranking
	Erith River	• Flow regulation due to settling ponds • 10% reduction in peak flows • Maintenance or slight increase in low flows • Overall modest change in annual runoff	• Revised mine plan will allow for natural flow regime through the Project area	• Negligible, no significant impact to fish habitat expected • Impacted habitat has high potential/utilization ranking
	Hay Creek	• Up to 50% reduction in peak flows • Up to 200% increase in low flows • Mean annual runoff may temporarily increase by as much as 25% during pit, groundwater dewatering	• Temporary reduction in flows during end pit lake filling • No change to original impact scenario expected once the end pit lake has been filled	• Reduced habitat availability for 2.25 kms downstream of pit during end pit lake filling (4,038 m^2) • Impacted habitat has low potential/utilization ranking
Robb Centre	Halpenny Creek	• Approximately 20% of flows altered depending on various diversions. • Impacts expected to be short term (temporary diversions) • Flow regulation due to settling ponds • Increased total annual runoff due to road runoff	• Revised mine plan will allow for natural flow regime through the Project area	• Negligible, no significant impact to fish habitat expected • Impacted habitat has high potential/utilization ranking
	Lendrum Creek	• Moderation of peak flows • Increase in low flows • Mean annual runoff may temporarily increase by as much as 20% during pit, groundwater dewatering	• No change to original impact scenario expected	• Negligible, no significant impact to fish habitat expected • Impacted habitat has moderate potential/utilization ranking
Robb East	Lund Creek	• Moderation of peak flows • Increase in low flows • Mean annual runoff may temporarily increase by as much as 25% during pit, groundwater dewatering • Reduced flows and habitat availability downstream of pit (potential loss of upper portion of creek if flows are diverted through lakes permanently)	• No change to original impact scenario expected	• Reduced habitat availability for 2.66 kms (8,714 m^2) due to flows being diverted through lakes • Impacted habitat has moderate potential/utilization ranking
	PET1	• Small portion of watershed may be re-directed into Lund Creek	• Revised mine plan will allow for natural flow regime through the Project area	• Negligible, no significant impact to fish habitat expected • Impacted habitat has high potential/utilization ranking
	Pembina River	• Minor influence, <2% decrease in flows in Pembina River due to permanent diversion of PET1	• With revised mine plan there is no expectation for measurable changes in flows in the Pembina River	• Negligible, no significant impact to fish habitat expected

[1] Conclusions subject to review by Matrix as mine plans progress

4.3 Summary of Habitat Impacts

With the updated mine plan, the Project is expected to impact almost 160,000 square metres of fish habitat (Table 8). This represents a decrease from the overall instream footprint presented in the Project Application, largely due to substantial reductions (31 %) in impacts to habitat with high potential/utilization (Table 8).

Table 8. Summary of fish habitat impacts in the Robb Trend Project area.

	Application (2012)	Revision (2013)
Impacts to habitat with low potential/utilization (m^2)	33,643	33,655
Impacts to habitat with moderate potential/utilization (m^2)	42,656	36,783
Impacts to habitat with high potential/utilization (m^2)	128,684	89,381
Total Habitat Impacts (m^2)	**204,983**	**159,819**

5.0 MITIGATION FOR HABITAT IMPACTS

Mitigation measures that will be implemented during the life of the Project were described in the Project Application (2012) and remain applicable. Some additional discussion regarding mitigation of potential impacts to fish habitat is provided below.

5.1 Mine Planning

As planning progresses, CVRI will continue to review options and scenarios to further minimize impacts to fisheries resources.

5.2 Surface Water Management & Erosion Control

Water management is a priority consideration throughout mine planning and development. Minimizing surface disturbance and completing timely reclamation are essential considerations that can affect water management. CVRI will implement a surface water management plan throughout the life of the Project to eliminate or minimize the potential adverse effects on the aquatic ecosystem associated with changes in water quality. The plan will include and/or incorporate the following:

- Mine planning to minimize the need for drainage diversions and runoff interception and to maximize vegetation buffers near waterbodies;
- Education/training of personnel to minimize disturbances while maintaining drainage and sediment controls;
- Design and construction details for settling ponds or retention and clean-out areas that will collect surface runoff and allow for settling treatment prior to release into receiving waterbodies;
- Design and construction details for watercourse diversions to ensure minimize changes of sediment loading to receiving waterbodies;

- General measures that will be implemented to contain road runoff including berms and haulroad sump/retention areas such that run-off will be intercepted and treated prior to release into the aquatic ecosystem; and
- Monitoring and maintenance of surface water management facilities.

It is assumed that the surface water management plan will provide effective mitigation of impacts to aquatic resources related to potential sediment introduction due to Project activities. TSS concentrations in the waterbodies in the LSA are not predicted to increase to be above baseline or guideline levels (Hatfield 2012). In addition, Matrix (2012) predicts that the Project will have insignificant effect on sediment loads compared to natural conditions. As such, potential increases in TSS are not expected to adversely affect aquatic resources.

Potential adverse effects associated with activities that are outside of normal operations are addressed by CVM's emergency response plan. The emergency response plan includes methods for spill containment in streams and site clean-up. Such incidents are considered highly unlikely to occur and designated emergency response personnel are on-site 24-hours/day in connection with current CVM activities. Emergency response procedures will be expanded to the Project. In order to mitigate the long term potential for sedimentation due to surface runoff it is assumed that exposed ground and riparian areas will be revegetated during reclamation.

5.3 WATERCOURSE CROSSING CONSTRUCTION

All defined watercourse crossings will be designed, and constructed to meet the regulatory requirements for approval under the provincial *Water Act* and federal *Fisheries Act*. It is the goal of CVM to adhere to the "No Net Loss Guiding Principle" (NNL principle) and minimize the instream footprint of all haulroad crossings to ensure that the productive capacity of streams is maintained. Depending on construction plans (to be developed at a later date), habitat compensation measures will be identified and implemented at specific sites as needed, in consultation with DFO, ESRD, and stakeholders, in order to ensure NNL of habitat productivity.

Watercourse crossing structures will consist of clear span arch structures or culverts that are sized to accommodate fish passage. Smaller culverts will be used to convey water in ephemeral non-fish bearing streams (Matrix 2012).

Standard practices that are proven to be effective measures to mitigate potential adverse effects during instream construction, associated with watercourse crossings, will be implemented and include the following:

- Consideration of sensitive periods during construction planning by either planning construction to avoid these periods or implementation of additional site specific mitigation;
- Design structures located on fish-bearing waters to provide fish passage;
- Isolation of instream work site if flowing water is present at time of construction;
- Completion of a fish rescue and release from isolated areas;

- Implementation of sediment and erosion controls prior to work and maintenance during the work phase until the site has been stabilized;
- Implementation of measures to minimize introduction of deleterious substances during construction including cleaning, servicing, and fuelling of equipment well away from water bodies;
- Revegetation of disturbed areas around crossing sites;
- Upon reclamation of crossings, streambed and stream banks will be reclaimed to similar pre-disturbance conditions; and
- Implementation of TSS/turbidity monitoring during instream work if deemed necessary due to site conditions or timing of works.

5.4 STREAM DIVERSION PLANS

Construction plans for planned diversions will be refined as Project plans are developed and will include detailed plans to mitigate adverse effects to aquatic resources. General mitigation measures that will be employed during the construction and operation of diversion channels will include:

- Maintenance of downstream flow and monitoring to ensure instream flow needs are met;
- Appropriate sizing of diversion channels and/or pump systems based on the design life of the diversion and considering ramifications of greater than design runoff;
- Armouring and/or lining of channels or use of flumes where appropriate;
- Installation of silt fences and/or other erosion control measures on areas adjacent to open channel diversions;
- Placement and stockpiling of excavated materials in a location that is well away from the channel route;
- Gradual diversion of flow into constructed channels to minimize potential erosion and mobilization of sediment;
- Fish rescue and release (fish salvage) of sections or channel that will be abandoned due to diversion;
- Implementation of TSS/turbidity monitoring during instream work if deemed necessary due to site conditions or timing of works;
- Consideration of sensitive periods during construction planning by either planning construction to avoid these periods or implementation of site specific mitigation; and
- Construction of open channel diversions that allow for the movements of fish. If diversions are deemed to be impassable and are impeding important spawning migration then a fish relocation programs will be implemented whereby fish will be trapped and relocated to appropriate habitat upstream of the impediment.

6.0 HABITAT COMPENSATION FRAMEWORK

Final reclamation will consist of reconstructed channels and end pit lakes (Figures 3 to 9).

6.1 PRIMARY HABITAT COMPENSATION CONCEPTS

CVRI is committed to developing and implementing habitat compensation to ensure 'no net loss' (NNL) to the productive capacity of fish and fish habitat. Key habitat compensation strategies include construction of enhanced stream channel habitat and creation of several end pit lakes. Overall, the updated closure landscape is expected to result in a 5,504,934 m^2 increase in available habitat (Table 13).

6.1.1 RECONSTRUCTED STREAM CHANNEL HABITAT

Key to the compensation strategy proposed by CVRI is the reconstruction of disturbed stream reaches to provide viable fish habitat. The updated mine plan was developed to maximize the amount of lotic habitat that will be reconstructed. Almost 100 % of habitat considered to have high potential/utilization will be reclaimed to channel (Table 9). In total, 77 % of all lotic habitat will be reclaimed to channel under the new plan (Table 9).

Table 9. Fish habitat reclaimed to channel.

	Application (2012)	**Revision (2013)**
Low habitat potential/utilization reclaimed to channel (m^2)	1,553 (7 % of total impacts to low potential/utilization streams)	13,163 (39 % of total impacts to low potential/utilization streams)
Moderate habitat potential/utilization reclaimed to channel (m^2)	982 (2 % of total impacts to moderate potential/utilization streams)	21,573 (59 % of total impacts to moderate potential/utilization streams)
High habitat potential/utilization reclaimed to channel (m^2)	12,021 (9 % of total impacts to high potential/utilization streams)	88,017 (98 % of total impacts to high potential/utilization streams)
Total Habitat Reclaimed to Channel (m^2)	**14,556 (7 % of total impacts)**	**122,753 (77 % of total impacts)**

Sections of disturbed stream habitat will be reconstructed with habitat enhancement added in order to compensate for habitat losses associated with creek diversions. Stream reconstruction will include:

- Reclamation of diversion channels to have a similar grade and channel dimensions as the pre-disturbance channel.
- Reclamation of diversion channels will be lined in this order: clay, sand/gravel, and cobble.
- Design and construction of diversion channels so that physical habitat characteristics in the new channel are similar to the pre-disturbance channel in terms of size, habitat composition, substrate and cover.
- Reclamation of riparian areas to be similar to pre-disturbance condition and revegetation of the areas with rapid establishing species and native species.

