APPENDIX 8

MEMO

Date: September 4, 2014 HCP Ref No.: CZN6788

From: John Wilcockson

To: Dave Harpley, Canadian Zinc Corp

Subject: **All Season Road – Review of Stream Crossings in NNPR - DRAFT**

INTRODUCTION

On July 27 and 28, 2014, Canadian Zinc Corp (CZN) and Parks Canada (Parks) staff collaborated on a site review of stream crossings in the Nahanni National Park Reserve (NNPR) associated with CZN's proposed all-season road. Jonathan Tsetso (Parks), Garry Scrimgeour (Parks), David Harpley (CZN), and John Wilcockson (Hatfield Consultants) participated in the review, the purpose of which was to classify the crossings with respect to probability of fish presence. The data collected will be used to determine the scope of follow-up field studies, and aid in the selection of suitable crossing structures. All sites were accessed by helicopter. Where the helicopter could safely land, ground-based assessments were carried out, including the completion of habitat sheets. In other instances, an assessment, including photographs, was completed from the air at low level with repeated passes. Crossings classified as potentially fish-bearing that were not assessed previously will be the subject of additional habitat assessments, likely in September 2014.

The proposed all season road traverses the eastern side of the park from near the Mine (km 17) to the Silent Hills (km 100), a total of 83 km. Over this distance it traverses mountains, large flood plains, a karst plateau, wetlands and tree-covered hills. The all-season road will generally follow the footprint of the existing winter road with some exceptions. Options for crossings include clear-span bridges, open-bottom culverts and various sizes of conventional culverts. The type of crossing structure selected will be determined by crossing geometry, hydrologic properties and fish passage requirements.

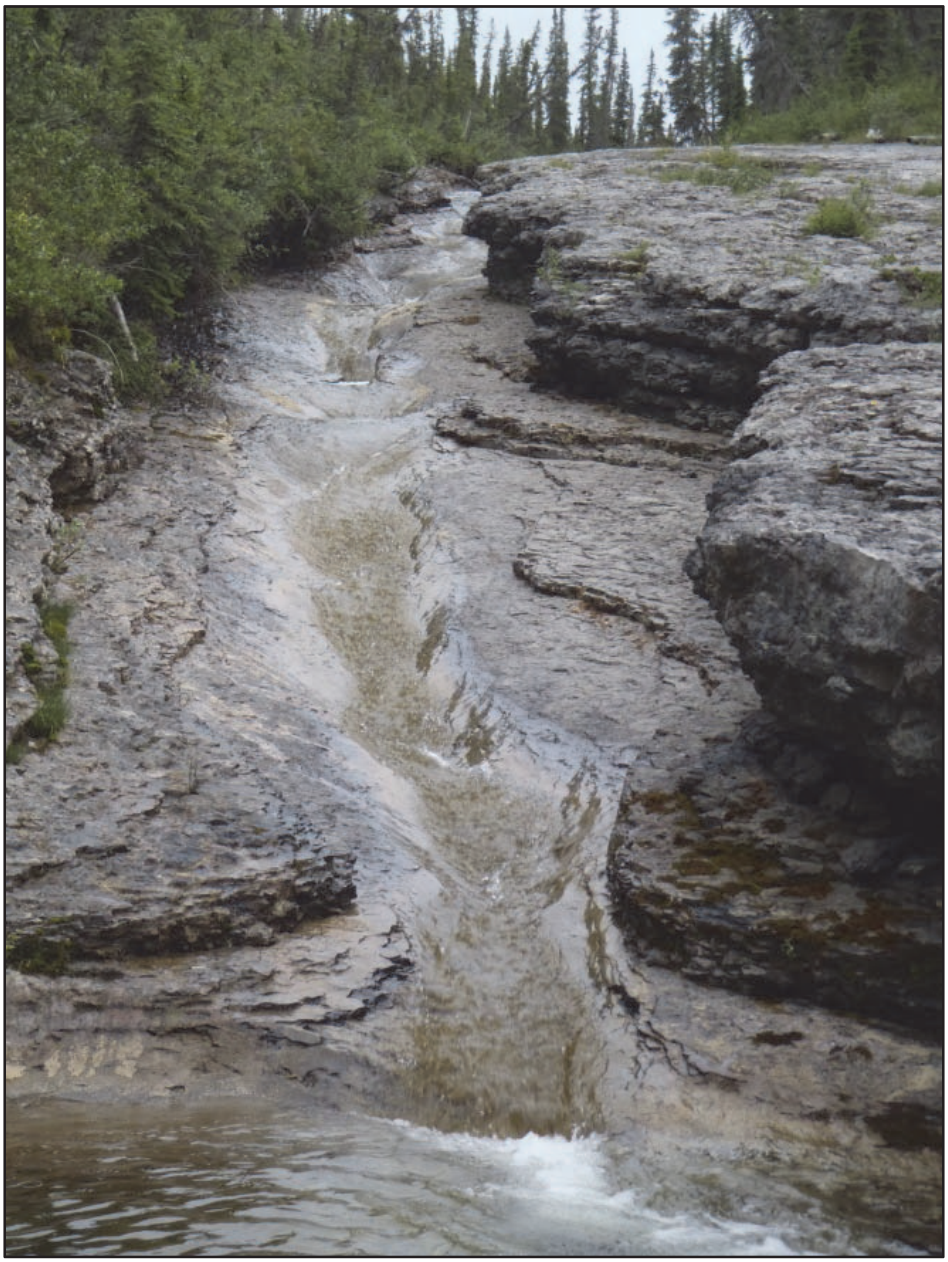
It was generally assumed that fish are present at all streams, unless weight of evidence suggests otherwise. The latter includes barriers to migration downstream, lack of a defined channel with flow, and shallow, warm oxygen-depleted water unlikely to sustain fish. Seven geographic areas are discussed in this memo below.

