

Joyce Lake

Watershed: Attikamagen Lake **Latitude:** 54°53'45.0" N
Altitude (m): 505 **Longitude:** 66°31'25.5" W

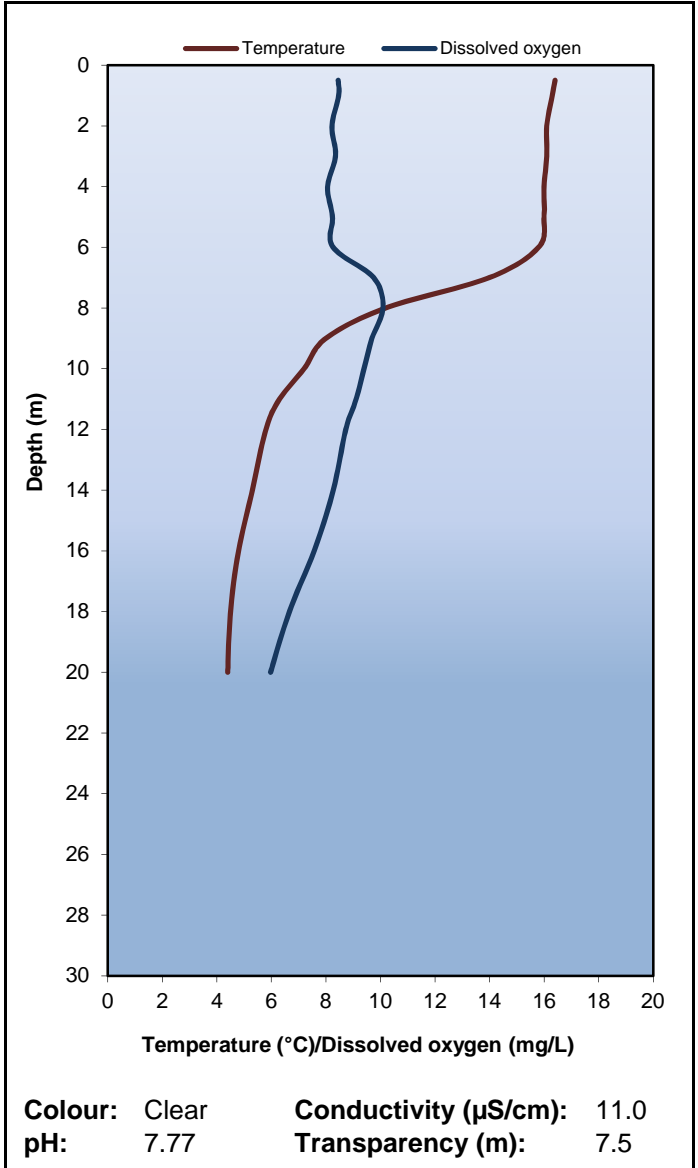
Morphometry

Surface area (ha):	37.0	D_L²:	1.44
Perimetre (m):	3,110	D_V³:	1.00
Volume (m³):	2,846,175	Island (#):	0
Maximum length (km):	1,346	Connecting streams:	0
Mean depth (m):	7.7		

Water physico-chemistry

Date: July 29, 2012 **Maximum depth (m):** 23.0

Depth (m)	Temperature (°C)	Dissolved oxygen (mg/L) ¹	Min. requirement (mg/L)
0.5	16.4	8.45	5.38
1.0	16.3	8.47	5.39
2.0	16.1	8.22	5.41
3.0	16.1	8.35	5.41
4.0	16.0	8.06	5.43
5.0	16.0	8.24	5.43
6.0	15.8	8.26	5.45
7.0	14.0	9.75	5.65
8.0	10.2	10.09	6.15
9.0	8.0	9.69	6.47
10.0	7.2	9.40	6.60
11.0	6.3	9.11	6.75
12.0	5.8	8.73	6.83
14.0	5.3	8.27	6.92
16.0	4.8	7.57	7.01
18.0	4.5	6.66	7.07
20.0	4.4	5.97	7.09



¹ Minimum requirement for fish (Turgeon, 1985); the values shown in red indicate that the dissolved oxygen concentration is below the minimum requirement.
² Shoreline development index
³ Volume development index

Figure 9. Morphometric Characteristics and Water Physicochemistry in Joyce Lake

Joyce Lake

Date: August 1, 2012

Overnight set: No

Fishing Effort and Yield

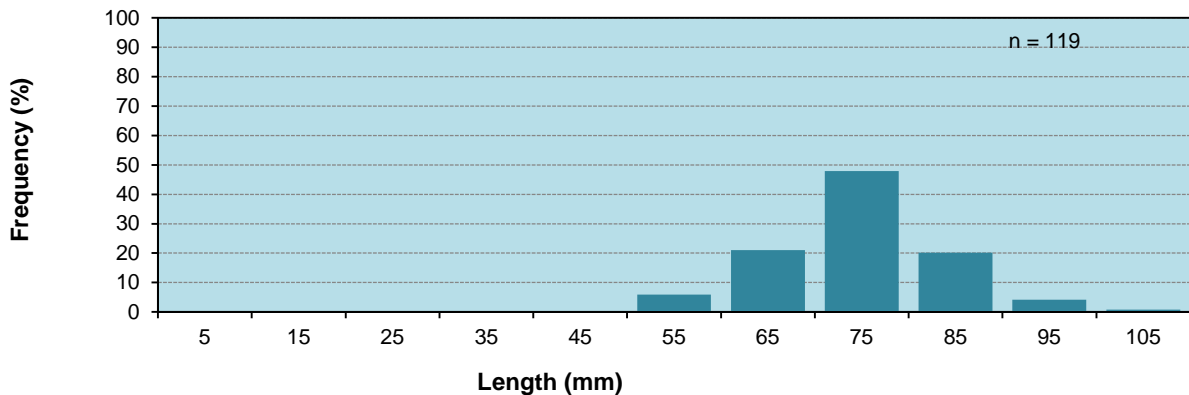
Gear	Number of gear	Species ¹	Capture	Biomass (g)	CPUE ²	BPUE ³
Gillnet	4	---	---	---	---	---
Minnow trap	8	PD	119	ND	14.9	ND

Fish Population Characteristics

Parameters	PD
Mean length ± S.D. (mm):	73.5 (9.4)
Mean weight ± S.D. (g):	ND
Mean condition factor:	ND
Weight-length equation:	ND
Sex ratio: Male	ND
Female	ND
Juvenile or not determined	ND
PSD index	-
RSD: Sub-stock	-
Stock	-
Quality	-
Preferred	-
Memorable	-
Trophy	-

Length Frequency

Pearl dace (PD)

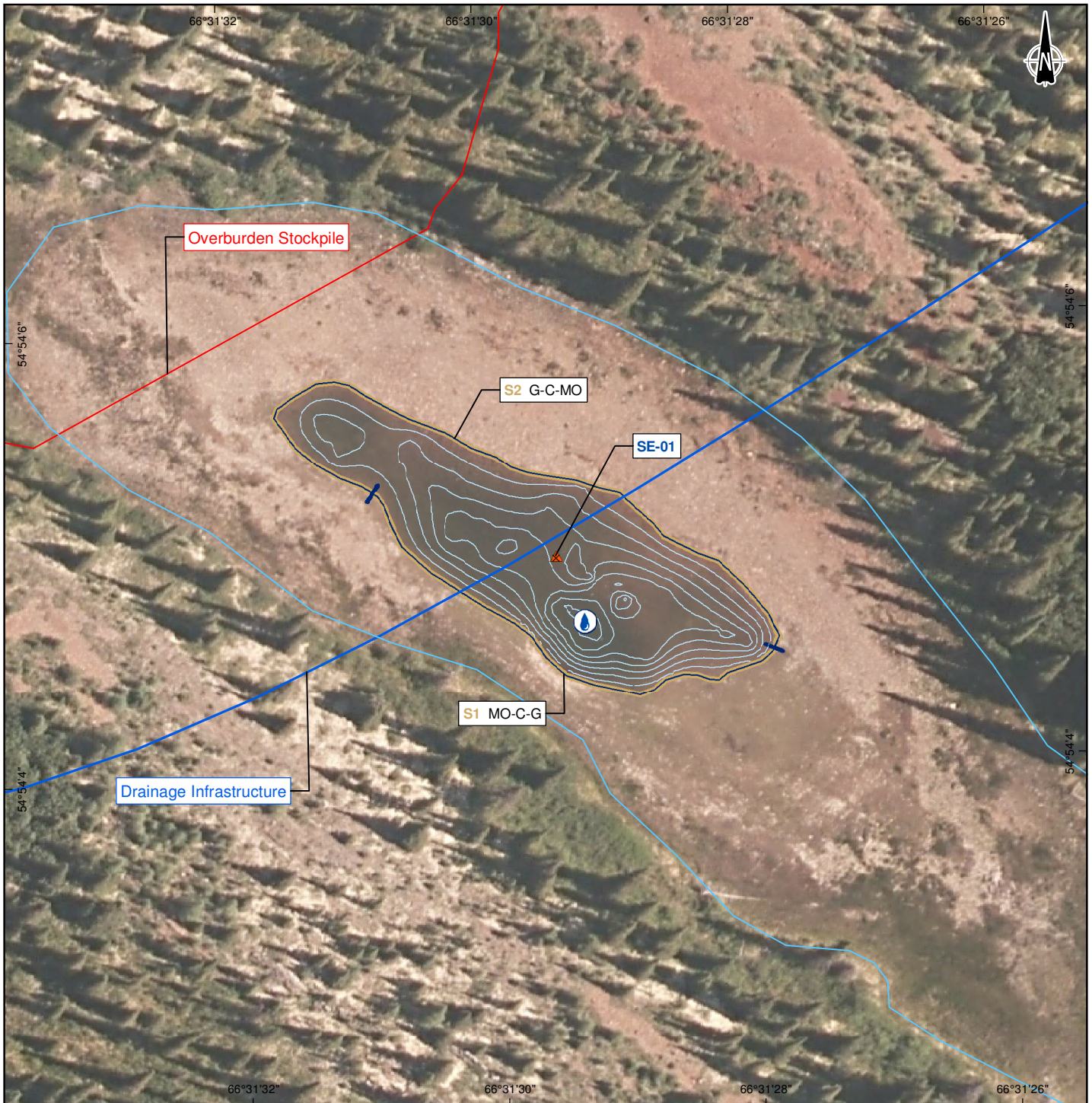


¹ Species: PD: Pearl dace.