- Additional habitat enhancement (i.e. pools) on diversion channels to meet the NNL principle.

In order to meet the 'no net loss' of productivity requirement, CVRI proposes to evaluate productivity losses due to stream channel diversions versus productivity gains due to habitat restorations based on a Habitat Evaluation Procedures (HEP) type approach (USFWS 1980). This system estimates habitat productivity based on a combination of habitat area and habitat suitability.

In the HEP-type analysis, Habitat Units (HUs) are calculated by multiplying habitat quantity with habitat quality. Habitat quantity is represented by surface area measured in m^2 and habitat quality is an estimate of the suitability of the habitats for use by fish as defined by Habitat Suitability Index (HSI) models. HUs are dimensionless numbers representing the overall value of the habitat for fish species that are present and these HU values are used as a representation of habitat productivity. Comparison of the HUs altered as a result of stream diversions with the HUs gained through stream channel restoration will allow an assessment of the degree to which the compensation measures employed can achieve the principle of no net loss of fish habitat. The quantity of habitat lost due to stream channel diversions is known, and is presented above. Habitat quality will be estimated using the HSI value to rank the importance of available habitat for specific species and life stages of fish. HSI models are species-specific models that evaluate the suitability of the habitat in question based on specific habitat conditions, represented by model variables, that are each considered crucial to the development of a self-sustaining population. Under HEP-type analysis procedures, an HSI value ranging between 0 and 1 is determined for each waterbody or watercourse segment for each species present. This is sometimes further assessed by each life stage, for example, embryo, fry, juvenile and adult.

At this time, CVRI intends to focus quality rating on the habitat requirements of Rainbow Trout since they are the most ubiquitous fish within the Project area. However, there will be opportunity to assess habitat requirements for other species (i.e. Arctic Grayling or Bull Trout) if necessary depending on local reclamation strategies of CVRI and ESRD fisheries management objectives for the area.

6.1.2 End Pit Lakes

CVRI also proposed to construct end pit lakes to off-set habitat losses associated with the Project. There were 12 proposed end pit lakes in the Project Application; 11 end pit lakes will be constructed as part of the reclamation landscape for the revised Project (Lake 4 will no longer exist). Six of the lakes will be "flow-through" lakes (7, 8, 9, 10, 11, and 12) that are constructed on streams and will have an inlet and an outlet. Five of the lakes will be constructed "off-channel" (1, 2, 3, 5, and 6) and will have no inlet but will have an outlet to adjacent streams.

Robb West End Pit Lakes

Two end pit lakes are planned for Robb West. Figure 3 shows the location of the lakes and the drainage patterns post reclamation. Current reclamation plans indicate that Lake 1 will be connected with Lake 2 via a 700 metre constructed channel. Lake 2 will ultimately outlets into Bryan Creek.

Robb Main End Pit Lakes

Two end pit lakes will be constructed in Robb Main. Figures 4 and 5 show the location of the lakes and drainage patterns post reclamation. Current reclamation plans indicate that Lake 3 will be situated in the upper portion of the Hay Creek drainage and will flow into Hay Creek, and eventually the Embarras River. Lake 5 (West, Middle, and East) will be connected by short constructed channels and subsequently will outlet to the Erith River.

Robb Centre End Pit Lakes

Two end pit lakes are planned to be developed in Robb Centre. Figures 6 and 7 show the location of the lakes and general drainage patterns post reclamation. Current reclamation plans indicate that Halpenny Creek will flow around Lake 6. Lake 6 will outflow to Bacon Creek and Lake 7 will accept flows from LET3 and will outlet to Lendrum Creek.

Robb East End Pit Lakes

Five end pit lakes are planned to be developed in Robb East. Figures 8 and 9 show the location of the lakes and general drainage patterns post reclamation. Current reclamation plans indicate that two lakes (Lakes 8 and 9) will be situated on LDT1. The lakes will be connected by a 100 metre constructed channel. A similar configuration will exist on LDT3, with water flowing through two lakes (Lakes 10 and 11) before returning to the natural channel. The lakes will be connected by a 600 metre constructed channel. Lastly, Lake 12 will collect water from upper Lund Creek and will outlet to a 1,500 metre constructed channel that ultimately flows into Lake 10.

End Pit Lake Final Design

The flow-through lakes will be designed to maximize habitat and biological diversity and use by native fish populations. Final design will incorporate guiding principles that are described in the draft guidelines for end pit lake development at coal mine operations (EPLWG 2004) and/or procedures provided in similar guideline documents that may be available in the future. Some of the lakes may be constructed to preclude fish access but conceptually, the lakes will be designed to maximize habitat and biological diversity and use by native fish populations.

The off-channel lakes may be designed to be fishless, stocked fisheries, or possibly self-reproducing populations (depending on local conditions). The lakes may be designed to allow or preclude natural recruitment to the lake. Final design will incorporate the primary objective for the lake and will consider the guiding principles that are described in the draft guidelines for end pit lake development at coal mine operations (EPLWG 2004) and/or procedures provided in similar guideline documents that may be available in the future.

Key design features that will be considered in the planning and creation of the end pit lakes are presented in Table 10.

Table 10. Key design parameters for a self-sustaining native salmonid end pit lake.

Design Factor	Parameter Ranges and Probability of Success (from EPLWG 2003)		
	High	Medium	Low
Sustainability (water balance)	Mean annual inflow > mean annual losses	Mean annual inflows = mean annual losses	Mean annual inflows< mean annual losses
Lake dynamics/function	Very stable water level (<1m annual variation)	Stable water level (1-2m annual variation)	Unstable water level (>2m annual variation)
Filling method/schedule	1-5yrs	5-10yrs	>10yrs
Lake geometry	<25m max depth	25-75m max depth	>75m max depth
Shoreline stability	>90% stable	60-90% stable	<60% stable
Stratification/mixing	<10m mean depth <20m max depth	10-15m mean depth 20-23m max depth	>15 m mean depth >23 m max depth
Water Quality	Close to median water quality values of natural water bodies in the region	Within the range of values for natural water bodies in the region	At the extreme, or outside of the range of natural water bodies in the region
Potential toxic substances	Meets water quality guidelines	Slightly exceeds guidelines	Significantly exceeds guidelines
Littoral zone	20-40%, <3m max littoral depth	10-20%	<10%, >40%, 3-6m max littoral depth
Substrate in littoral zone (high importance in truck/shovel lakes)	High density of boulders and fines in littoral zone		Low density of boulders and fines in littoral zone
Connectivity of lake to stream	Stable surface inlet and outlet	Ephemeral outlet only	No inlet/outlet
Riparian	High diversity of well-established plants	Medium diversity of well-established plants	Poor establishment of vegetation

6.2 RATIONALE

CVRI has successfully constructed stream channels and end pit lakes in the past and is therefore confident that they will be able to construct/implement the proposed compensation concepts to ensure that the productive capacity of fish habitat is maintained.

6.2.1 RECONSTRUCTED STREAM CHANNEL HABITAT

Over the last two decades, CVRI has reconstructed and/or enhanced a number of stream channels in the CVM area. A summary of these projects including photo documentation of current conditions and a discussion of monitoring results (and associated response plans) are provided in Appendix A.

6.2.2 END PIT LAKES

End pit lakes can exhibit various attributes and their potential to serve as fish habitat is often linked to the attributes and characteristics that they possess. The morphometric, geologic, hydrogeologic, geochemical and biological attributes of these lakes, directly influences the potential uses of these water bodies (Gammons et al. 2009). CVRI has accumulated considerable information regarding existing end pit lakes in the region. The following is a brief synopsis of how this existing information supports the idea that end pit lakes can provide good quality native fish species in the region.

Water quality is often the limiting factor in determining whether or not a pit lake has the potential to become fisheries habitat (Gammons et al. 2009). The local geology and the product being mined can have a profound effect on the water quality found in an end pit lake. Acidification and the introduction of heavy metals into ground and surface waters are often difficult to mitigate and can negatively impact biological environments due to contamination of ground and surface waters (Lemly 2007, Rudolf et al. 2008, Stekoll and Smoker 2009).

Silkstone, Lovett and Pit 24 (Stirling) Lakes are the oldest fish bearing end pit lakes located on the CVM lease; having been developed in the late 1980's and early 1990's. Water chemistry concerns with these end pit lakes have generally been negligible and the water quality in these pit lakes is very similar to Fairfax Lake, a naturally occurring lake in the area (Hatfield 2011). The CVM Lease is located in an area where acidification of ground and surface waters is rare due to the calcareous nature of the parent material. The thermal coal mined at the CVM Lease is also significantly different than the metallurgical coal found at the nearby Cheviot and Cardinal River Mine Leases and previously on the Gregg River Mine lease. Selenium enrichment of ground and surface waters is generally of lesser concern on the CVM lease.

One of the challenges with reclamation on the CVM is that there is often an insufficient amount of overburden material available to refill the end-pits. Left as is, these end-pits would naturally fill with surface and ground waters to form a body of water. Without prescribed reclamation procedures and guidelines, these lakes would have lesser ecological value. Guidelines for the development of end pit lakes are provided by Alberta Environment (EPLWG 2002) and include various design factors including hydrological, physical, chemical and biological design factors. Additional recommendations for developing end pit lakes in this area have also been identified in various pit lake studies (Hatfield 2011, Sonnenberg 2011). In addition, CVM is currently conducting research on existing end pit lakes on the mine to increase their understanding of these systems and to identify key design factors to maximize habitat productivity for target species.