TRIBUTARY TO SUNDOG

The crossing of this tributary to Sundog Creek occurs at km 43.5 of the proposed all season road (based on the LiDar sheets reproduced by Allnorth). On July 27, CZN and Parks conducted a ground assessment of a 900 m section of the creek downstream of the crossing. There is a prolonged section of 10° to 12° slope over bedrock (Figures 1 to 4). The formation resembles a chute, with minimal back eddies or pools. While it would not be impossible for a fish to swim upstream during flood conditions, it is unlikely. Therefore, this feature is assumed to preclude

fish passage. Upstream of the chute, the habitat for fish improves, the gradient decreases and there are numerous pools, overhangs, backwaters and boulders. In this area, substrate consists primarily of bedrock, cobble and gravel. In 2005, electrofishing was conducted of a 40 m section of this reach and no fish were found (Bathurst 2005[1]). During the current investigation, CZN and Parks staff conducted additional electrofishing over a 300 m reach and also found no fish. These results indicate that the creek section downstream of the proposed road crossing is likely inaccessible to fish.

Figure 1 Upper chute on tributary to Sundog looking south (upstream), July 27, 2014.



[1] Bathurst, 2006. Canadian Zinc Prairie Creek Mine Winter Access Road Liard River (Km 175.5) to Prairie Creek Mine (Km 0). Report to Canadian Zinc.

Figure 2 **Flow over bedrock against cliff on tributary to Sundog, looking north, downstream, July 27, 2014.**

Figure 3 **Small cascade on tributary to Sundog, looking upstream, south, July 27, 2014.**

Figure 4 Lower chute on tributary to Sundog, looking upstream, south, July 27, 2014.

SMALL TRIBUTARIES TO POLJE CREEK

West of the Polje Creek crossing, the proposed road alignment travels along the side of a hill (km 45 to 53) and crosses several small tributaries of Polje Creek that were viewed from the air (Figure 5, 6 and 7). There were five small creeks with defined channels, and the locations of four of these are shown on the drawing provided as Attachment 1. The largest creek appeared to have a width of approximately 1.5 m. Ground-based assessments will need to be conducted on these creeks; however, observations from the air indicate that habitat upstream of the proposed crossing would be limited by flow as a result of the close proximity to the creek headwaters. The creeks with defined channels are located at km 46.7, 47, 49.3 and 54.3.

Figure 5 **Creek near km 47 (waypoint 37 on Attachment 1), tributary to Polje Creek, looking downstream, south, July 28, 2014.**