² Catch per unit effort: Number of capture per day; where a day is approximately 6 hours.

³ Biomass per unit effort: Biomass per day; where a day is approximately 6 hours

Figure 10: Fish Sampling Results in Joyce Lake



Project Components	Segmentation	Habitat Characteristics
Revised project layout (May 2013)	Shoreline segment	Isobathe (Equidistance: 0.2 m)
Drainage infrastructure (May 2013)	Substrate	High water mark
		Water physico-chemistry
Fish Sampling	Substrate	
Gear type Sequential number	G Rubble (140 to 250 mm)	
No fish	C Cobble (30 to 140 mm)	
Fishing Gear	MO Organic material	
Seine net (SE)		



Joyce Lake Direct Shipping
Iron Ore Project

- Fish and Fish Habitat Baseline Study -

Pond A

Sources:
 Base: CanVec, 1/50 000, RNCan, 2010
 Orthophoto: Mosaïque photo XEOS

Mapping and Inventory: GENIVAR 2012
 File: 121-18002-00_F11_FAQ_Pond_A_130619.mxd


Scale 1:800

0 8 16 24 m

UTM, zone 19, NAD83

Figure 11

November 2013



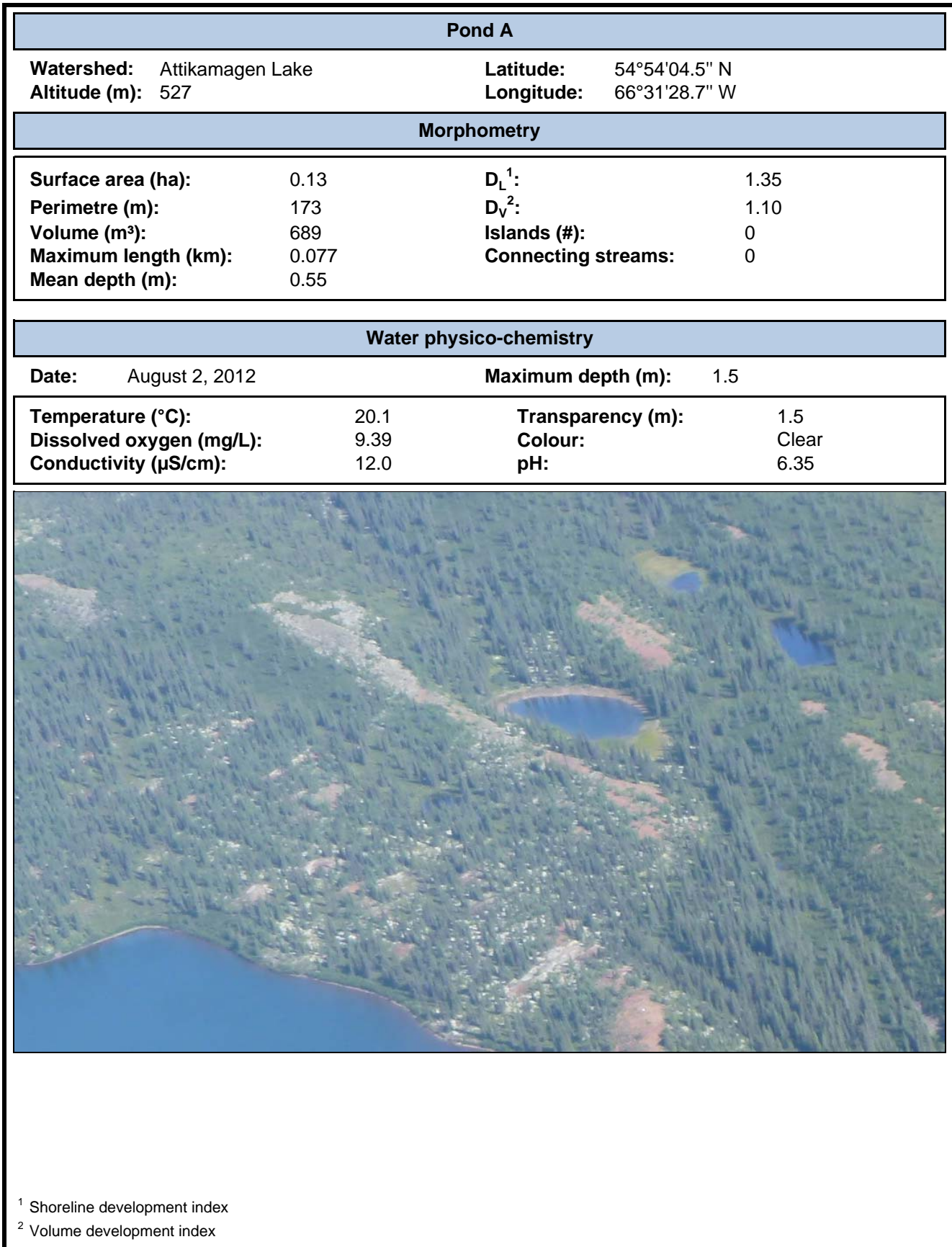


Figure 12. Morphometric Characteristics and Water Physicochemistry in Pond A

Water Chemistry

The water was transparent enough to observe the bottom of the pond at 1.5 m deep and the water showed no particular colour. The surface temperature was 20.1 °C and the dissolved oxygen was 9.39 mg/L (Figure 12). The pH was slightly acidic (6.35) and the conductivity low (12 µS/cm).

Fish Population

Fish sampling was conducted in this lake on August 2, 2012 using a seine net and no fish was found (Appendix A). Due to the small size of the pond and the low water depth, seining covered the entire surface area of the pond. Considering its morphometric characteristics and the absence of fish, this pond is not considered a fish habitat.

5.2.4 Pond B

Morphometry

Pond B is a small waterbody adjacent to Joyce Lake (Figure 13). The surface area is 2.51 ha. The maximum depth was 5.3 m with a mean depth of 1.7 m. The shoreline development and volume development indices are respectively 1.53 and 0.96 which indicate a low potential for productivity.

No connecting stream was found during the field characterization. However, based on the topography and on the high-resolution aerial photographs, there could be one intermittent stream between Pond B and Joyce Lake. If it occurs, Pond B discharges into Joyce Lake on exceptional occasions as there is not much evidence of a connection between these two waterbodies.

Water Chemistry

The water was transparent enough to observe the bottom of the pond at 5.3 m deep and the water showed no particular colour. The surface temperature was 18.6 °C and the dissolved oxygen was 7.68 mg/L (Figure 14). The pH was near neutrality (6.87) and the conductivity low (9.0 µS/cm).

Fish Population

Fish sampling was conducted in this pond on August 2, 2012 using one gillnet and two minnow traps set overnight (Appendix A). No fish were found in Pond B. Considering the absence of permanent streams and the absence of fish, Pond B was not considered to be a fish habitat.

5.2.5 Pond C

Morphometry

Pond C is a small pond located between Ponds B and D (Figure 13). The surface area of Pond C is 0.30 ha (Figure 15). The maximum depth was 1.4 m with a mean depth of 0.53 m. This small waterbody is part of a bog and no connecting stream was found during the field characterization (Photo 26, Appendix D). No sign of any

connection between Pond C to Ponds B or D was observed on high-resolution aerial photographs.

Water Chemistry

The water was transparent enough to observe the bottom of the pond at 1.4 m deep and the water showed no particular colour. The surface temperature was 17.6 °C and the dissolved oxygen was 8.81 mg/L (Figure 15). The pH was slightly acidic (6.59) and the conductivity low (12.0 µS/cm).

Fish Population

Fish sampling was conducted in this pond on August 2, 2012 using a seine net and no fish were found (Appendix A). Seining covered the entire surface area of the pond. Considering the morphometric characteristics of this pond (shallow water, no connecting stream) and the absence of fish, Pond C was not considered a fish habitat.

5.2.6 Pond D

Morphometry

Pond D is a small waterbody adjacent to Joyce Lake (Figure 16). The surface area of Pond D is 2.1 ha (Figure 17). The maximum depth was 8.3 m with a mean depth of 3.1 m. The shoreline development and volume development indices are respectively 1.28 and 1.12 which indicate a low potential of productivity.