End pit lakes have provided habitat and angling opportunities for Rainbow Trout (*Oncorhynchus mykiss*), Bull Trout (*Salvelinus confluentus*) and Brook Trout (*Salvelinus fontinalis*) on or near the CVM lease. Lakes such as Silkstone, Lovett, Pit 24 (Stirling), Pit 35, Pit 44 and Pit 45 are regularly stocked with Rainbow Trout and provide recreational angling opportunities (ESRD 2013). In addition to these "put and take" fisheries, fish have moved into end pit lakes on the CVM through channels that connect the lakes to natural drainages (Pisces 2013). Fisheries and Oceans Canada (Authorization No. ED 03-3080) have approved reclamation plans on the CVM which include a series of pit lakes on the Upper Embarras River for the purpose of establishing a self-sustaining population of Athabasca Rainbow Trout. Preliminary results indicate that the barrier downstream of the lake system is working to preclude fish species downstream from moving upstream. Rainbow trout in the Embarras Lake system have also successfully spawned in the connecting channels (Pisces 2013).

Populations of Athabasca Rainbow Trout and Bull Trout have been documented in several end-pit lakes in the area including Lac des Roches, Sphinx Lake and Pit-lake CD (Schwartz 2002, Pisces 2008, Pisces 2009, Sonnenberg 2011). Spawning at the outlets and in the streams downstream of Sphinx Lake and Pit-lake CD is well documented and the Rainbow Trout populations are self-sustaining. Productivity downstream of Sphinx Lake and Pit-lake CD has increased from pre-mining conditions, likely due to the buffering and warming effect of the lake (Sonnenberg 2011).

In addition to Athabasca Rainbow Trout, Bull Trout, and Brook Trout, end pit lakes may have the potential to bolster the dwindling Arctic Grayling (*Thymallus arcticus*) population in the CVM area. Arctic Grayling are native to portions of the McLeod watershed (SRD 2005). Arctic Grayling populations are found in several lakes in Alberta and natural recruitment has been documented in several of these water bodies (SRD 2005). End-pit lakes with outlet channels may provide suitable habitat for Arctic Grayling if reclamation plans include barriers that preclude the movement of other fish species from downstream. The planned and calculated development of end pit lakes is an important part of reclamation practices on the CVM.

6.3 Quantification of Predicted Effects and Habitat Gains

Table 12 provides a summary of predicted impacts for each watercourse and identifies the type of habitat (lotic or lentic) that will be available after final reclamation.

Table 12. Summary of predicted impacts to fish habitat by watercourse.

Mine Area	Watercourse	Impacted Habitat Area (m^2)	Reclaimed Habitat	
			Reconstructed Channel (m^2)	Lake
Robb West	Bryan Creek	15,688	15,688	
Robb Main	Bacon Creek	2,777	2,777	
	Erith River	67,485	67,485	
	ERT1	1,000	1,000	
	ERT2	406	406	
	ERT3	7,751		Lake 5
	Hay Creek	6,363		Lake 3
Robb Centre	Halpenny Creek	4,129	4,129	
	Lendrum Creek	17,468	17,468	
	LET1	3,282	1,600	Lake 7
	LET3	7,959	6,595	Lake 7
Robb East	Lund Creek	16,033	2,505	Lake 12
	LDT1	2,991	640	Lake 8 & 9
	LDT1A	1,091		Lake 8 & 9
	LDT2	209		Lake 10
	LDT3	3,831	1,800	Lake 10 & 11
	LDT4	542		Lake 10
	LDT5	154		Lake 12
	PET1	660	660	
Total		**159,819**	**122,753**	***5,542,000 m^2** (total lake habitat available upon final reclamation)

* Lake dimensions presented are consistent with Project Application but are likely subject to change as mine plans progress

Table 13 compares the predicted effects and habitat gains from the original application to the updated mine plan. In total, the predicted amount of fish habitat impacted is estimated at 159,819 m^2, which is a 22 % decrease from the original application. Final reclamation of aquatic resources will consist of reconstructed channel and 11 end pit lakes, for a total habitat gain of 5,504,934 m^2. With the updated mine plan, the amount of reconstructed channel will increase from 14,556 m^2 in the original application to 122,753 m^2 (approximately 77 % of impacted habitat will be reclaimed to channel).

Table 13. Summary of predicted effects and habitat gains in the Project area.

	Habitat Loss (m^2)		Habitat Gain (m^2)		
	Application (2012)	**Revision (2013)**	**Type of Reclamation**	**Application (2012)**	**Revision (2013)**
Natural Channel	204,983	159,819	Reconstructed Channel	14,556	122,753
			*End Pit Lake	*6,253,000	*5,542,000
Total Habitat Loss	**204,983**	**159,819**	**Total Habitat Gain**	**6,267,556**	**5,664,753**
Net Change (m^2)				**+6,062,573**	**+5,504,934**

* Lake dimensions presented are consistent with Project Application but are likely subject to minor change as mine plans progress

6.4 Additional Compensation Options

As a precautionary measure CVRI has identified several other habitat compensation initiatives that could be initiated if it is determined that the primary habitat compensation concepts are not sufficient to ensure no net loss of the productive capacity of fish habitat. These include:

- Habitat Defragmentation – CVRI has partnered with the Foothills Research Institute to complete a watercourse crossing inventory in the vicinity of the CVM to document fish presence and identify potential problem sites where fish passage or sediment deposition are issues. The compensation initiative would involve the repair and/or remediation of identified problem sites.
- Habitat Enhancement in RSA – CVRI is currently investigating other instream enhancement opportunities in the Erith River outside of the Project area. The compensation initiative would involve the completion of instream enhancement work to improve habitat suitability or address potential limiting factors.
- Rainbow Trout Research Initiative – CVRI is aware that an Athabasca Rainbow Trout Recovery Plan is likely to be released in the near future. The compensation initiative would involve participation or coordination of specific projects to address identified knowledge gaps, or contribute to research, or recovery techniques identified in the Recovery Plan.

7.0 MONITORING

7.1 CONSTRUCTION PHASE

All instream construction sites will be monitored to ensure best management practices are implemented and for compliance with the conditions and requirements of any and all regulatory permits applicable to construction. The most significant aspect of instream construction monitoring will be implementation of a sediment monitoring program. Sediment monitoring protocols will be designed site-specifically, but will be based on industry standards.

7.2 OPERATION PHASE

7.2.1 SURFACE WATER MONITORING

Surface water monitoring plans were originally discussed in the Project Application, (CVRI, 2012). Monitoring will be similar to existing CVM mine areas.

Surface water quality monitoring for the Project will include:

- A water quality monitoring program designed to meet the requirements of the Project approval will be implemented for the life of the Project (Hatfield 2012; CR#11);
- Flows and TSS will be monitored at all settling ponds (Matrix 2012; CR#6);
- Regular inspections of all drainage works will be conducted (Matrix 2012; CR#6); and
- Long term monitoring of flow in each main creek will be conducted to document critical low flow conditions during pit filling periods and to define the need for any bypass pumping to maintain in-stream flows (Matrix 2012; CR#6).

7.2.2 BIOLOGICAL MONITORING

The existing CVM aquatics monitoring program will be expanded to include additional benthic macroinvertebrate sample sites. Results of the monitoring will be used to assess the effectiveness of the surface water management plan and modifications will be made, if necessary.

Fish population monitoring programs to assess fish distribution, relative abundance and population structure will be developed as the Project progresses

7.3 FOLLOW-UP MONITORING

CVRI recognizes that periodic monitoring will be required to evaluate fisheries habitat components and populations in re-established aquatic environments (reconstructed channels). Monitoring protocols will be developed in conjunction with the details of the currently proposed compensation strategies. The general monitoring approach will be to monitor habitat created or enhanced by evaluation of the physical and biological characteristics of the habitats as well as fish utilization of the habitats. Habitat improvements would be implemented, as part of an adaptive management approach, if new or enhanced habitat were not providing the required habitat components for the target fish species (i.e. Rainbow Trout).

A detailed end pit lake monitoring program will be developed two to five years prior to construction of each lake allowing for CVRI to take advantage of information regarding end pit lake development that may become available in the future and to design the lake to meet future end-use objectives and regional management strategies. In general CVRI anticipates implementing a monitoring program that will include but is not necessarily limited to the following:

- Post-construction monitoring to assess physical stability of end pit lakes and connecting channels.
- Assessment of fish community and habitat within the end pit lakes and associated channel systems.
- Assessment of various biological and chemical parameters in end pit lakes including:
  - Fish, benthic invertebrates, zooplankton, phytoplankton, macrophytes.
  - Measurement of temperature, dissolved oxygen, conductivity profiles, as well as select water quality variables.

Monitoring results will be used, if necessary, to adjust mitigation and habitat compensation measures and make design improvements as required. Habitat monitoring will be key to confirming the no net loss objective can be achieved. Should, for some reason, the proposed habitat compensation not be sufficient to achieve no net loss of the productive capacity of fish habitat, additional habitat compensation would then be developed in consultation with the appropriate regulators.

8.0 SUMMARY

This document is intended to provide an updated outline of the impacts to fish habitat and proposed strategies to mitigate and compensate for the impacts that may occur as a result of the Project. Detailed habitat compensation plans will be developed for specific phases as the project progresses. Given that this project will be developed over the next 25 years there will be opportunity to adjust and adapt mitigation and compensation strategies to ensure that the project will not result in the loss of productive capacity of fish and fish habitat.