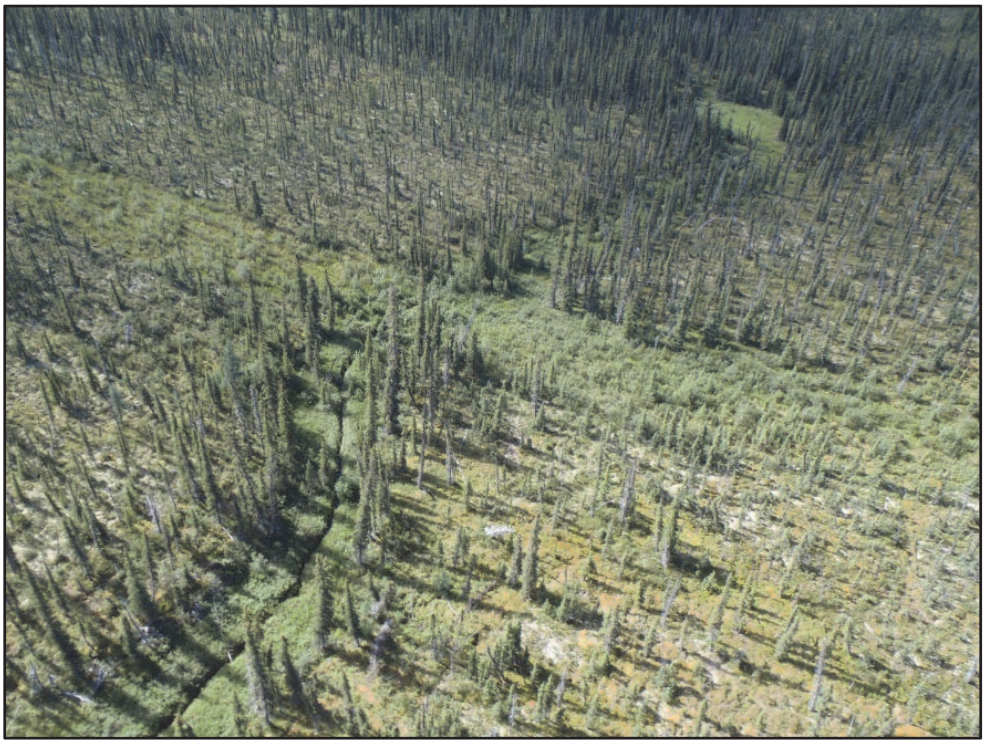
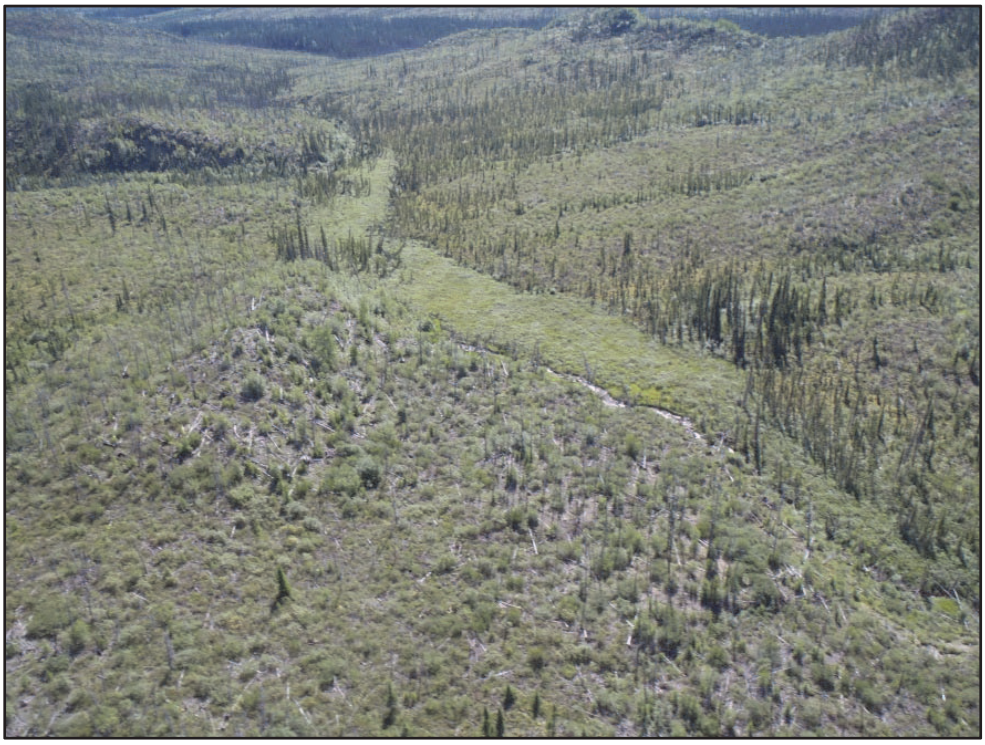


Figure 8 **Creek near km 49 (waypoint 34 on Attachment 1), tributary to Polje Creek, looking upstream, north, July 27, 2014.**

Figure 9 Creek near km 50 (waypoint 33 on Attachment 1), tributary to Polje Creek, looking downstream, south, July 28, 2014.