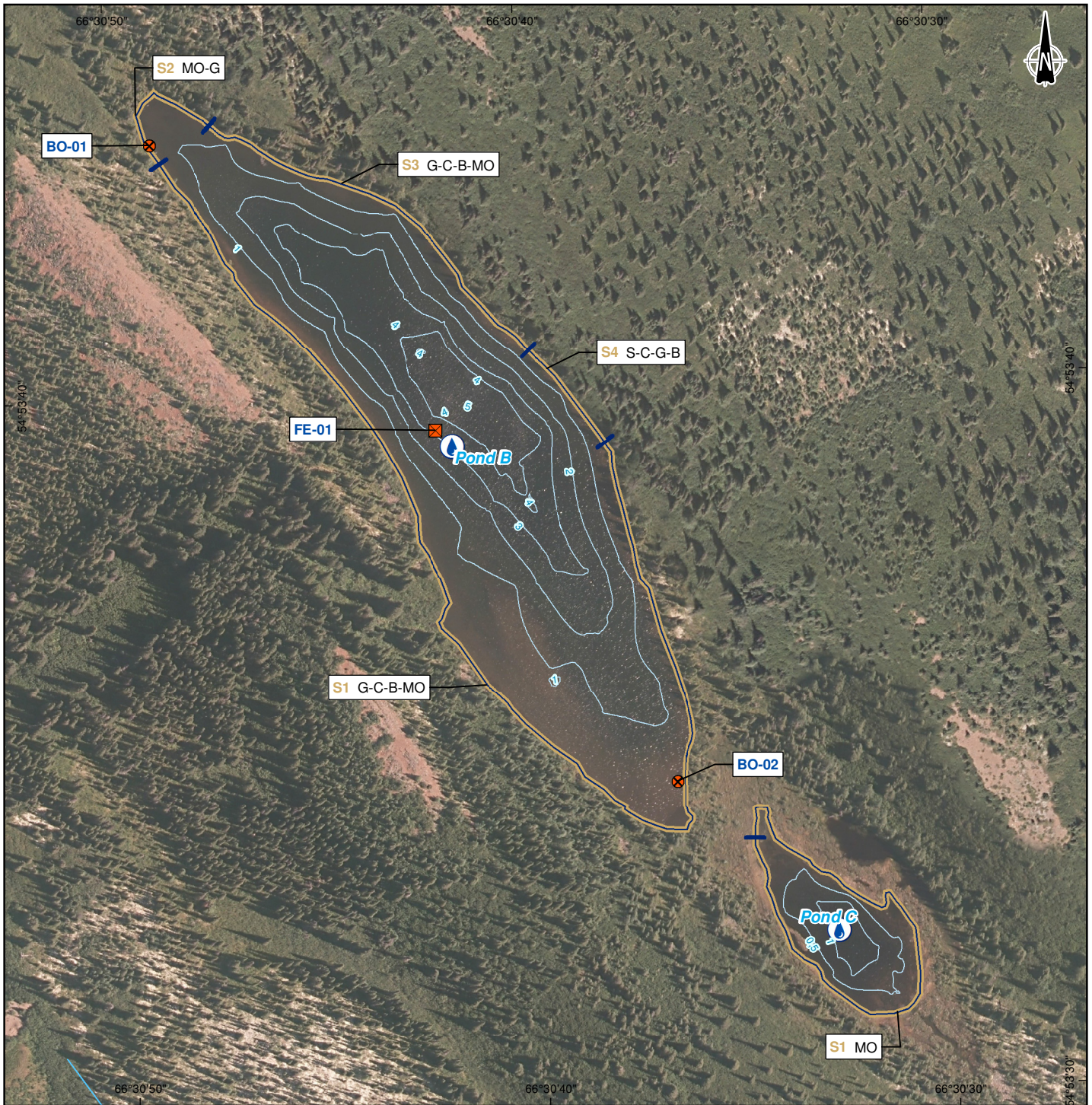
No connecting stream was found during the field characterization and none were observed on the high-resolution aerial photographs.

Water Chemistry

The Secchi depth was 6.5 m and the water showed no particular colour. The temperature-oxygen profile shows a thermal stratification near the bottom of the pond, where an increase in dissolved oxygen is also present (Figure 17). The surface temperature was 16.9 °C and the dissolved oxygen was 9.63 mg/L. The pH was slightly alkaline (7.45) and the conductivity low (11.0 µS/cm).

Fish Population

Fish sampling was conducted in this pond on August 3, 2012 using one gillnet, one fyke net and two minnow traps set overnight (Appendix A). No fish were found in Pond D. Considering the absence of fish and the absence of any connecting streams, Pond D was not considered a fish habitat.



Fish Sampling

- Gear type
Sequential number
 No fish
 Minnow trap (BO)
 Gill net (FE)

Segmentation

- Shoreline segment
 Substrate
Segment number
Substrates
 B Boulder (250 to 1,000 mm)
 G Rubble (140 to 250 mm)
 C Cobble (30 to 140 mm)
 S Silt and Clay (<0.006 mm)
 MO Organic material

Habitat Characteristics

- Isobathe
(Equidistance Pond B: 1 m)
(Equidistance Pond C: 0.5 m)
 Water physico-chemistry



Joyce Lake Direct Shipping
Iron Ore Project

- Fish and Fish Habitat Baseline Study -

Ponds B and C

Sources:
 Base: CanVec, 1/50 000, RNCan, 2010
 Orthophoto: Mosaïque photo XEOS
 Mapping and Inventory: GENIVAR 2012
 File: 121-18002-00_F13_FAQ_Ponds_B_et_C_130619.mxd