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Figures

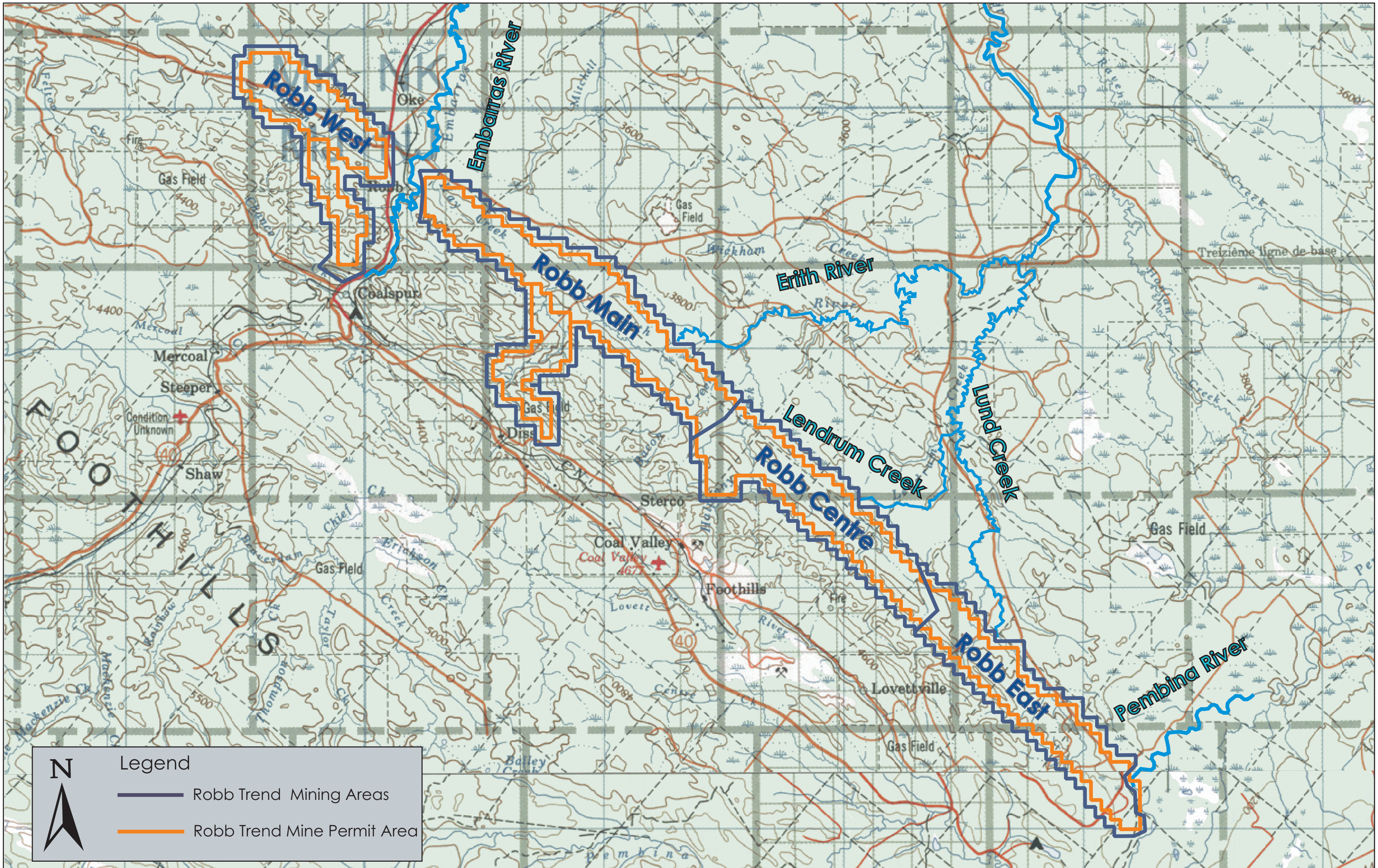


Figure 1. Robb Trend Project Area (adapted from Project Application)	Drawn by: JM	Checked by: ES
	August 2013	
Pisces Environmental Consulting Services Ltd.	CVRI Coal Valley Mine	
	Scale 1:250,000	

ORIGINAL SCENARIO

Watercourse	Watercourse Code	Diversion #	Fish Habitat Impacted (m²)
Erith River	ER	1	67,485
Erith River Trib #1	ERT1	2	5,834
Bacon Creek	BA	3	2,777
Halpenny Creek Trib#1	HLT1	4	2,239
Halpenny Creek	HL	5	7,601
Halpenny Creek Trib#2	HLT2	6	219
Lendrum Creek Trib#1	LET1	7	1,923
Lendrum Creek Trib#3	LET3	8	22,161
Lendrum Creek	LE	9	17,468
Hay Creek	HA	10	1,804
Lund Creek Trib#1	LDT1	11	2,991
Lund Creek Trib#3	LDT3	12	2,507
Bryan Creek	BR	13	14,208
Lund Creek	LD	14	11,026
Pembina River Trib#1	PET1	15	5,236

REVISED SCENARIO

Watercourse	Watercourse Code	Diversion #	Fish Habitat Impacted (m²)
Erith River	ER	1	67,485
Erith River Trib #1	ERT1	2	1,000
Bacon Creek	BA	3	2,777
Halpenny Creek Trib#1	HLT1	4	0
Halpenny Creek	HL	5	4,129
Halpenny Creek Trib#2	HLT2	6	0
Lendrum Creek Trib#1	LET1	7	3,282
Lendrum Creek Trib#3	LET3	8	7,959
Lendrum Creek	LE	9	17,468
Hay Creek	HA	10	2,325
Lund Creek Trib#1	LDT1	11	2,991
Lund Creek Trib#3	LDT3	12	3,831
Bryan Creek	BR	13	14,208
Lund Creek	LD	14	7,319
Pembina River Trib#1	PET1	15	660

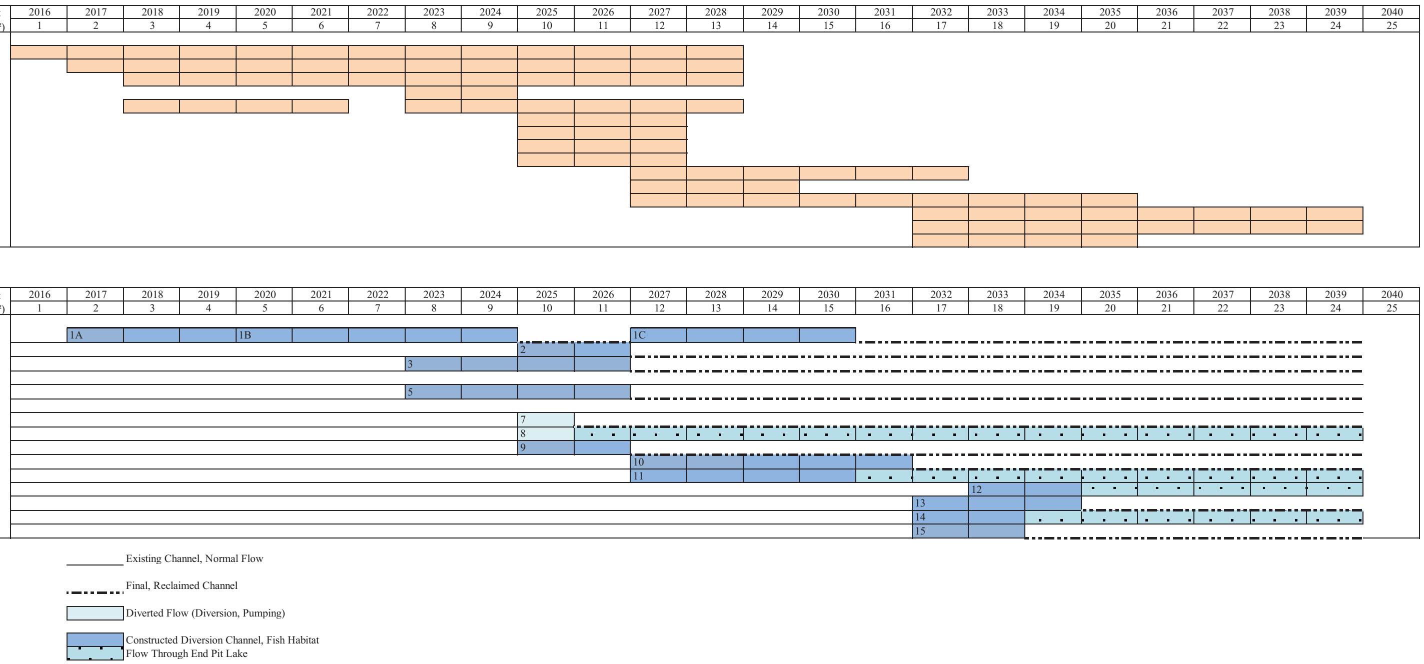
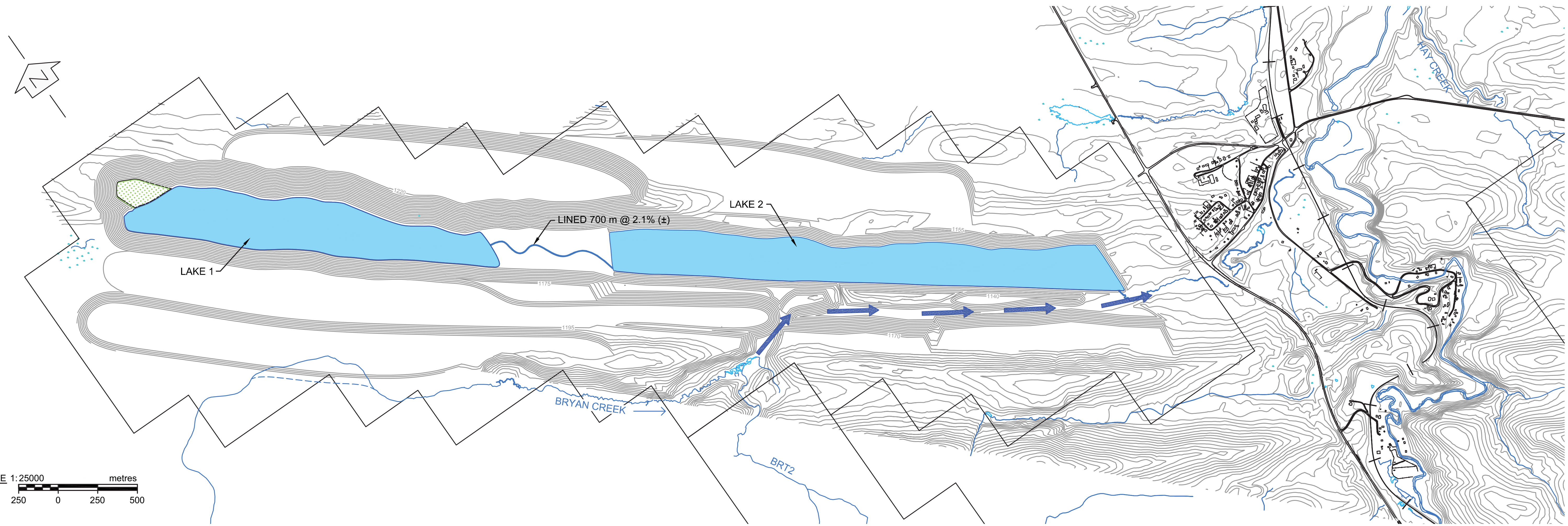


Figure 2. Anticipated schedule for mine development along with the predicted impacts to fish habitat



LEGEND

- Lake
- Wetland
- Constructed Steams

REF: Matrix Solutions Inc., December 2011.