POLJE CREEK

A ground-based assessment was conducted on the Polje Creek Crossing and two smaller creek crossings to the west. Both of the smaller creeks were identified as tributaries to Polje Creek. The first tributary west of Polje Creek was small, having an average wetted width of 1.5 m; however, water quality appeared to be good, and there was abundant surface cover for fish (Figure 10). The second tributary, further to the west, did not have a defined channel and flow, if present, would occur subsurface under a blanket of moss, small plants and buried, decaying logs (Figure 11). The second tributary would not provide suitable habit for fish. Full habitat assessments were conducted on Polje Creek (Figure 12) and the first tributary to the west. Both contain good habitat for fish, including a "diversity of cover and habitat types including deep water pools, undercut banks, in-stream structure from overhanging vegetation and woody debris"(Dillon, 2009). Electrofishing was not conducted in Polje Creek as part of this reconnaissance investigation. During a previous survey, researchers were unable to capture fish and no fish were observed (Dillon, 2009[2]). Despite this, the investigators indicated that the creek is likely to support fish similar to those species found in Sundog Creek, and fish were found upstream previously.

[2] Dillon, 2009. Prairie Creek Mine Winter Road Re-alignment A, B, C, Re-routing to Nahanni Butte, Polje Creek Bypass Air and Ground Stream Crossing Fish Habitat Assessments. Memo to David Harpley, CZN by Craig Thomas, Dillon Consulting Limited, November 25, 2009.

Figure 10 First Tributary to Polje Creek Crossing, looking upstream, north, July 28, 2014.

Figure 11 Second Tributary to Polje Creek Crossing, looking south, July 28, 2014.

Figure 12 Polje Creek Crossing Creek at km 49 (WP33), looking downstream, south, July 28, 2014.

CREEKS DRAINING TO POLJES

There are a number of drainage pathways draining into the Poljes from km 55-63. None have a defined channel and their outlets 'hang' above the Poljes, making them inaccessible to fish.

INLET TO MOSQUITO LAKE

An air-based assessment was conducted of a small drainage area feeding into Mosquito Lake on July 28, 2014. Flow from Mosquito Lake is known to drain to the Poljes, which are considered to be inaccessible to fish. However, there is a possibility that Mosquito Lake hosts a resident population. From the air, the inflowing drainage appeared to enter a series of small wetlands (Figure 13). Channels were poorly defined and appeared to be low-gradient and filled with aquatic vegetation. It is considered unlikely that fish would use these inflow channels for migration. The habitat value of the wetlands appears to be similar to the littoral habitat, containing abundant aquatic vegetation. Therefore, due to the marginal, littoral-like habitat in the wetlands and channel, the inflow area is unlikely to provide any critical habitat to fish even if they are present in Mosquito Lake.

Figure 13 Inlet of Mosquito Lake, looking downstream, north, July 28, 2014.

TETCELA RIVER

An air-based assessment was conducted on the two Tetcela River crossings. Tetcela River is a larger river: at the crossings, the river was about 15 m wide and appeared to provide relatively deep, run-type habitat (Figure 14 and 15). Water appeared to be tea stained and turbid. This river appears to provide good fish habitat. Fish surveys by Beak (1982)[3] and Rescan (1994)[4] recorded presence of Arctic grayling, whitefish, northern pike, lake chub, slimy sculpin, and longnose sucker.

[3] Beak 1982 Summary Document. Prairie Creek Project, Water Quality and Aquatic Biology. Report prepared for Cadillac Explorations limited, Calgary, Alberta, February 1982. K4606B

[4] Rescan 1994 Prairie Creek Mine. Fisheries and Aquatic Resources Baseline Studies -1994

Figure 14 First Tetcela River Crossing, looking upstream, north, July 28, 2014.

Figure 15 Second Tetcela River Crossing, looking upstream, north, July 28, 2014.

FISHTRAP CREEK

A ground-based assessment was conducted by CZN and Parks staff (Garry Scrimgeour) on July 28. Due to the boggy conditions, it was not possible to reach the crossing location from the landing site. However, a representative location, about 50 m upstream, was assessed. Fishtrap Creek in the area of the crossing consists of a series of ponds, many with beaver dams (Figure 16 and 17). Flow at the representative location was low and the channel was filled with aquatic vegetation. Water striders and aquatic snails were observed. Dissolved oxygen concentrations were adequate for fish (8.54 mg/L), but it is likely that DO levels drop significantly in this system at night when aquatic plants start removing oxygen from the water column. The high water temperature, 20° C, would also limit the types of fish that could survive at the site. Garry Scrimgeour believed the presence of water striders indicates either the absence or low abundance of fish, given these insects tend to be easy prey for fish. Observations indicate that Fishtrap Creek in the area of the all season road crossing, which is very near the upstream catchment boundary, provides poor habitat for fish. Electro-fishing by Beak (1982)[5] failed to locate fish. In addition, a water quality assessment under ice by Beak (1981)[6] observed dissolved oxygen concentrations below 1 ppm, thus likely precluding fish overwintering.

Figure 16 Fishtrap Creek Crossing, looking downstream, south, July 28, 2014.