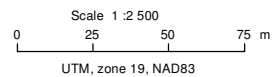


Figure 13

November 2013



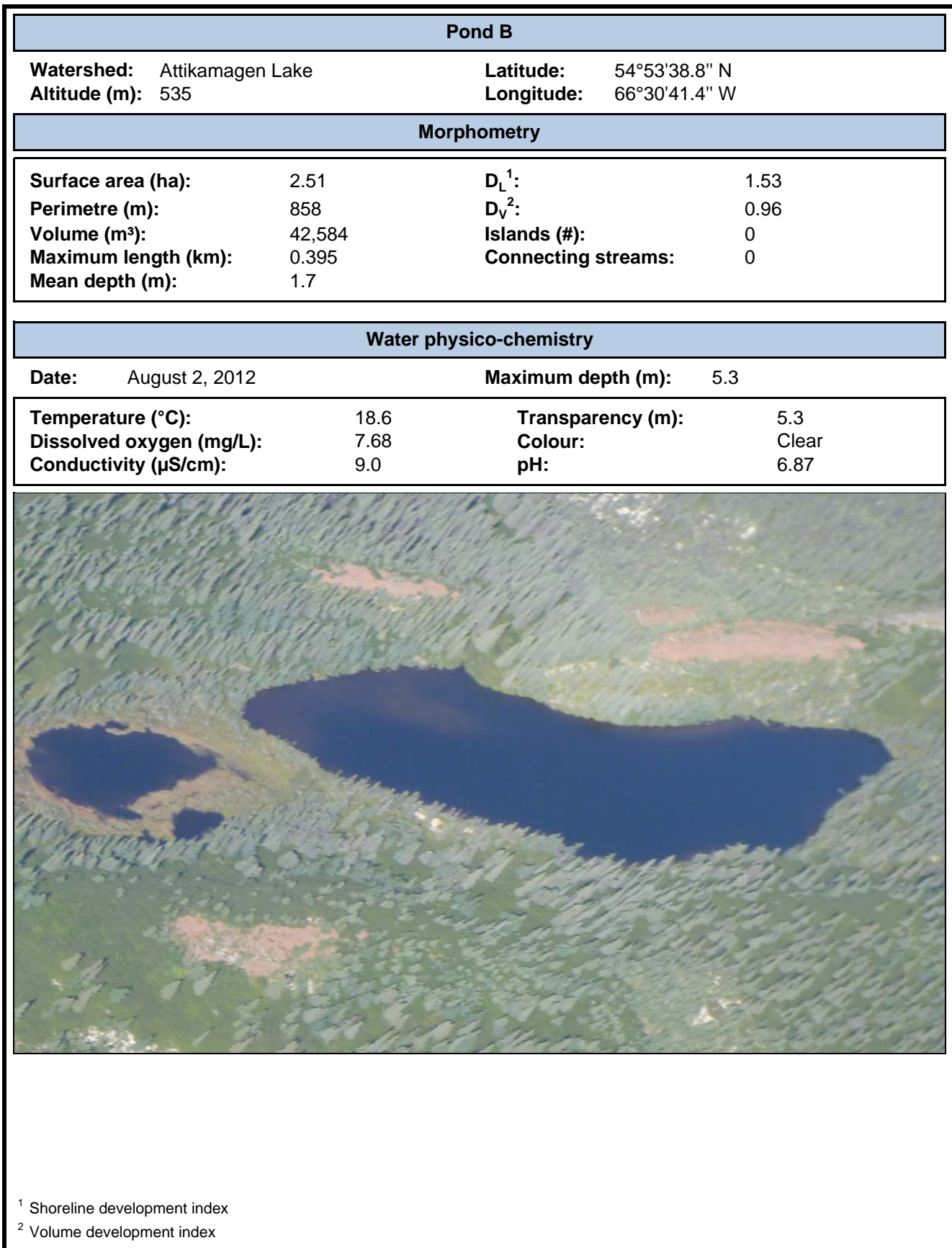


Figure 14. Morphometric Characteristics and Water Physicochemistry in Pond B

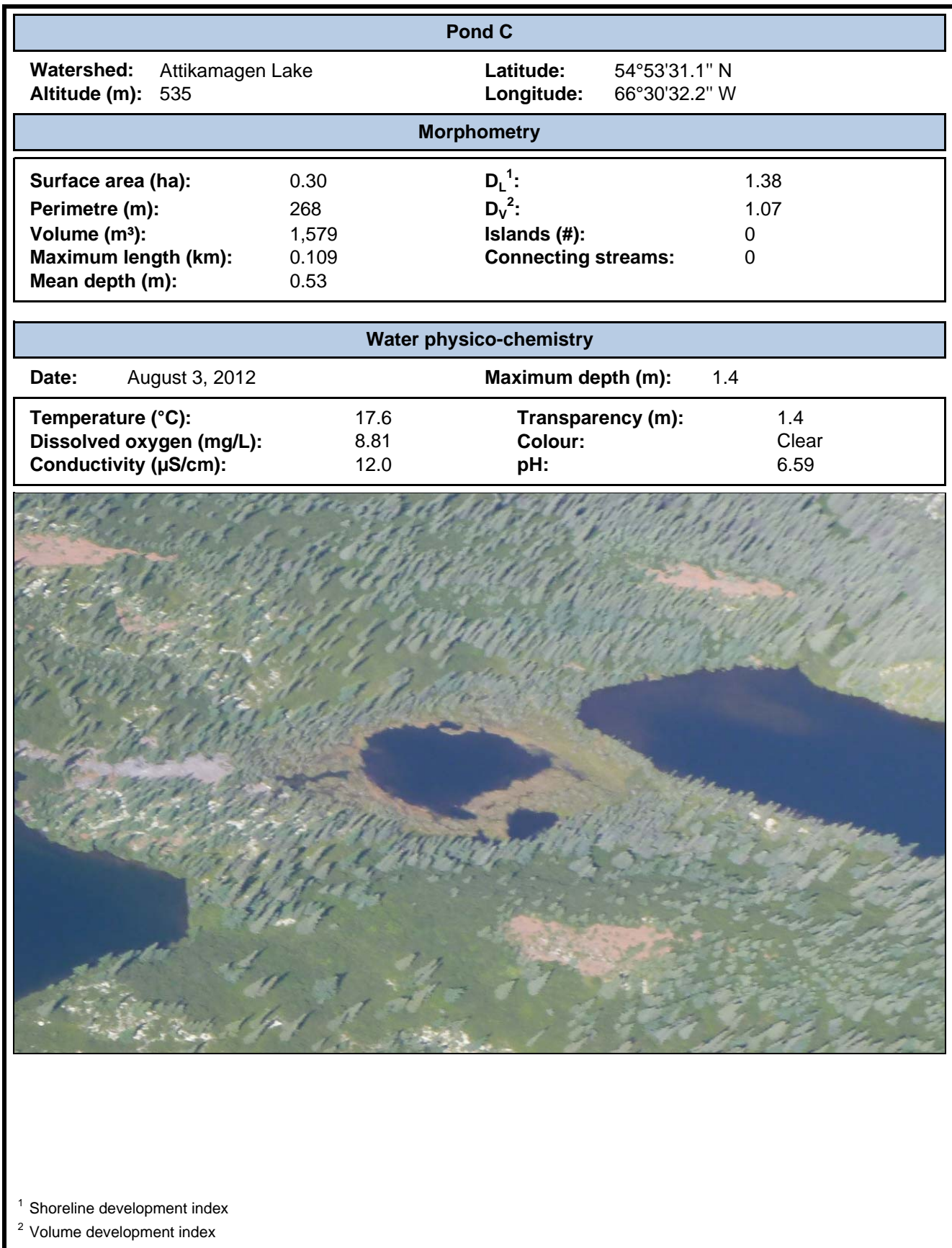
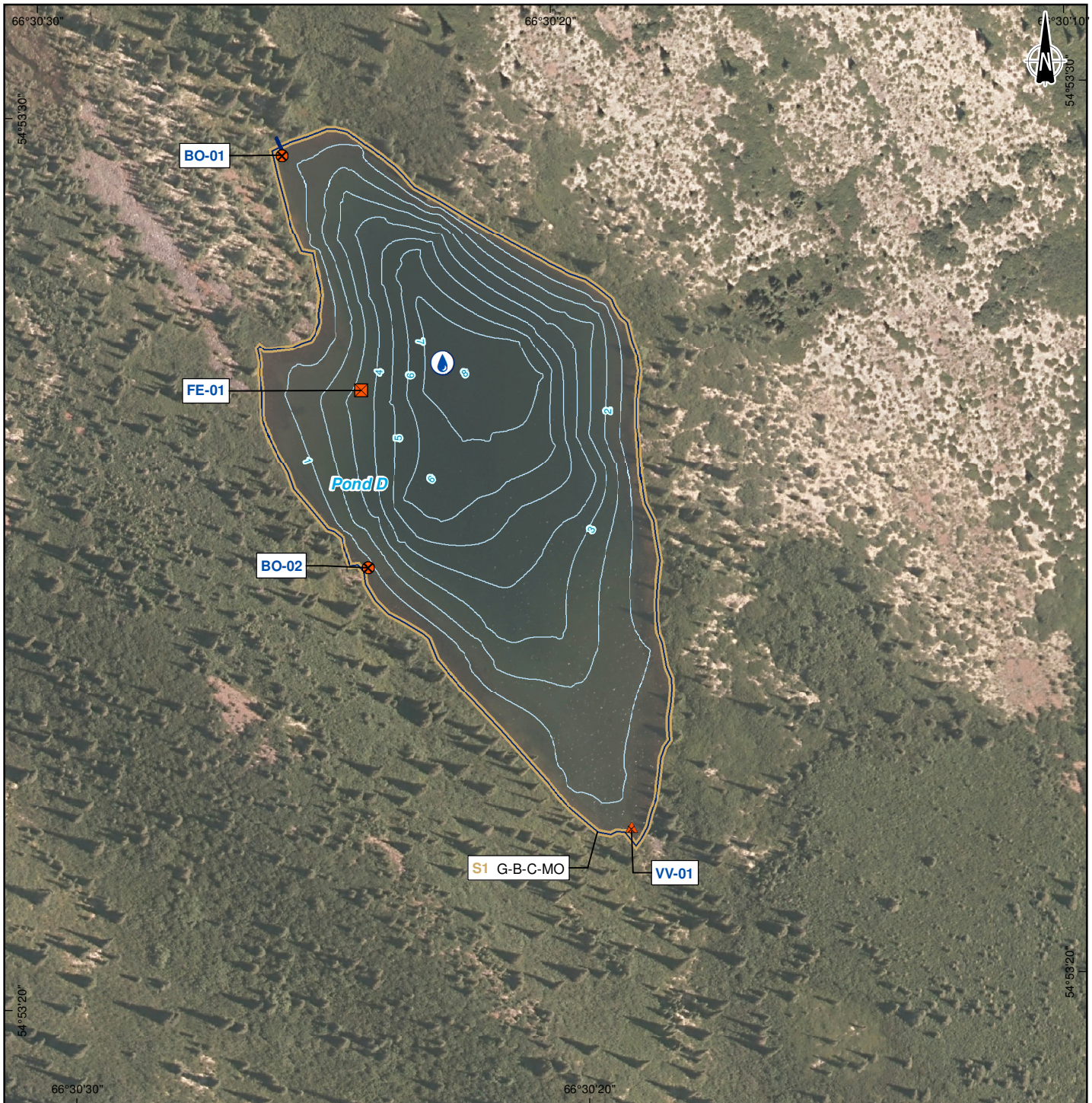


Figure 15. Morphometric Characteristics and Water Physicochemistry in Pond C



Fish Sampling

Gear type
 Sequential number
 X No fish

Fishing Gear

- Minnow trap (BO)
- Gill net (FE)
- Fyke net (VV)

Segmentation

Shoreline segment

 Substrate
 Segment number

Substrate

- B Boulder (250 to 1,000 mm)
- G Rubble (140 to 250 mm)
- C Cobble (30 to 140 mm)
- MO Organic material

Habitat Characteristics

Isobathe (Equidistance: 1 m)

 Water physico-chemistry



Joyce Lake Direct Shipping
Iron Ore Project

- Fish and Fish Habitat Baseline Study -

Pond D

Sources:
 Base: CanVec, 1/50 000, RNCan, 2010
 Orthophoto: Mosaïque photo XEOS
 Mapping and Inventory: GENIVAR 2012
 File: 121-18002-00_F16_FAQ_Pond_D_130619.mxd