PROJECT:

Coal Valley Mine
Robb Trend SIR - DFO Compensation Plan

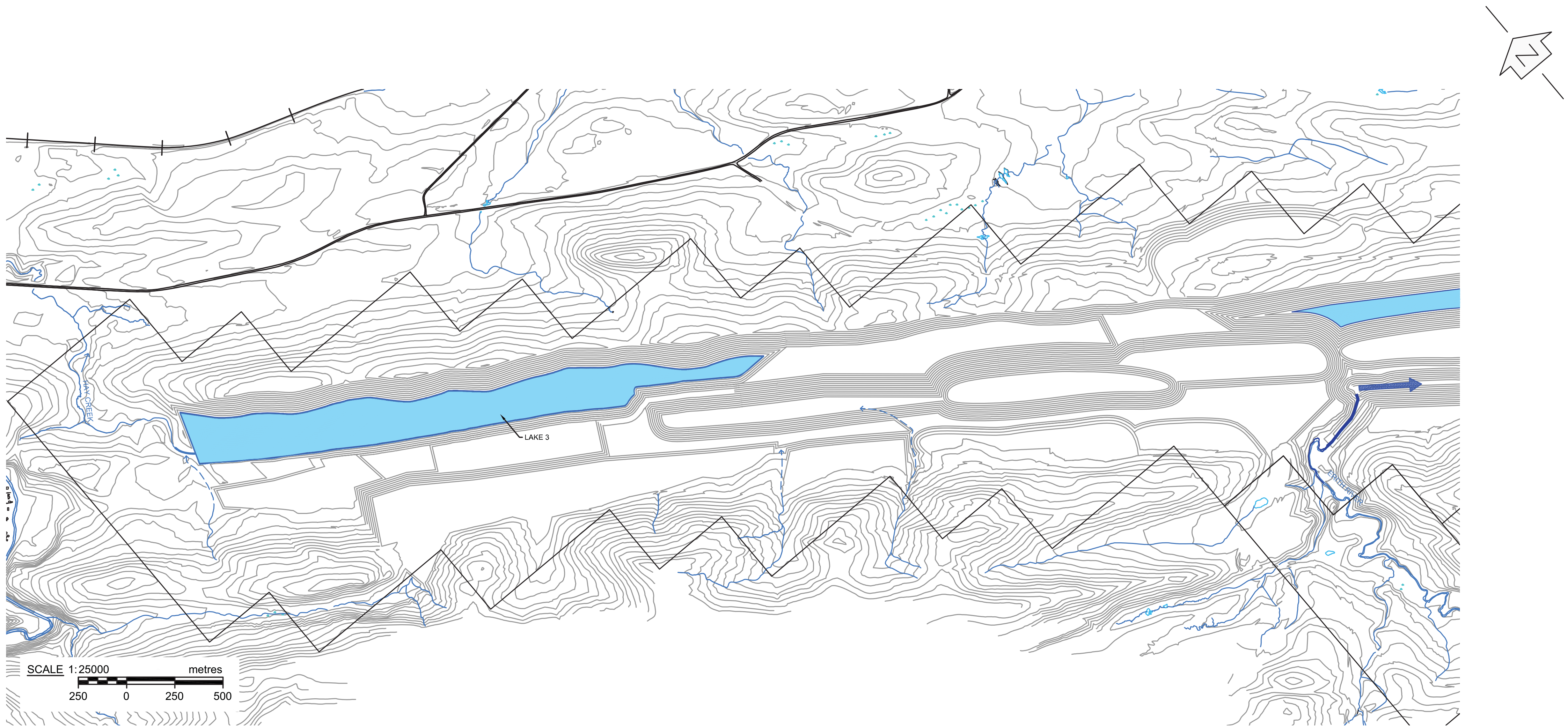
TITLE:

Figure 3. Lakes 1 and 2 Reclamation Plan

FILE: Final Docs\08-041b\DFO\Fig_Various.dwg

DRAWN:	JG
CHECKED:	KP
DATE:	Aug 1/13
PROJECT:	08-041b

FIGURE:



LEGEND

Lake

Wetland

REF: Matrix Solutions Inc., December 2011.

PROJECT:

Coal Valley Mine
Robb Trend SIR - DFO Compensation Plan

cvri

TITLE:

Figure 4. Lake 3 Reclamation Plan

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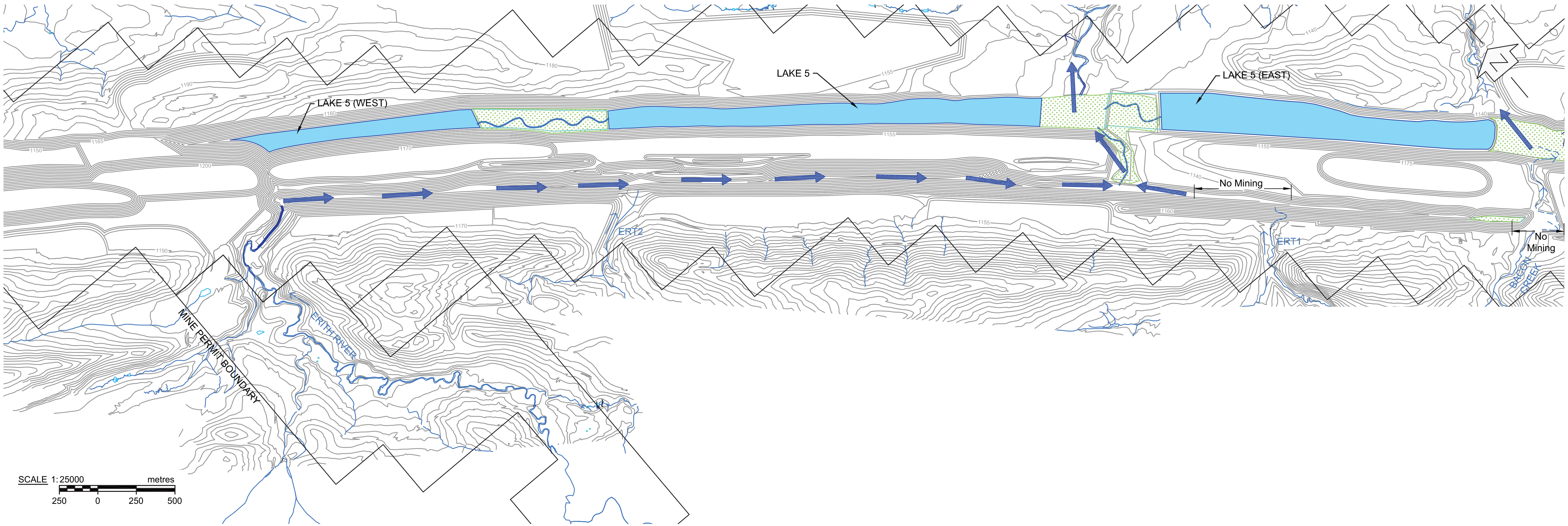
DRAWN: JG	FIGURE:
CHECKED: KP	
DATE: Aug 1/13	
PROJECT: 08-041b	



LEGEND

- Lake
- Wetland
- Constructed Streams

REF: Matrix Solutions Inc., December 2011.

PROJECT:

Coal Valley Mine
Robb Trend SIR - DFO Compensation Plan

cvri

TITLE:

Figure 5. Lake 5 Reclamation Plan

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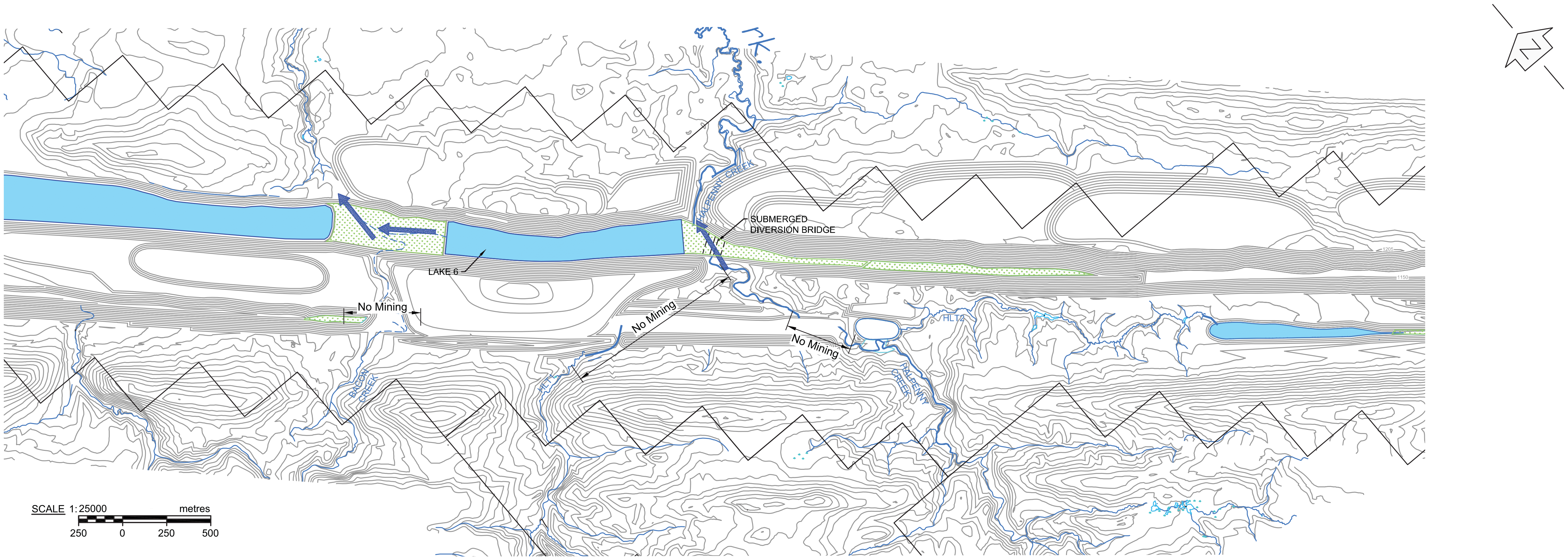
DRAWN:	JG
CHECKED:	KP
DATE:	Aug 2/13
PROJECT:	08-041b
FIGURE:	