[5] Beak 1982 Summary Document. Prairie Creek Project, Water Quality and Aquatic Biology. Report prepared for Cadillac Explorations limited, Calgary, Alberta, February 1982. K4606B

[6] Beak 1981. Prairie Creek Project. Fisheries and Invertebrate Studies, 1981. Prepared for Cadillac Explorations Ltd. Calgary, Alberta. September, 1981. K4606

Figure 17 Fishtrap Creek Crossing, looking upstream, north, July 28, 2014.

Table 1 GPS Coordinates.

Location Name	Coordinates (UTMs)
Tributary to Sundog, midpoint of bedrock chutes	10 V 431407 6830537
Tributary to Polje Ck (approx. km 47, waypoint 37))	10 V 434571 6829304
Tributary to Polje Ck (approx. km 47.6, waypoint 40)	10 V 435177 6829130
Tributary to Polje Ck (approx. km 47.6, waypoint 36)	10 V 435193 6828981
Tributary to Polje Ck (approx. km 49.1, waypoint 34)	10 V 436433 6829080
Tributary to Polje Ck (approx. km 50.2, waypoint 33)	10 V 436877 6829835
First Tributary east of Polje Ck	10 V 440615 6830774
Second Tributary east of Polje Ck	10 V 440509 6830759
Polje Ck Crossing	10 V 440688 6830794
Outlet of Mosquito Creek	10 V 446766 6825508
Tetcel River Crossing	10 V 461330 6815569
Fishtrap Creek Crossing	10 V 465062 6813912

Attachment 1

Map of Polje Creek Tributaries, Prairie Creek Mine

434000 435000 436000 437000

6830000 6829000

WP 33 KP50 WP 37 WP 38 WP 39 KP47 WP 40 WP 36 KP48 WP 34 WP 35 KP49

Prairie Creek Mine
Polje Creek Tributaries

Legend

- Polje Creek Waypoints
- Bridge
- Culvert
- Access Road Update KPs
- Access Road Update
- Comment Lines
- Roads

Water Features

- CREEK - INDEF
- RIVERSHORE

Date: 8/22/2014
Projection: NAD 1983 UTM Zone 10N
Scale: 1:10,000
Author: ainglis
Last Modified By: ainglis
Checked By:
Revision #:

0 100 200 400
Metres

Map Location

Sources: Esri, HERE, DeLorme,

Path: C:\14-GP-0128_CanadianZinc-PrairieCreekMineRoad\2400-GIS\2420-MXD\Prairie_Creek_Mine_Polje_Creek_10k_B.mxd

Attachment 2

Field Notes from July 27 and 28, 2014

CZN6788 27 July '14

Purpose: First day of Road assessment - Sundog to cat camp + Polge (Bubbling Springs) Ck. Electrofishing Sundog + net/trap mosquito

Crew: John, Dave, Garry + Jon

Electrofishing settings used in ~~past~~ last year 425v ± 25v 30Hz
~~Duty cycle 12%~~ (Neal)
US: sculpin - 400v 50Hz 20DC
Trout - 40 Hz

Km 44 look at potential migration barrier prefer culvert over bridge.
Km 35-38 - possible re-alignment, shocking here.
Trib to Polge (bubbling springs)

Km 24 - falls
wp 10 drop of electrofishing gear. ~Km 36

Tetsela
44 fish migration barrier ... 47-49 alignment

CZN6788 27 July '14

WP 11 Catcamp

Km 43 Crossing 431569 6829953 WP 012

WP 13 ~~APP~~ Trib to Sundog long chute ~75m S
Photo + Photo north ~150m long against black coloured cliff 10° slope ~12° further upstream in chute

0431295 6830730
WP 14 Downstream pool,
~~Dave~~ saw fish ~10cm upstream of pool ~10°
Furthest D/S point

WP 15 S N , WP ~~17~~ 16 S N W pool
WP 17 S N WP 18 S N (not recorded)

1215 @ Sundog Ck realignment location #1
pH ~~9.51~~ 7.6°C 221 µS (AJ)
JW pH 8.60 8.68°C 260 µS (AK)

upstream riffle flows / depths

		depth	flow
Top	25	22cm	.29
~~Mid~~	50	40cm	.75
~~bottom~~ ~~75~~		26 cm	.61
Mid	25	32cm	.59
	50	46cm	.97
	75	22	.27
Bottom	25	28	.92
	50	32	1.20
	75	42cm	1.06

DO on meter 11.20 mg/L
94.8%
DO titration 10.8 mg/L

WP22 Sundog goes to ground.