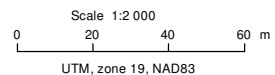


Figure 16

November 2013



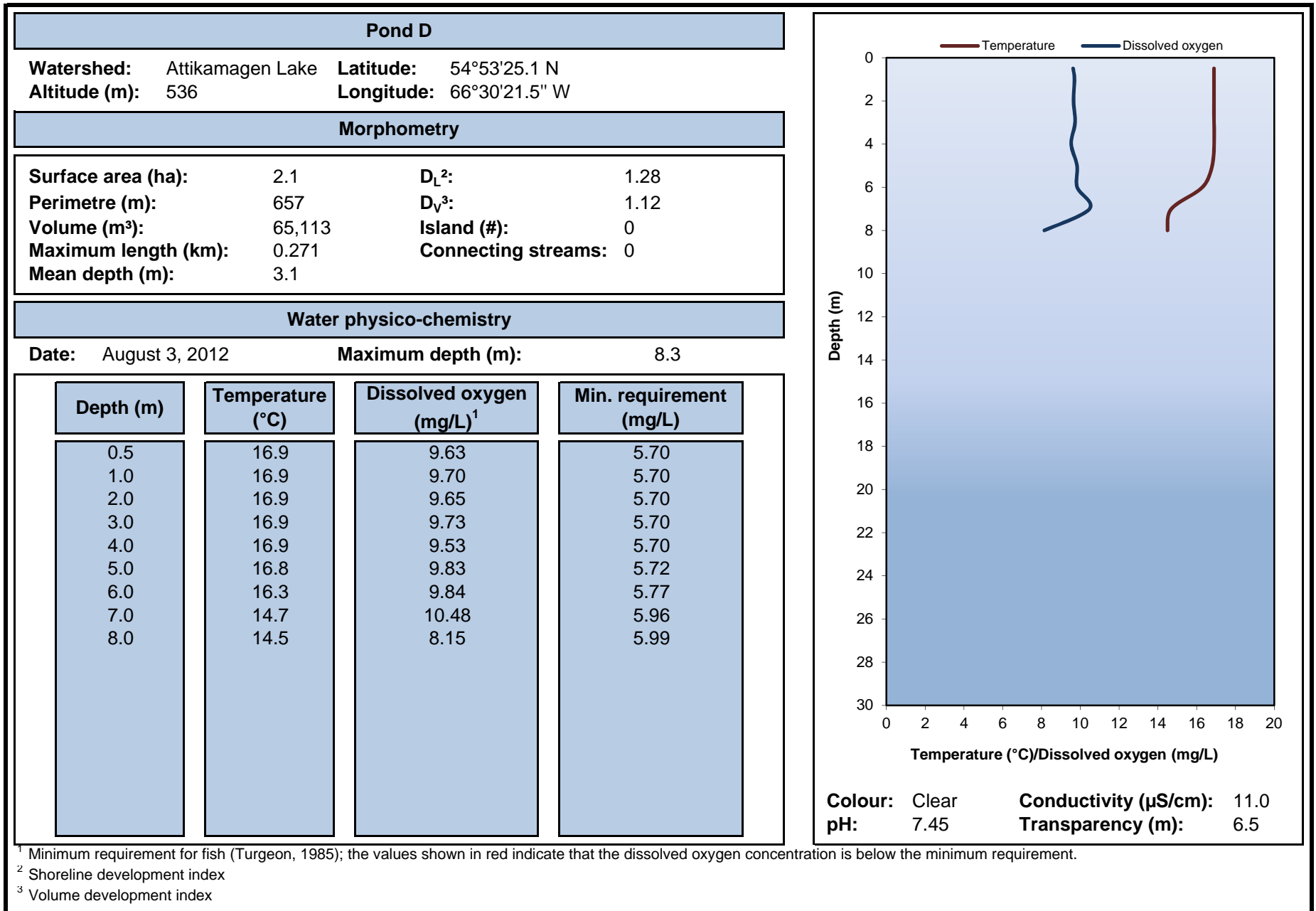


Figure 17. Morphometric Characteristics and Water Physicochemistry in Pond D

5.2.7 Lake E

Morphometry

Lake E is located halfway between Joyce Lake (north) and Hollinger Lake (south) (Figure 18). This waterbody has a surface area of 26.9 ha and the bathymetric survey indicates that there are three basins in the lake and the deepest (19.0 m) is located in its eastern part. The mean water depth is 5.3 m (Figure 19). This lake has a very long shoreline as compare to its surface area (D_L : 2.20) which, in general, indicates a relatively high potential of productivity. The volume development index is 0.84 which suggest, on the opposite, a low potential of productivity.

Water Chemistry

The temperature-oxygen profile in Lake E is typical of a heterograde dimictic lake (Figure 19; Wetzel, 2001). The thermocline was present between 5 and 10 m and suggests that two thermoclines were formed during the summer; the earliest being present between 7 and 10 m. The dissolved oxygen increases near 6 m and 10 m, corroborates that the stratification of the water occurred in two stages separated probably by a period of mixing. The dissolved oxygen concentrations below 10 m were below the minimum requirement for fish. Some fish species more sensitive to dissolved oxygen (such as brook trout) may avoid the deepest parts of the lake (<10 m).

The water showed no particular colour and the Secchi depth was 7.5 m, which is similar to what was measured in Attikamagen and Joyce lakes. This value is quite high and is generally representative of a low-productivity lake. The pH is alkaline with a value of 8.00. However, the pH value decreases from the top to the bottom of the water column to reach a lower value of 6.51 near the bottom of the lake. The conductivity is relatively high as compare to the other lakes found in the Study Area (94.0 $\mu\text{S}/\text{cm}$) and confers to this lake a good productivity potential.

Fish Population

On August 8-9, 2012, fish sampling was conducted in Lake E using gillnets, a fyke net and minnow traps (Figure 20; Appendices A and B). Fishing gear was set overnight. A total of seven fish species were caught, longnose sucker, white sucker and pearl dace being the three most abundant with relative abundances of 47.5, 14.6 and 19.1 %, respectively. The other species found were lake trout, brook trout, burbot and mottled sculpin, which accounted for less than 5 % each. The fyke net provided the highest yield with 67.0 captures per gear-night (Figure 20). Catches per unit effort for gillnets were 57.0 captures per gear-night and 9,289 g per gear-night. These results confirm that Lake E is a productive waterbody.

Longnose sucker has a mean length of 167.0 mm and a mean weight of 62.7 g (Figure 20). Most specimens caught were juveniles and the 150-200 mm class was predominant. The mean length of white sucker was slightly higher at 196.7 mm, mostly due to the presence of some adults. The mean weight was 141.1 g. The 150-200 mm class is also predominant as shown by the length-frequency distribution histogram. Both juveniles and adults were captured.

Pearl dace had a mean length of 117.2 mm and a mean weight of 17.8 g (Figure 20). The length-frequency is widely distributed and the specimens from 120 to 130 mm were predominant.

Lake trout have a mean length of 537.3 mm and a mean weight of 1,290. g. The lake trout condition factor in Lake E (0.808) is lower than the factor estimated for lake trout in Attikamagen Lake (Figure 20). Lake E is quite small to support such a species but the high density of the other species may explain the presence of lake trout in providing food to support a small population. Specimen caught ranged from 450 to 650 mm and they were mostly distributed in the stock (88) category. The PSD index was 88, which may indicate an unbalanced population. However, the number of captures (n = 8) is too low to draw any conclusion.

Lacustrine Habitats

The shoreline substrate was mainly composed of cobble, rubble and boulders (Figure 18; Appendix C). Bur-reed was found in segment S3 and covers a surface area of approximately 140 m². Riparian vegetation was mostly composed of mature trees. A beaver lodge was observed in segment S10.

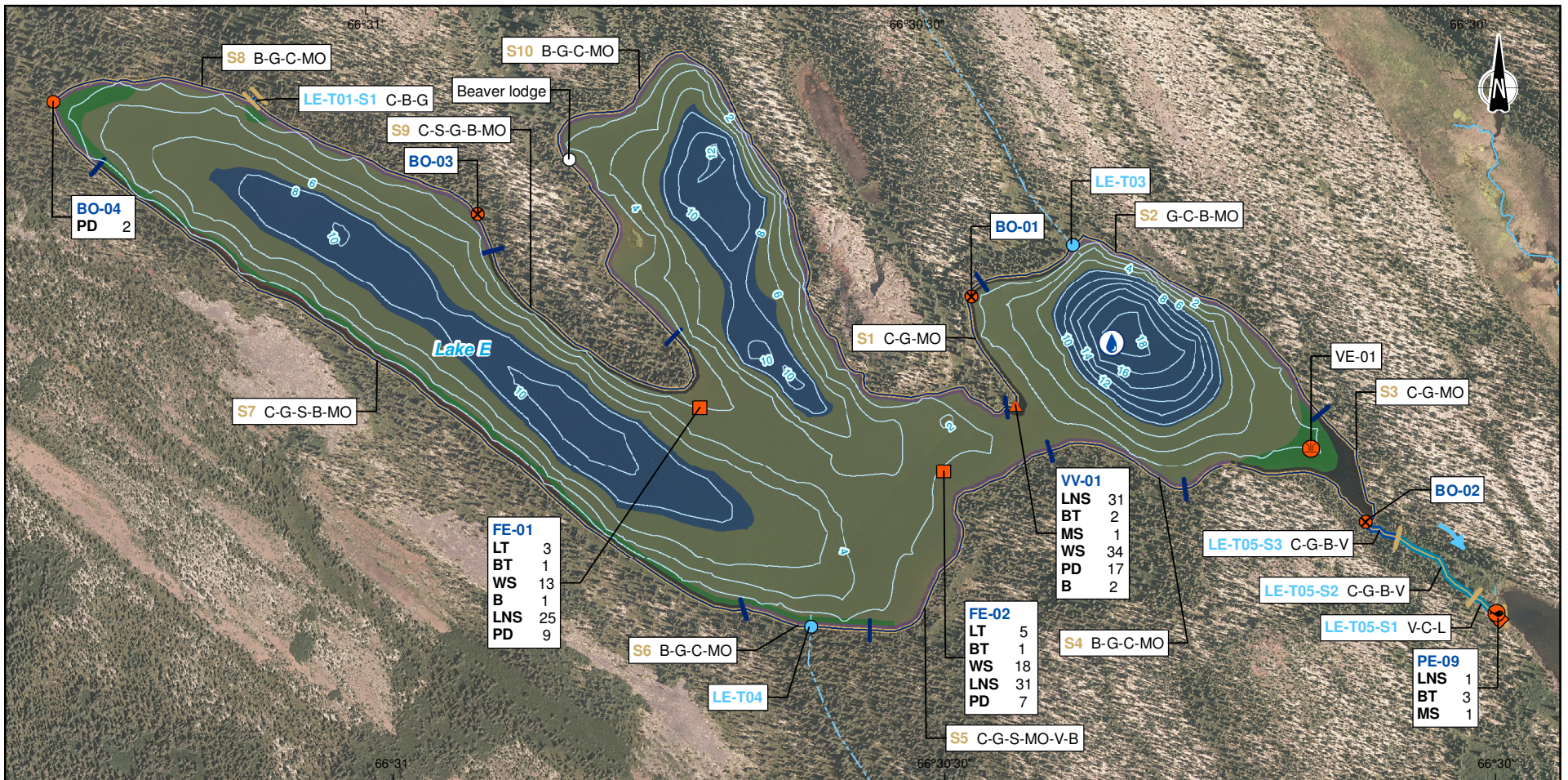
The habitat classification is shown on Figure 18. In the littoral zone, fine substrate without vegetation is predominant. Medium substrate and coarse substrate without vegetation were mostly found along the shoreline. Two small areas with vegetation were found, a small one in segment S3 with fine substrate and one thin area along the south-west shore composed of medium substrate (Photo 27, Appendix D). In the non-littoral zone, fine substrate is predominant but coarse substrate was also found.

The number of suitable habitat equivalent units was calculated for the seven species found in the lake (Appendix F). The total habitat equivalent units varies from 12,276 m² (longnose sucker) to 175,634 m² (lake trout). However, the non-littoral zone may be unsuitable at times for fish or some fish life stages, when dissolved oxygen concentrations below 10 m are very low. This condition may occur during the summer, when the thermocline is established, or during the winter under ice cover.