LEGEND

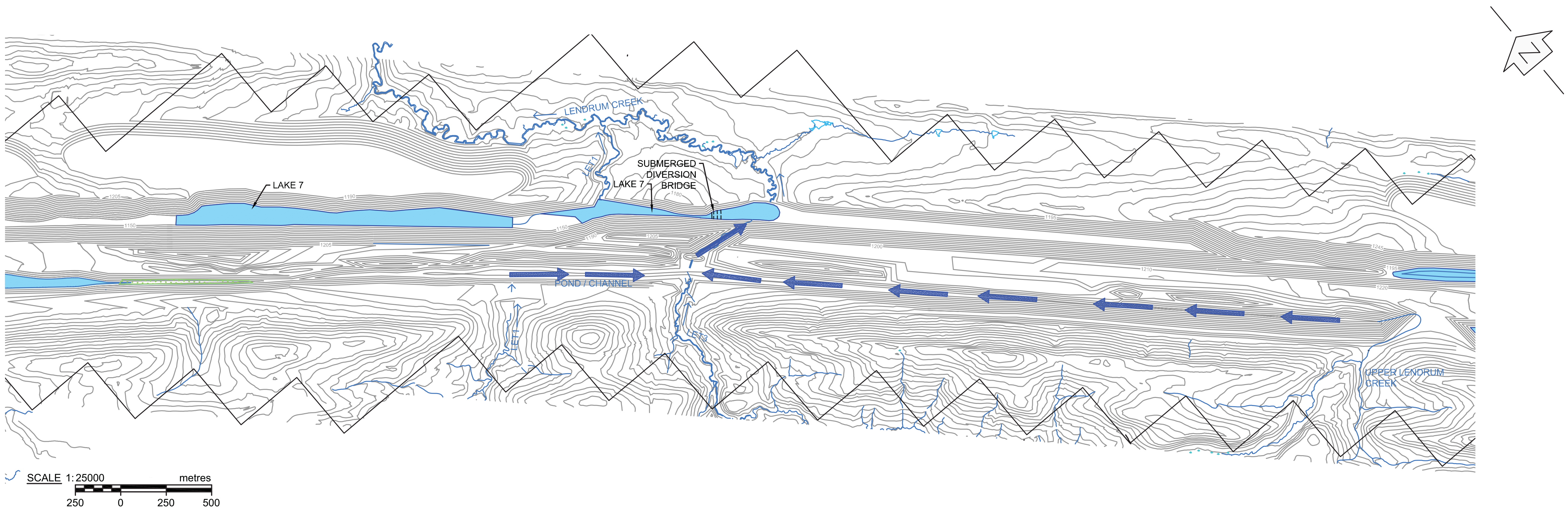
Lake

Wetland

Constructed Streams

REF: Matrix Solutions Inc., December 2011.

PROJECT: **Coal Valley Mine Robb Trend SIR - DFO Compensation Plan**	cvri
TITLE: **Figure 6. Lake 6 Reclamation Plan**	FILE: Final Docs\08-041b\DFO\Fig_Various.dwg DRAWN: JG CHECKED: KP DATE: Aug 2/13 PROJECT: 08-041b FIGURE:



LEGEND

Lake

Wetland

Constructed Streams

REF: Matrix Solutions Inc., December 2011.

PROJECT:

Coal Valley Mine
Robb Trend SIR - DFO Compensation Plan

cvri

FILE: Final Docs\08-041b\DFO\Fig_Various.dwg

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Figure 7. Lake 7 Reclamation Plan

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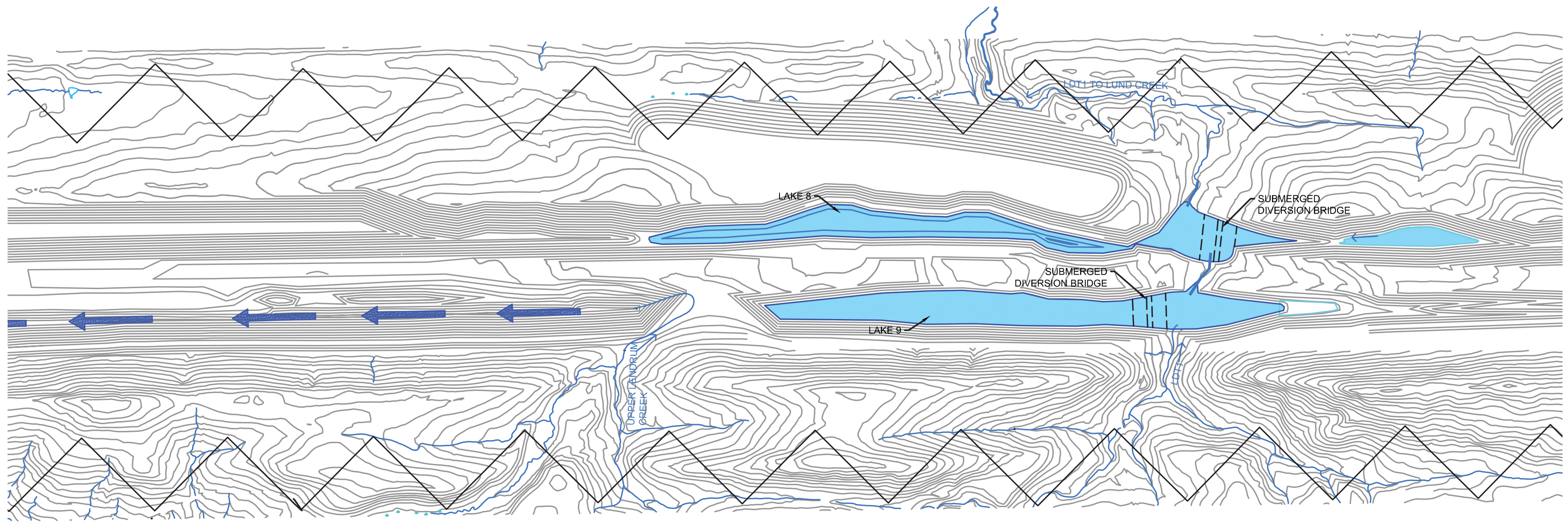
CHECKED:	KP
DATE:	Aug 2/13
PROJECT:	08-041b

FIGURE:



SCALE 1:25000 metres

250 0 250 500

LEGEND

- Lake
- Wetland
- Constructed Streams

REF: Matrix Solutions Inc., December 2011.

PROJECT: **Coal Valley Mine Robb Trend SIR - DFO Compensation Plan**	cvri
TITLE: **Figure 8. Lakes 8 and 9 Reclamation Plan**	FILE: Final Docs\08-041b\DFO\Fig_Various.dwg
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	DATE: Aug 2/13
	PROJECT: 08-041b
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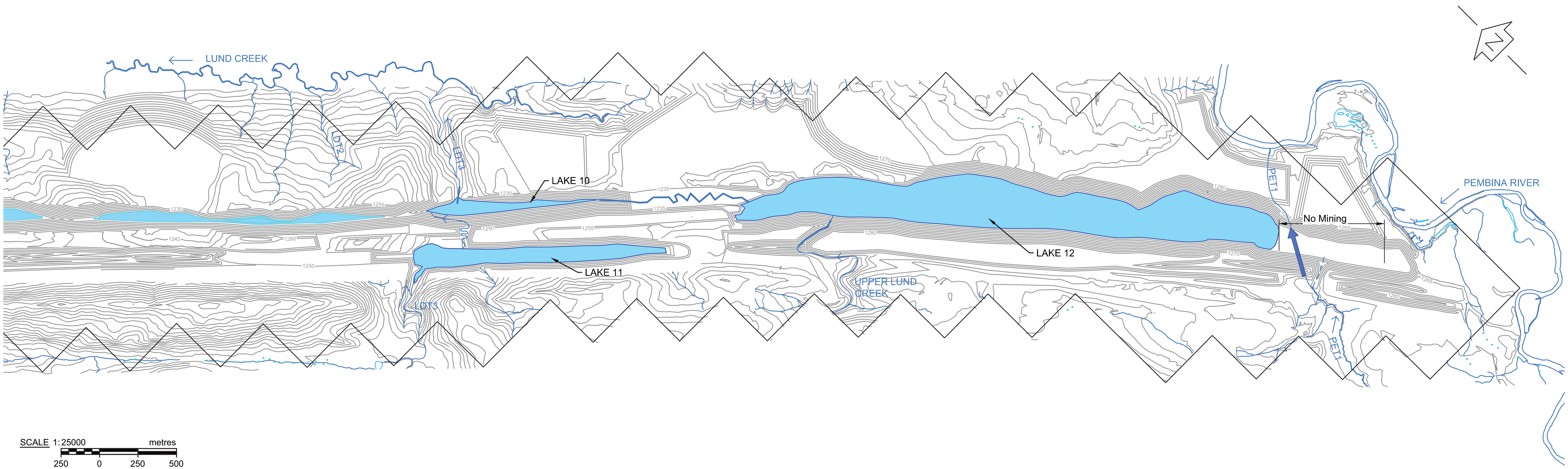

REF: Matrix Solutions Inc., December 2011.