Second sundog realignment site (Location ~~#2~~ A ~~Site A~~)
Top WP023 426356
6829278
Bottom WP024 426418
6829265
Cond 268.5/9.1°C / 7.40 (AK)

DO meter 99.4% 11.83 mg/L
pH 8.63 7.4°C 233 µS (AJ)
DO titration 10.2 mg/L
second sundog realign site
Location B

Top wpt 025 426255
6829318
Bottom wpt 026 426323
6829305

End ~ 1635.
Pilot late picking us up - decided to send just Garry + Dave to sundog trib to electrofish 1730 - 1815
back @ camp about 1835

For the sundog allignment locations, Jon and I did habitat sheets, while Garry + Dave electrofished

A sundog 1, ~~site A~~ 1348sec
ARGR FL (mm): 190, 183, 181, 192
SLSC FL (mm): 81, 92, 93, ?

Rite in the Rain

CZN6788 27 July '14

Settings for sites ~~A + B~~ 1 + 2
500v, freq: 50

For the Sundog Alligment, site 2
d/s location ("A") - no fish 327 sec
u/s " ("B") - no fish 188 sec

For trib to Sundog (visited earlier in day)
724 sec
wp 27 (431594 / 6829949)
to wp 28 (431514 / 6829743)
assume sinusosity of 2.0
assume welted width 2.5m

CZN6788 28 July '14

Purpose:- habitat ass @ Polje Creek crossings + assess trib's. Trapping near outlet of Mosquito. + Flying much of road alligment where ~~cros~~ there are crossings.

Crew:- Dave H, Garry S, Jonathan T, John W.

Broken high overcast took off @ 742.

Road alligment from air photos
~~WP 28~~

Picked up gear (nets + traps) + dropped at "dry" lake near polgi ck - then dropped ~~two~~ people in at a time to Polgi Ck. ~ km 53
wp 28 is landing spot created log landing pad.
Walked to two small trib's to west - second trib

not flowing + no defined channel
~~gocs~~ moss, ~~sed~~ shrubs + holes w/ logs. walked further 100 m to confirm that second channel was not missed (wp 29, 277 m from landing site) Area. Photo WNES Labrador tea, dwarf spruce, lichen, moss, horsetail. Larch (?)

2nd stream west WP30
photo WNES (before this photo)

Following road back looking for tribs
WP 33 small defined channel
< 1m wide
WP 34/35 larger trib quite incised dead + falling trees in channel
WP 36 small defined channel
< 1m wide
WP 37 another small channel
< 1m wide (photo just before)
last 3 photos WP39

JW

WP 34/35 likely green dot on map
km 46.5
last 4 photos WP40

Polgies
Tetsela - last photo first crossing
Next photos second crossing
WP 41

Fish trap - last few + next few
WP 42
Flow ~0.02 m/s (Gary's estimate
Pen: 20.3°C 589 µS pH 8.08
YSI (DO calibrated) 19.7°C 11.3 mg/L
124% O_2 Sat pH 8.54 476 µS
Water striders noted on surface
Gary said that they are a good indicator for fish absence, since they get hammered by fish. Gary also believes that DO of Fish Trap would be much lower at night when aquatic plants start using O_2.

JW

(14) CZN6788 28 July 14

Sampling site WP 043
Bank height ~ 1m
DO titration 9.8 mg/L
1345 finish
- collected nets + minnow traps + fish cat on way back,
- Took multiple photos of ~~wall~~ Sundog Creek realignment
- Back @ camp ate lunch + downloaded photos.
- went out w/ Dave to look @ Casket Ck comp habitat opened up some channels, saw a young grizzly. Then to water storage pond. took 4 cores for geotech purposes.

John Fellows

Attachment 3

Fish Habitat Data Sheets from July 27 and 28, 2014

Stream Habitat Information

Data Collectors JW, DH, Garry, Jon	**Date** 28 July	**Time (24 H)** 0942
Site Polge Ck Crossing	**Station** Main Creek (E of landing)	**Project** CEN6788
UTM NAD WP 31	**Upstream Northing**	**Upstream Easting**
Access Helecopter	**Downstream Northing**	**Downstream Easting**

Morphology

Stream Morphology Types (%)	Length (m)				Velocity (60% depth or surface)		
(Run) (Riffle) Pool	Depth Transect (m)	@ 25% width	50%	75%	25%	50%	75%
Fall Other:	1						
Depth/Pool (m)	2						
Channel Slope (°)	3						
Wetted Width / 8 / 8 / 8 m	Channel Width (m)	/ 10 / 11 / 11		Unstable Banks (5%)			
Meander Frequency / / / / m	Regular / Irregular meanders			Bank slope (5°)	L 30	R 70	