Connecting Streams

There are three tributaries and the outlet streams that connect to Lake E. Two of them, LE-T03 and LE-T04, are intermittent, and they were dry during the field characterization. A small stream was found in the western bay (LE-T01). This is mostly an underground stream as only the first 4 m could be seen (spring water; Photo 28, Appendix D).

The most important watercourse is LE-E01, which is the lake outlet that discharges into a small pond that connects to HO-T02 (Figure 18). The downstream segment in LE-E05 (S1) is 37 m long, has a mean width of 1.5 m and had a mean water depth of 0.26 m (Appendix E). The substrate is mainly composed of gravel (80 %), with cobble (10 %) and silt (10 %) as well. This segment was judged to have a high potential as a brook trout spawning habitat (Photo 29, Appendix D). The vegetation cover is mostly overhead, and herbaceous plant species are dominant (Photo 30,



Fish Sampling

PE-09	—	Gear type
	—	Sequential number
	—	Number of capture
	—	Species

Species

X	No fish
LNS	Longnose sucker
WS	White sucker
MS	Mottled sculpin
B	Burbot
PD	Pearl dace
BT	Brook trout
LT	Lake trout

Fishing Gear

●	Minnow trap (BO)
■	Gill net (FE)
▲	Fyke net (VV)

Segmentation

—	Shoreline segment
—	Stream segment

Type of habitat

●	Moderate water
●	Fast water

S3 C-G-MO	Substrate
3	Segment number
LE-T05-S1	Substrate
5-1	Segment number
1	Stream number
E	Lake E

Substrate

B	Boulder (250 to 1,000 mm)
G	Rubble (140 to 250 mm)
C	Cobble (30 to 140 mm)
V	Gravel (2 to 30 mm)
S	Sand (0.006 to 2 mm)
L	Silt and Clay (<0.006 mm)
MO	Organic material

Habitat Characteristics

—	Isobathe (Equidistance: 2 m)
●	Water physico-chemistry
●	Potential spawning ground (SAFO)
●	Aquatic vegetation
—	Flow direction
—	Intermittent

Non-Littoral Zone

■	Fine substrate
■	Coarse substrate without vegetation
■	Medium substrate without vegetation
■	Medium substrate with vegetation
■	Fine substrate without vegetation
■	Fine substrate with vegetation

Littoral Zone



Joyce Lake Direct Shipping Iron Ore Project

- Fish and Fish Habitat Baseline Study -

Lake E

Sources:
 Base: CanVec, 1/50 000, RNCan, 2010
 Orthophoto: Mosaïque photo XEOS
 Mapping and inventory: GENIVAR 2012
 File: 121-18002-00_F18_FAQ_Lake_E_130619.mxd

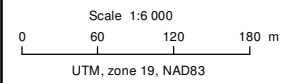


Figure 18

November 2013



Lake E

Watershed: Attikamagen Lake **Latitude:** 54°52'45.4" N
Altitude (m): 493 **Longitude:** 66°30'40.9" W

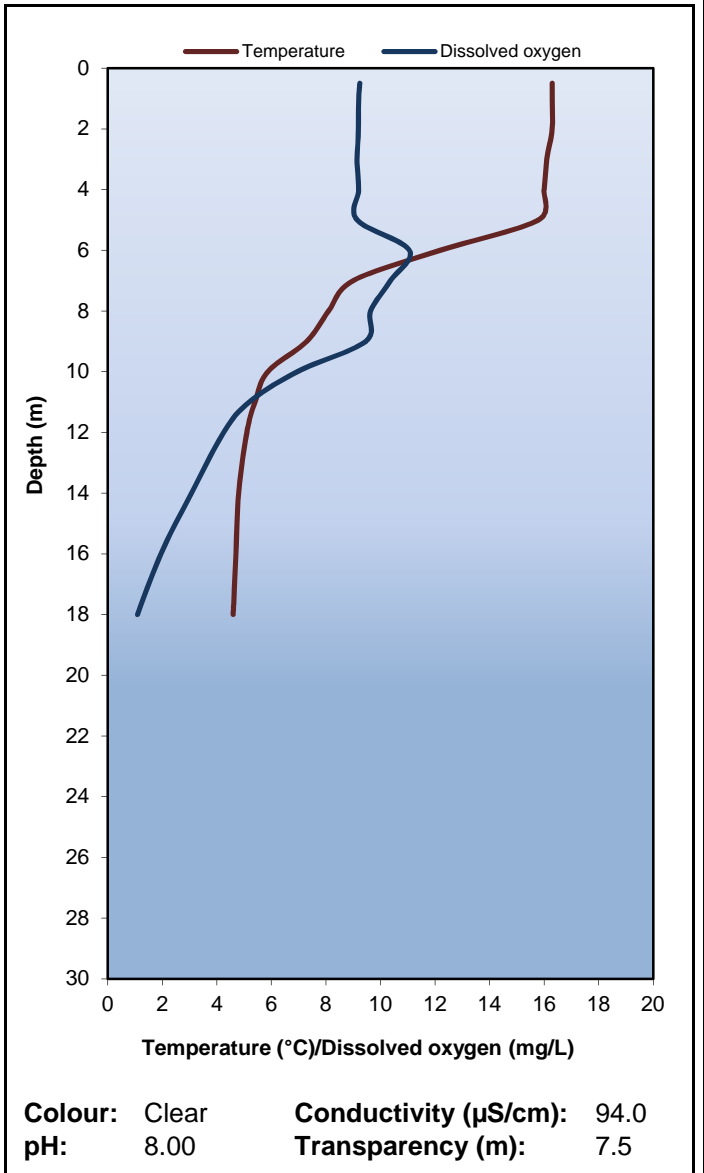
Morphometry

Surface area (ha): 26.9 **D_L²:** 2.20
Perimetre (m): 4,048 **D_V³:** 0.84
Volume (m³): 1,434,489 **Island (#):** 0
Maximum length (km): 1,330 **Connecting streams:** 1
Mean depth (m): 5.3

Water physico-chemistry

Date: August 4, 2012 **Maximum depth (m):** 19.0

Depth (m)	Temperature (°C)	Dissolved oxygen (mg/L) ¹	Min. requirement (mg/L)
0.5	16.3	9.24	5.74
1.0	16.3	9.20	5.74
2.0	16.3	9.19	5.74
3.0	16.1	9.14	5.77
4.0	16.0	9.20	5.78
5.0	15.8	9.14	5.80
6.0	12.2	11.06	6.26
7.0	9.0	10.37	6.73
8.0	8.1	9.64	6.87
9.0	7.3	9.46	7.01
10.0	5.9	6.95	7.26
11.0	5.4	5.19	7.35
12.0	5.1	4.25	7.41
14.0	4.8	3.07	7.47
16.0	4.7	1.95	7.49
18.0	4.6	1.09	7.51



¹ Minimum requirement for fish (Turgeon, 1985); the values shown in red indicate that the dissolved oxygen concentration is below the minimum requirement.
² Shoreline development index
³ Volume development index