PROJECT:

Coal Valley Mine
Robb Trend SIR - DFO Compensation Plan

TITLE:

Figure 9. Lakes 10 - 12 Reclamation Plan

FILE: Final Docs\08-041b\DFO\Fig_Various.dwg

DRAWN:	JG
CHECKED:	KP
DATE:	Aug 22/13
PROJECT:	08-041b

FIGURE:

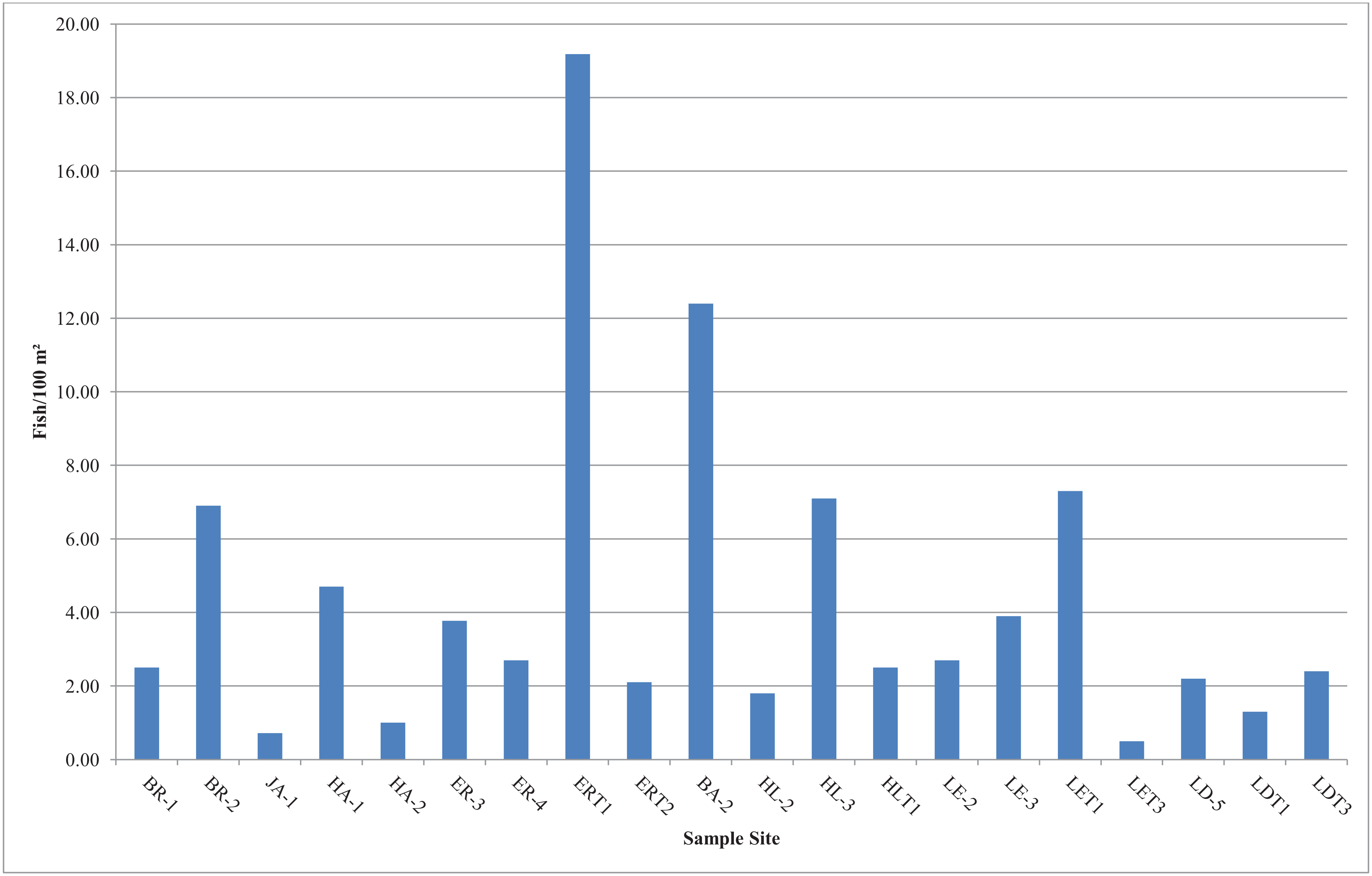

Figure 10. Rainbow Trout densities (fish/100 m^2) for population estimates performed in the Robb Trend Mine Area.	CVRI Robb Trend Project
	August 2013
	Pisces Environmental Consulting Services Ltd.

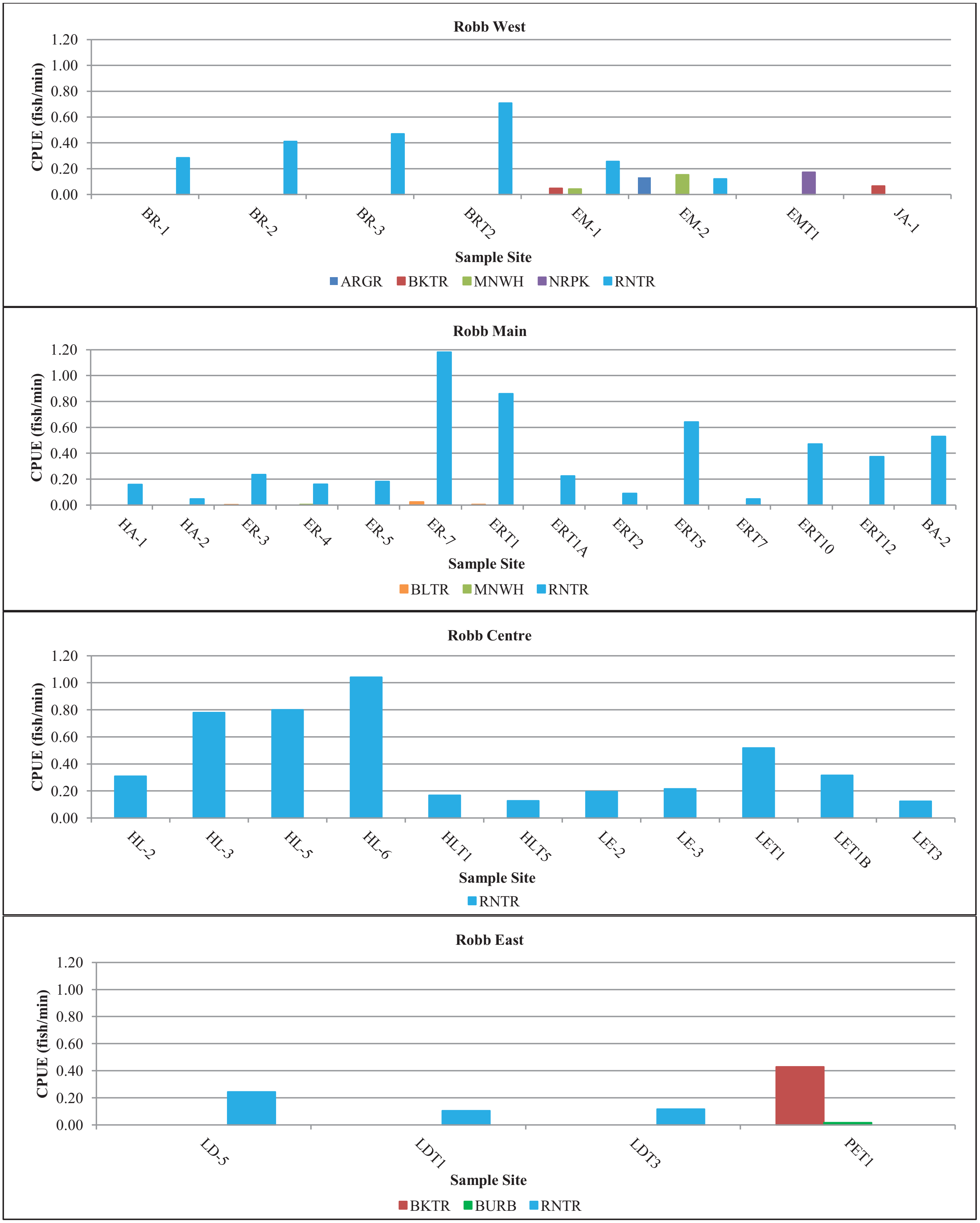

Figure 11. First-pass catch per unit effort (CPUE) for sport fish captured at Robb Trend sample sites.

CVRI Robb Trend Project

August 2013

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Low	Moderate	High
		
Photo 1. Upper Hay Creek.	Photo 3. Unnamed tributary to Halpenny Creek #1 (HLT1).	Photo 5. Unnamed tributary to the Erith River #1 (ERT1).
		
Photo 2. Unnamed tributary to the Erith River #2 (ERT2).	Photo 4. Lendrum Creek.	Photo 6. Erith River.

Figure 12. Photos of typical habitat conditions found within Low, Moderate, and High habitat potential rankings.

CVRI Robb Trend Project

August 2013

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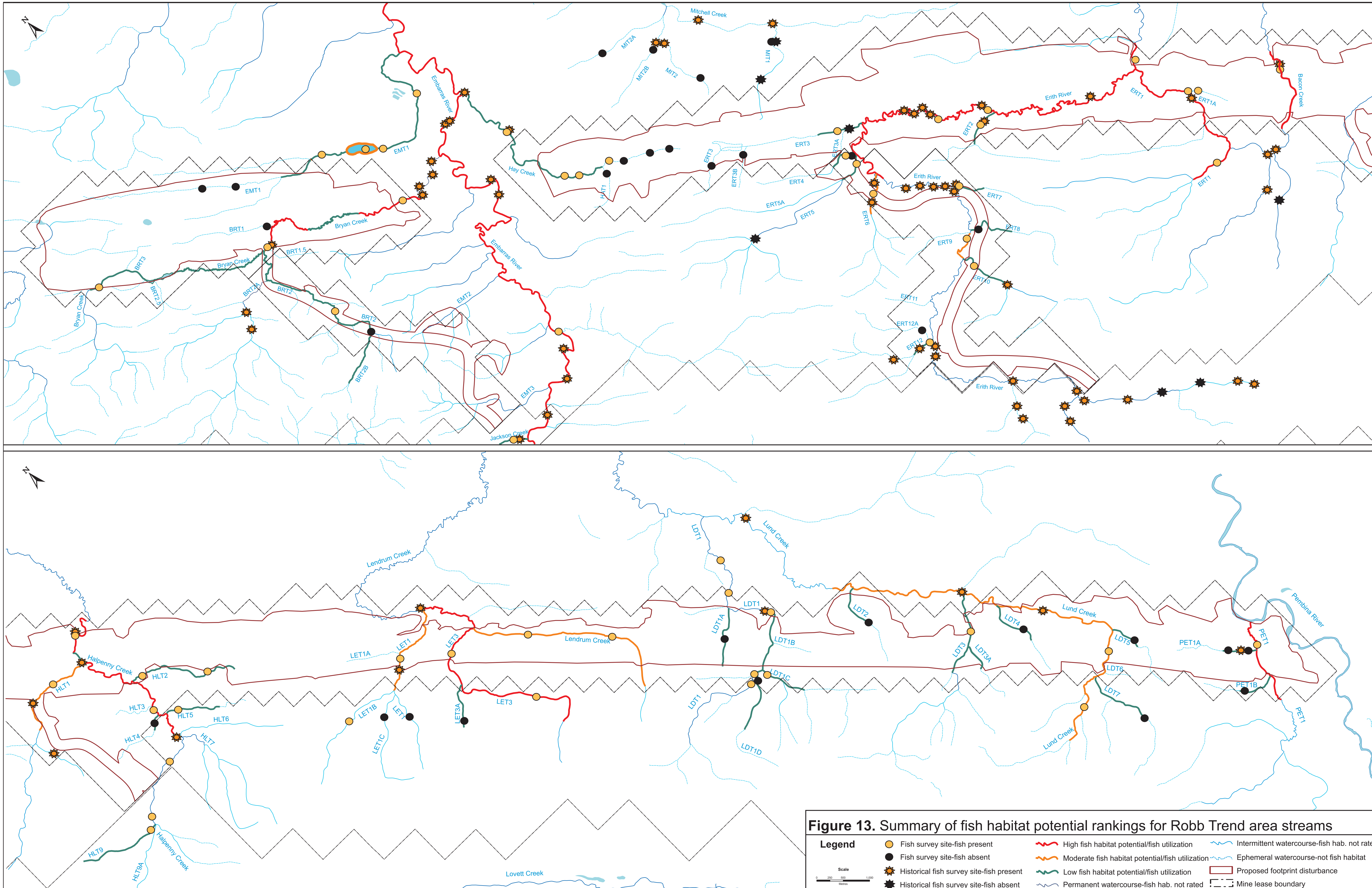

Figure 13. Summary of fish habitat potential rankings for Robb Trend area streams

Appendix A

CVRI has reconstructed several stream channels as part of past reclamation efforts. The following summarizes past work and discusses challenges and improvements in channel construction proposed for the future.