Instream Cover

Instream Cover (Detritus)	0 %	Instream Cover (Twigs/Sticks, etc)	1 %	Substrate (as cover)	— %
Instream Cover (logs, etc)	1 %	Instream vegetation	— %	Undercut Bank	2 %

Woody Debris Description (log jams, fallen trees, beaver activity, etc)

Substrate Composition (Sum 100%)

		Embed. (%)
% Organics	—	-
% Clay	—	-
% Silt	—	-
% Sand	20	-
% Gravel	60	0
% Cobble	20	50
% Boulder	—	—
% Bedrock	—	-

Instream Vegetaion (Sum 100%)

Rooted Emergent	0 %
Rooted Submergent	0 %
Rooted Floating	0 %
Free-floating	0 %
Floating Algae	0 %
Attached Algae	0 %
Periphyton	0 %
Filamentous	0 %
Aquatic Moss	0 %
Flooded Terrestrial Plants	1 grass %

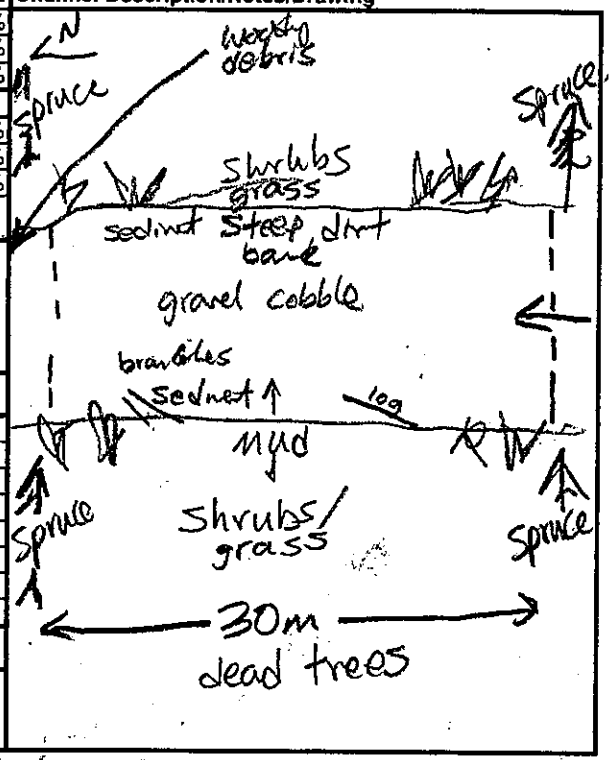
Riprian Zone (25 m Buffer) circle

Mixed Forest	(Coniferous Forest)
Grasses	Deciduous Forest
Re-growth forest	(Shrubs)
Flooded	Sedges
(Roads) — evidence of old winter road	Cutlines

Overhead Cover

Overhead Litter <150 mm	0 %	Overhead Litter >150 mm (%)	0 %
Overhead Undercut Banks	2 %	Overhanging Trees	1 %
Overhanging Grasses	1 %	Overhanging Shrubs	1 %

Channel Description/Notes/Drawing



Miscellaneous

High water mark	1m m	Weather: previous 24 H
Flood Evidence (Debris on plants, etc)	— m	clear
Air Temperature	°C	
Cloud Cover (5%)	60 thin cirrus	
Wind Direction + speed (km/h)	N 2	

In situ Water Parameters / YSI / Titration

Sample Depth (m)		/		
Dissolved Oxygen (%)	97.6			
Dissolved Oxygen (mg/L)	12.21	10.8		
Secchi Depth (m)				
Temperature (°C)	6.2			
pH	8.39			
Turbidity (TCU)				
Conductivity (uS/cm)	353			

Landscape (Beyond 25 m Buffer) circle

Mixed Forest	(Coniferous Forest)	Roads	
Grasses	Deciduous Forest	Cutlines	
Re-growth forest	(Shrubs)	Hills	

Visible Disturbance circle

Surface Debris	Culvert
Beaver Dam	Weir
Collapsed Bank	NO

Photos dead trees

U/S D/S CC

Channel Features	#	Dimensions
Islands		
Bars		

Notes

- Flat ~~75%~~ 50% embedded stones
- Moose ~~feet~~ pits

Stream Habitat Information

Data Collectors Palae Ck Crossing	**Date** Small trib (west)	**Time (24 H)** 10:09
Site JW, DH, Gerry, Jon	**Station** 28 July	**Project** CEN6788
UTM NAD WP032	**Upstream Northing**	**Upstream Easting**
Access Helecoptor	**Downstream Northing**	**Downstream Easting**