Figure 19. Morphometric Characteristics and Water Physicochemistry in Lake E

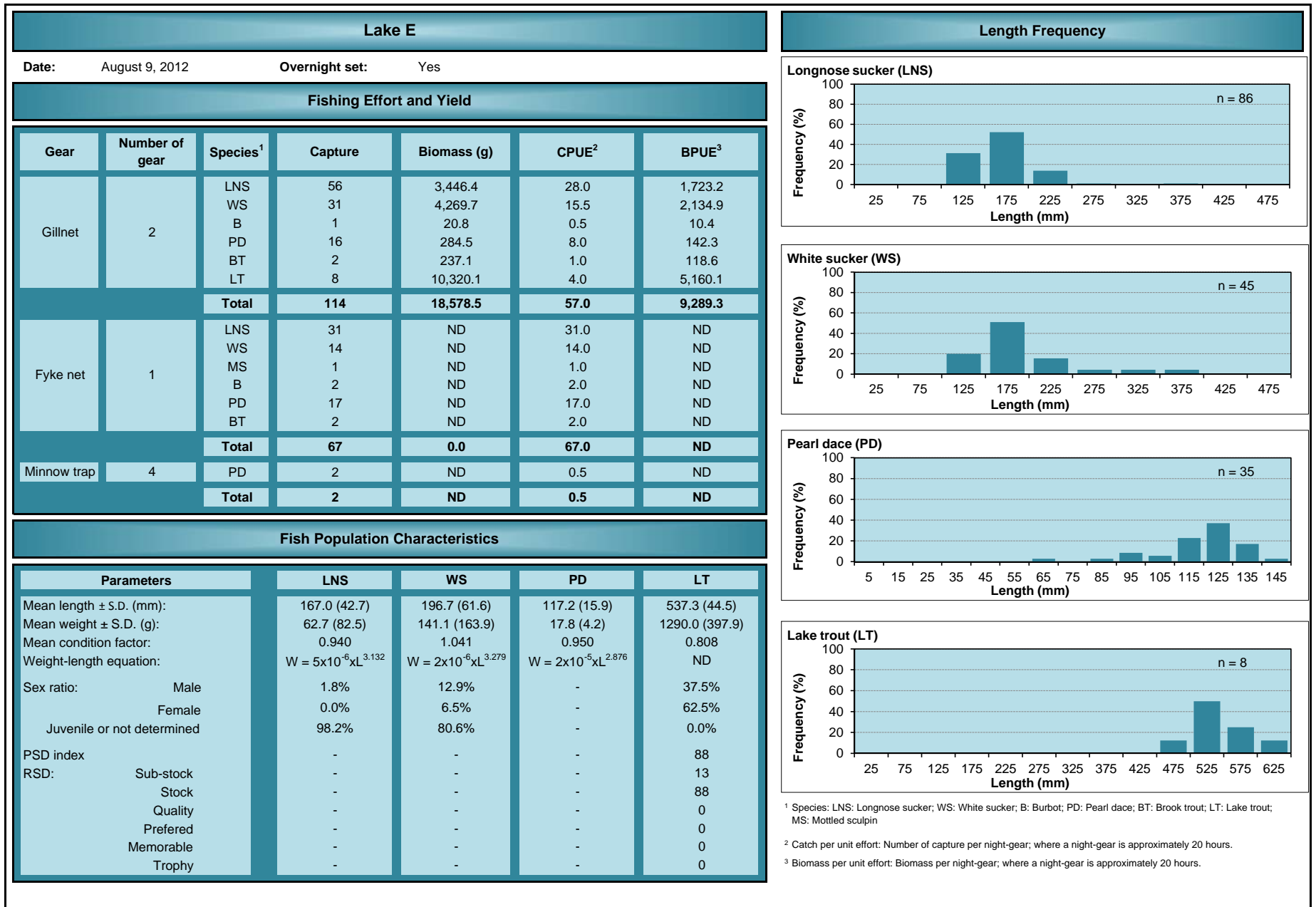


Figure 20: Fish Sampling Results in Lake E

Appendix D). Segment S2 is the longest at 97 m with fast waters alternating with slow waters. The substrate is composed of cobble, rubble, boulders and gravel. The vegetation cover is approximately 40 % overhanging and 20 % overhead, with shrubby vegetation being predominant. The upstream segment (S3) is a fast water habitat (rapid/run with eddies). Cobble is the dominant substrate category (60 %) with some rubble, boulders and gravel. The overhanging vegetation covers approximately 50 % of the stream and is composed of shrubs (Photo 32, Appendix D). There is no barrier to fish passage in this stream.

Electrofishing was conducted in LE-E01 on August 8, 2012. The station covered 120 m² and the fishing effort totalled 900 seconds (Appendix G). Flow pattern included riffle, run and a small eddy area. The mean water depth was 0.37 m and the mean flow velocity was 0.40 m/s. The substrate was mainly composed of gravel (70 %) with cobble (20 %), boulders (5 %) and muck (5 %) as well. Three fish species were caught: brook trout, longnose sucker and mottled sculpin.

5.2.8 Lake F

Morphometry

Lake F is a small waterbody (3.8 ha) located on the east shore of Iron Arm (Figure 21). The bathymetric survey indicates that the water is very shallow, with a maximum and a mean water depth of 1.1 and 0.48 m, respectively (Figure 22). The shoreline development and volume development indices are respectively 1.39 and 1.31 which indicate a low productivity potential.

Water Chemistry

The water has a yellowish colour but the Secchi depth reached the maximum depths of the water (1.1 m; Figure 22). The surface temperature was 13.9 °C and the dissolved oxygen was 8.18 mg/L. The pH was slightly alkaline (7.30) and the conductivity was relatively high, with a value of 54 µS/cm. In addition, such a shallow water depth suggests that this waterbody could freeze to the bottom during winter or, if some water remains free, the dissolved oxygen concentrations could become very low.

Fish Population

On August 4-5, 2012, fish sampling was conducted in Lake F using gillnets and minnow traps (Figure 23; Appendices A and B). Fishing gear was set overnight. A total of three fish species were caught; these being white sucker (53.7 %), longnose sucker (41.5 %) and brook trout (4.9 %). Catches per unit effort in gillnets were 41.0 captures per gear-night, which is relatively high, but BPUE was only 1,684 g per gear-night.

Longnose sucker has a mean length of 126.9 mm and a mean weight of 21.6 g (Figure 23). All specimens caught were juveniles and the 100-150 mm class was predominant. The mean length of white sucker was slightly higher at 163.7 mm, and the mean weight was 46.7 g. The 150-200 mm class is also dominant as shown by the length-frequency distribution histogram. Most specimens were juveniles, but some adults were also present. This small waterbody probably cannot sustain large species, or at least not a high density of large specimens.

Brook trout ranged from 169 to 286 mm and only two specimens were caught.

Lacustrine Habitats

Lake F shoreline is mostly composed of muck, with some boulders and rubble (Appendix C). The riparian vegetation is essentially composed of mature trees (85 %), with some shrubs (15 %). Concerning aquatic vegetation, pond-lilies are present on the western shore of the lake, and bur-reeds are found on the north-eastern side of the lake (Photos 33 and 34, Appendix D).

The habitat classification is shown on Figure 21. Due to the shallow depth, the entire lake is classified as being in the littoral zone. Two types of habitats are found within Lake F; these being fine substrate without vegetation (80 %) and fine substrate with vegetation (20 %; Appendix F).

The number of suitable habitat equivalent units was calculated for the three species found in the lake (Appendix F). The total habitat equivalent units vary from 6,302 m² (longnose sucker) to 26,818 m² (brook trout). However, considering the shallow depth, this lake could occasionally be unsuitable for fish or some fish life stages during winter. Anoxic conditions could be found in this lake during winter under ice cover or the water could freeze to the bottom of the lake.

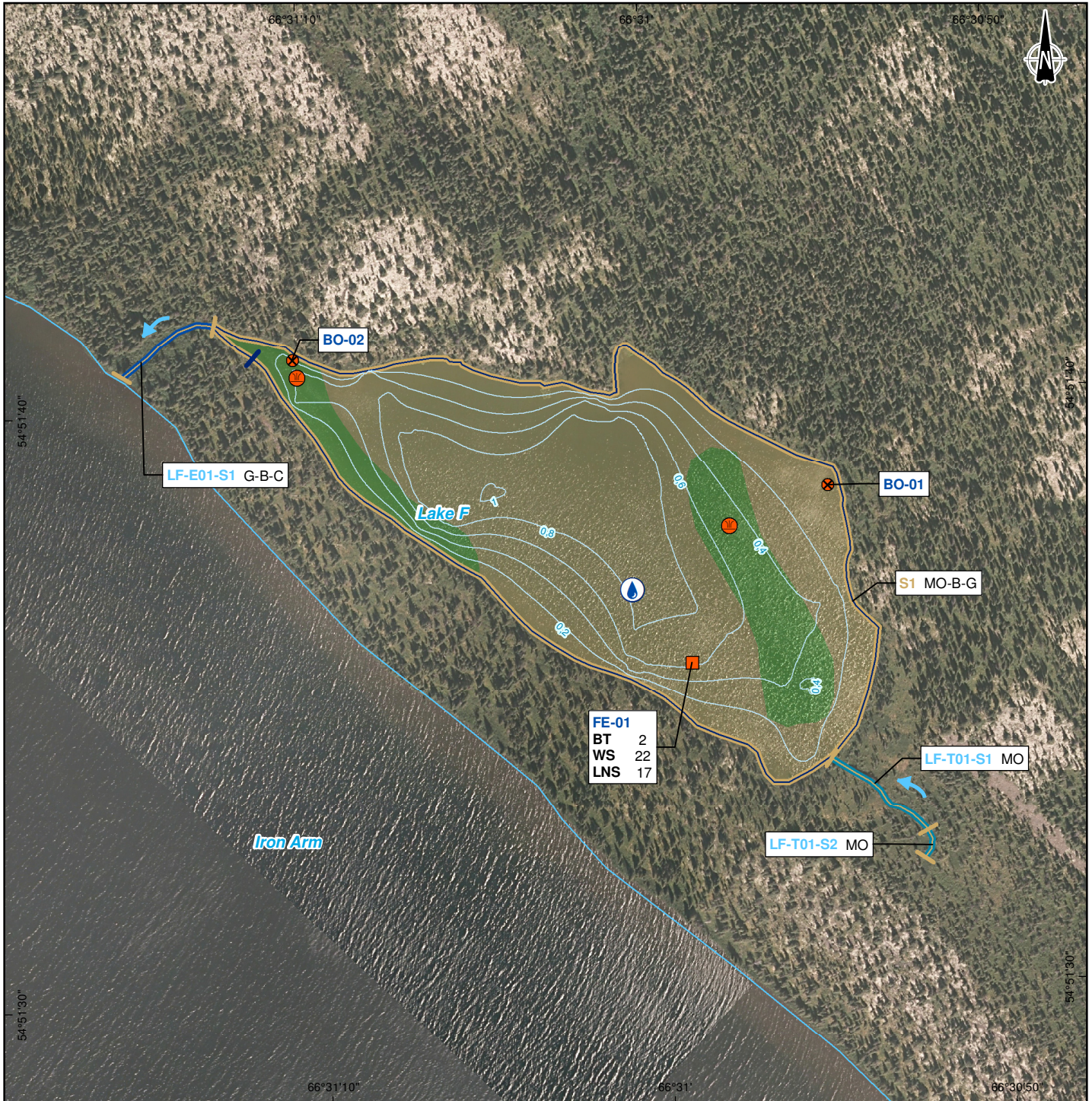
Connecting Streams

Two connecting streams were found in Lake F. LF-T01 is the only tributary found and is 82 m long (Appendix E). This stream is a moderate water habitat (steady/flat) with a mean width of 2.5 m downstream, and becoming narrow (0.3 m) in its upper part. In the upper part, the water comes from the ground and runoff from the surrounding environment. The substrate was composed of muck. The stream has riparian vegetation made of sweet gale and ericaceous species.

LF-E01 is a small stream, 59 m long with a mean width of 0.8 m (Appendix E) that discharges into Iron Arm. The substrate is composed of rubble (55 %), boulders (40 %) and cobble (5 %). Stream cover is abundant and riparian vegetation is mainly composed of shrubs. Due to the heavy rain that occurred a few days before the characterization was conducted, some of the riparian herbaceous vegetation was submerged. Fish found in Lake F can migrate between this lake and Iron Arm since there is no barrier to fish passage on this small stream. This stream could explain why fish were found in the lake while the morphometric characteristics are not favourable.