Centre Creek Tributary (1989)

In the winter of 1989, a 2.3 kilometer stretch of an unnamed tributary to Centre Creek was diverted to facilitate mining (Pisces 1989). Habitat assessments completed following the reconstruction showed the reconstructed channel exhibited good diversity, increased the amount of deep water habitat, and increased the overall habitat area of the unnamed tributary (Pisces 1989). During sampling conducted in 1996 this channel was found to have the highest Brook Trout density of all sites sampled with 56 fish/100m^2 being captured (Carson and Allan 1999). Carson and Allan (1999) also classified the habitat within the tributary as high quality habitat. Brook trout were observed spawning within the reconstructed channel during the fall of 1999 (Allan 1999).

The diverted channel as it currently exists (fall 2012) is portrayed in Figure 1.

Figure 1. Centre Creek Tributary Diversion fall 2012 (Dean Woods Photograph).

Pit 45 Lake Outflow (2000)

The Pit 45 Lake outflow channel drains Pit 45 Lake, which is managed as a quality stocked lake by AESRD. The channel has well established vegetation and exhibits no slumping or instability. No fisheries enhancements were completed within the channel and minimal discharge was noted in spring 2013.

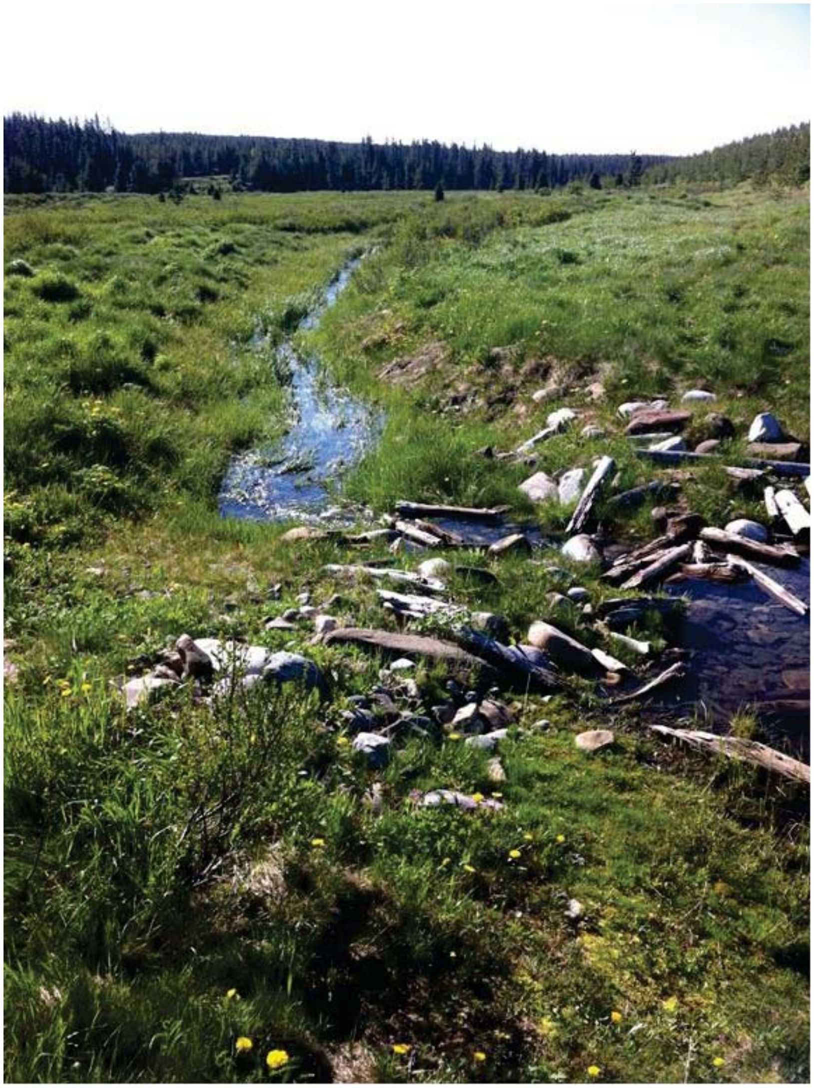

Figure 2. Pit 45 Lake Outflow Summer 2011 (Dean Woods photo)

Pit 43 W Outflow (2004)

The Pit 43W Outflow drains a small end pit lake and connects to the Lovett River (Figure 3 and 4). Fish were observed in the bottom 50 metres of channel but no sampling has been completed. Monitoring was initiated in spring 2013 and is ongoing.

Figure 3. Pit 43W outflow channel spring 2013.

Figure 4. Pit 43 W outflow channel downstream section.

Pit 34 Lake Outflow (2004)

The Pit 34 Lake outflow was constructed in 2004 but final reclamation and enhancement is ongoing in the area. Preliminary investigations conducted in spring 2013 indicate Brook Trout are occupying the constructed habitat. The channel is stable and vegetation is slowly becoming established (Figure 5). Monitoring was initiated in spring 2013 and is ongoing.

Figure 5. Pit 34 Lake Outflow spring 2013.

25E Creek Channels (2010)

CVRI has more recently completed construction of several lake outlet channels as part of the reclamation process. Monitoring of many of these outlets is ongoing but early indicators show the reclaimed landscape is providing habitat for colonizing fish species. 25E creek was heavily influenced during mining and has been reconstructed (Figure 6 and 7). Fish were observed in 25E Creek in the constructed inlet and outlet channels of Pit 25E Lake in spring 2013. Additional fisheries surveys are scheduled for summer 2013. Brook Trout were documented in 25E Lake during the winter of 2010.

Figure 6. 25E Creek immediately upstream of 25E Lake spring 2013.

Figure 7. 25E Creek at outlet of 25E Lake (looking downstream) spring 2013

Fish presence has not been documented in the headwaters of 25E Creek but monitoring of the constructed 25E Creek channel was initiated in the spring of 2013. The constructed channel exhibited significant discharge in spring 2013 and preliminary measurements indicate it is capable of providing fish habitat (Figure 8 and 9). Monitoring was initiated in spring 2013 and is ongoing.

Figure 8. 25E Creek immediately downstream of 25S Lake spring 2013

Figure 9. 25E Creek approximately 100 metres downstream of 25S Lake.

Upper Mercoal Creek Diversion (2009)

A portion of the headwaters of Mercoal Creek was diverted into an enhanced channel in the summer of 2009. The reconstructed channel appears to provide an increased amount of fish habitat compared to baseline conditions (Figure 10) and vegetation is becoming established (Figure 11). No fish have been captured in the vicinity of the diversion during fish salvage operations in 2009 or during subsequent monitoring (2010, 2012). However, large beaver dams located a substantial distance downstream of the diversion are suspected of impeding fish movements into this constructed habitat.

Figure 10. Baseline conditions of upper Mercoal Creek during fish salvage operations in 2009.

Figure 11. Upper Mercoal Creek diversion channel in summer 2012.

Embarras Lakes (2011)

The Embarras Lakes system was constructed to connect three end-pit lakes located in the headwaters of the Embarras River. Prior to mining, low densities of fish were present a short distance downstream of the mining area (Figure 12). Though the system is early in its developmental stages and some final reclamation work still needs to be completed, the constructed channels have been found to provide habitat for native Athabasca Rainbow Trout (Pisces 2013).

Although vegetation and instream habitat enhancements still need to be constructed (Figure 13 and 14) preliminary investigations show increased fish densities in the upper Embarras drainage compared to baseline conditions. Prior to mining, very few fish were present in the vicinity of the existing Embarras Lakes (single Rainbow Trout captured) while low densities of Rainbow Trout ($2.6/100m^2$), Brook Trout ($0.34/100m^2$), and a single Bull Trout were captured downstream of where the existing fish exclusion barrier is located (Boorman 2003). In August 2012, 85 Rainbow Trout were captured from within constructed channels upstream of the exclusion barrier during single pass surveys. Population estimate data collected downstream of the fish exclusion indicates Rainbow and Brook Trout densities have increased orders of magnitude over baseline conditions.

Figure 12. Upper Embarras Baseline condition (2004) downstream of existing fish exclusion barrier.

Figure 13. Reconstructed channel downstream of Lower Embarras Lake spring 2012.

Figure 14. Outlet channel of Upper Embarras Lake spring 2012.

Challenges and Future Work

Monitoring of existing diversions and reconstructed channels continues in 2013 as CVRI prepares for future reclamation projects. A significant amount of the Chance Creek channel will be constructed in the Yellowhead Tower area following mining.

CVRI has acknowledged limited fisheries work/enhancement has been carried out in several of the diversion channels. Monitoring is ongoing and preliminary results will be relied to make recommendations for enhancements. A lack of woody vegetation and fish cover components in several of the existing channels will be addressed as final replanting and reclamation occurs. Gravel and instream habitat placements are proposed in systems where self-sustaining fish populations are desired.

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