Morphology

Stream Morphology Types (%)			Length (m)				Velocity (60% depth or surface)		
Run	Riffle	Pool	Depth Transect (m)	@ 25% width	50%	75%	25%	50%	75%
Fall	Other:		1						
Depth/Pool (m)			2						
Channel Slope (°)			3						
Wetted Width 1.4 / 1.4 / 1.9 /		m	Channel Width (m)	1.6 / 1.6 / 2.0		Unstable Banks (5%)			
Meander Frequency / / / /		m	Regular / Irregular meanders			Bank slope (5°)	L 60	R 60	

Instream Cover

Instream Cover (Detritus)	— %	Instream Cover (Twigs/Sticks, etc)	20 %	Substrate (as cover)	— %
Instream Cover (logs, etc)	5 %	Instream vegetation	5 %	Undercut Bank	10 %

Woody Debris Description (log jams, fallen trees, beaver activity, etc)

Substrate Composition (Sum 100%)

		Embed. (%)
% Organics	—	-
% Clay	—	-
% Silt	—	-
% Sand	—	-
% Gravel	60	0
% Cobble	40	0
% Boulder	—	—
% Bedrock	—	-

Instream Vegetaion (Sum 100%)

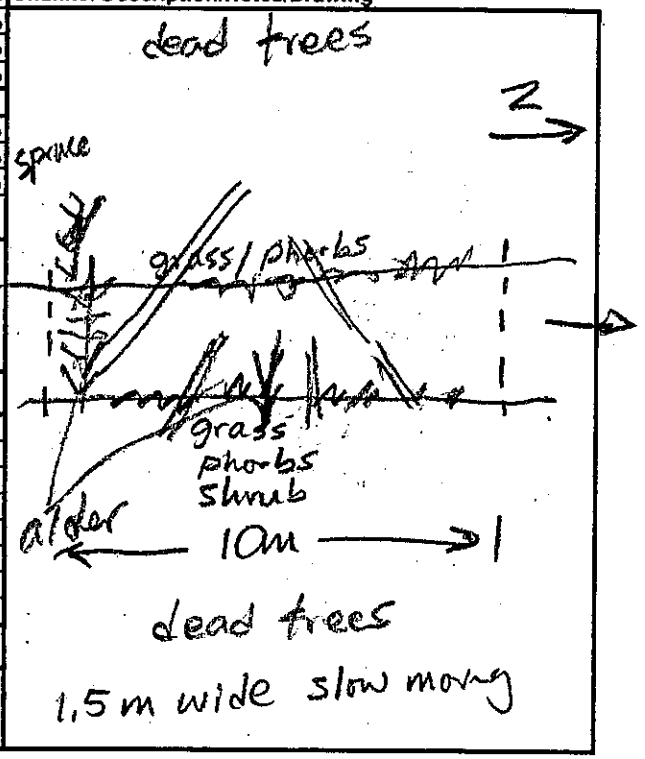
Rooted Emergent	0 %
Rooted Submergent	0 %
Rooted Floating	0 %
Free-floating	0 %
Floating Algae	0 %
Attached Algae	0 %
Periphyton	0 %
Filamentous	0 %
Aquatic Moss	0 %
Flooded Terrestrial Plants	0 %

Riprian Zone (25 m Buffer) circle

Mixed Forest	Coniferous Forest
Grasses	Deciduous Forest
Re-growth forest	Shrubs
Flooded	Sedges
Roads	Cutlines

old road r.o.w.

Channel Description/Notes/Drawing



Overhead Cover

Overhead Litter <150 mm	%	Overhead Litter >150 mm (%)	%
Overhead Undercut Banks	%	Overhanging Trees	%
Overhanging Grasses	%	Overhanging Shrubs	%

Miscellaneous

High water mark	.60 m	Weather: previous 24 H
Flood Evidence (Debris on plants, etc)	.60 m	clear
Air Temperature	°C	
Cloud Cover (5%)	Cirrus 60%	
Wind Direction + speed (km/h)	0	

In situ Water Parameters

pen probe titration

Sample Depth (m)			
Dissolved Oxygen (%)		60.5	
Dissolved Oxygen (mg/L)		8.45	7.2
Secchi Depth (m)			
Temperature (°C)	9.5		
pH	7.1	8.6	
Turbidity (TCU)			
Conductivity (uS/cm)	480		

Landscape (Beyond 25 m Buffer) circle

Mixed Forest	Coniferous Forest	Roads	
Grasses	Deciduous Forest	Cutlines	
Re-growth forest	Shrubs	Hills	

Visible Disturbance circle

Surface Debris	Culvert
Beaver Dam	Weir
Collapsed Bank	

Photos Dead trees (forest fire)

Channel Features	#	Dimensions
Islands		
Bars		

Notes 4.8