5.2.9 Petitsikapau Lake

Petitsikapau Lake is a vast (17,087 ha) waterbody located to the south of the Project. Only a small part of the lake, identified as Bay 3 for the purposes of this baseline study, was characterized due to its proximity to the initial project infrastructure (Figure 24). Bay 3 has shallow waters, many bays and several small



Fishing Sampling

FE-01	Gear type
BT	Sequential number
2	Number of capture
WS	Species
22	
LNS	
17	

Species

X	No fish
LNS	Longnose sucker
WS	White sucker
BT	Brook trout

Fishing Gear

●	Minnow trap (BO)
■	Gill net (FE)

Segmentation

—	Shoreline segment
—	Stream segment

Type of habitat

●	Moderate water
●	Fast water

S1 MO-B-G

S1	Substrate
MO	Segment number
B-G	Stream number

LF-T01-S1 MO-B-G

LF-T01-S1	Substrate
MO	Segment number
B-G	Stream number
	Lake F

Substrate

B	Boulder (250 to 1,000 mm)
G	Rubble (140 to 250 mm)
C	Cobble (30 to 140 mm)
MO	Organic material

Habitat Characteristics

—5—	Isobathe (Equidistance: 0.2 m)
●	Water physico-chemistry
●	Aquatic vegetation
→	Flow direction

Littoral Zone

■	Fine substrate without vegetation
■	Fine substrate with vegetation

Joyce Lake Direct Shipping Iron Ore Project

- Fish and Fish Habitat Baseline Study -

Lake F

Sources:
 Base: CanVec, 1/50 000, RNCAN, 2010
 Orthophoto: Mosaïque photo XEOS

Mapping and Inventory: GENIVAR 2012
 File: 121-18002-00_F21_FAQ_Lake_F_130619.mxd

Scale 1:3 000

0 30 60 90 m

UTM, zone 19, NAD83

Figure 21

November 2013

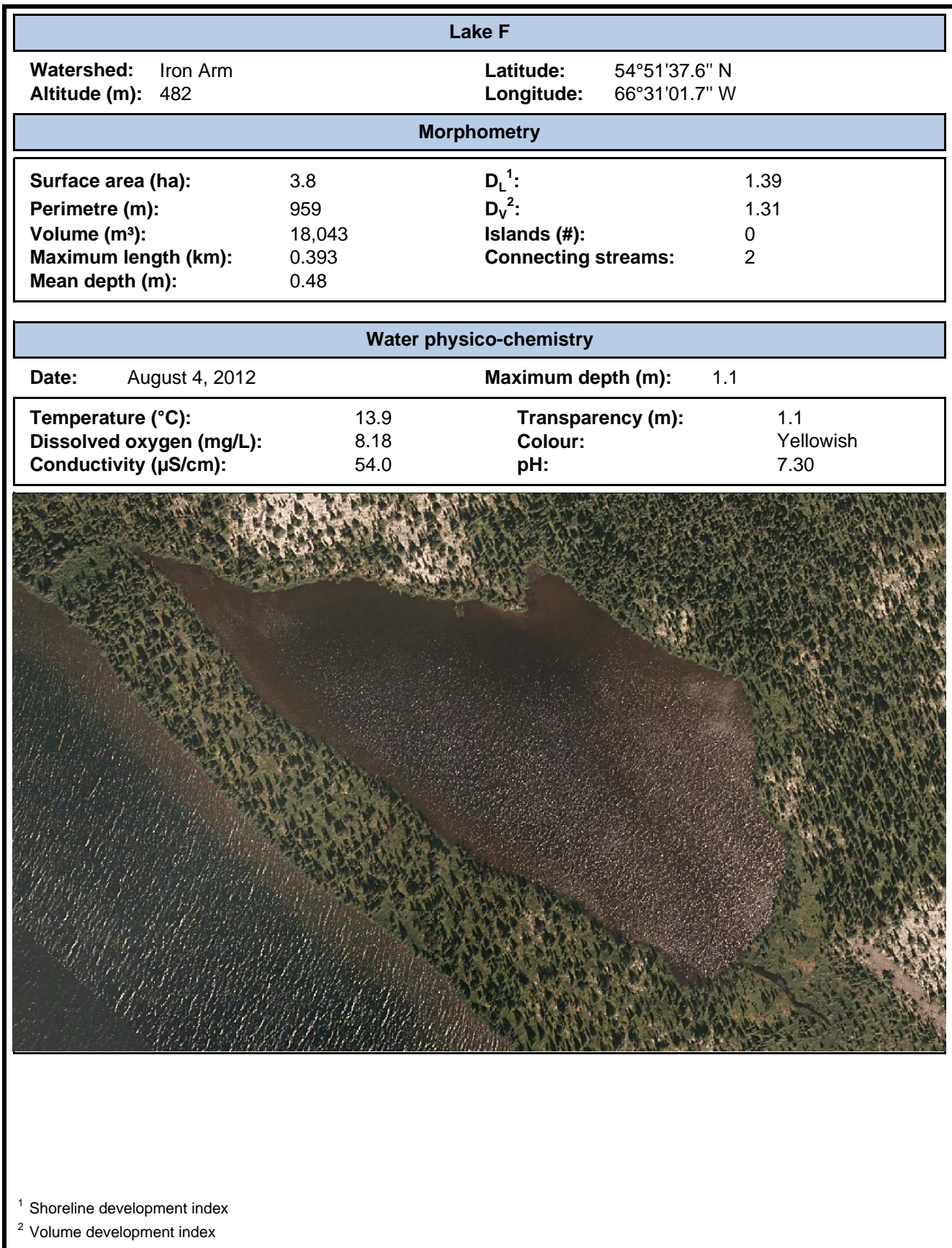


Figure 22. Morphometric Characteristics and Water Physicochemistry in Lake F

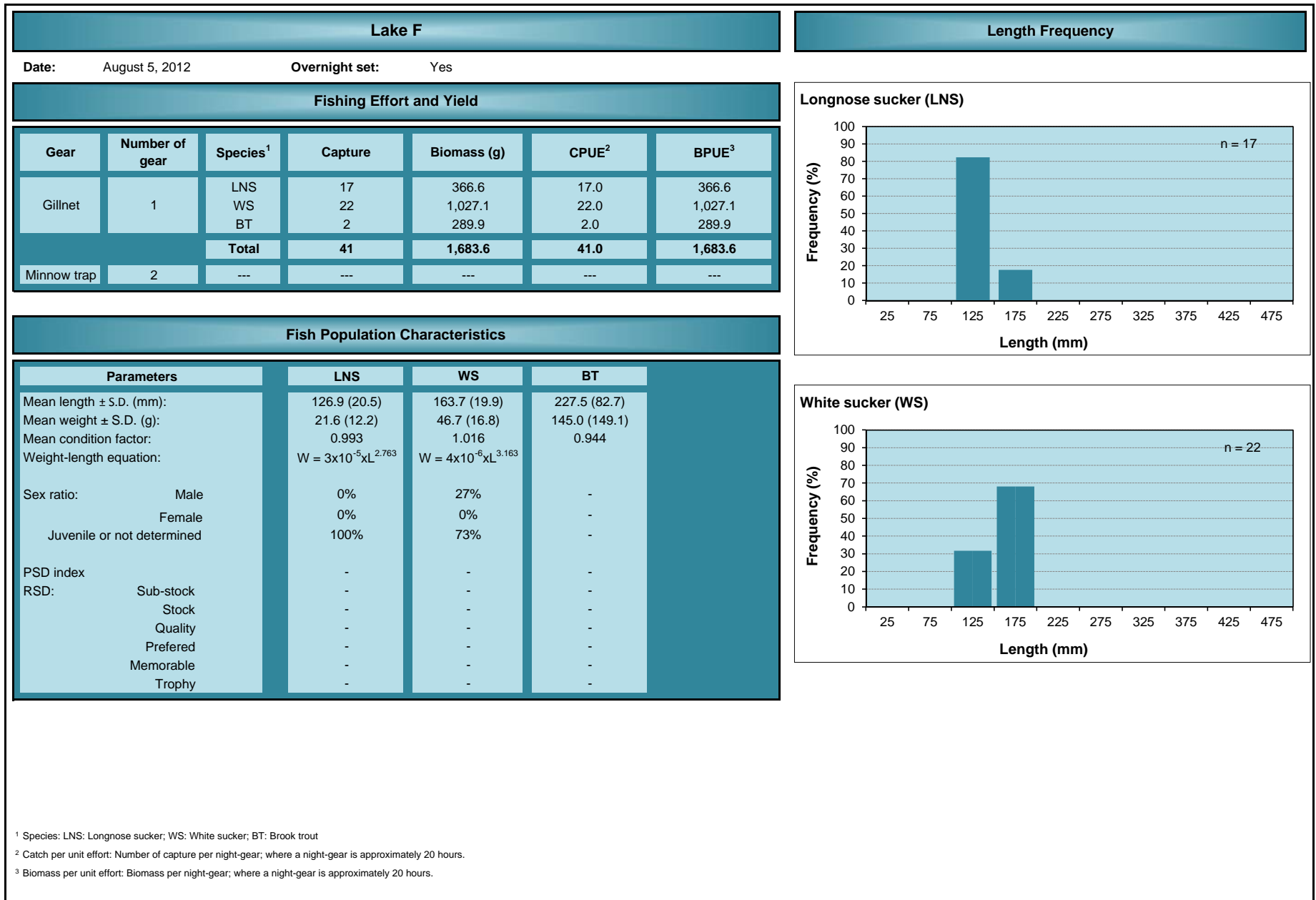
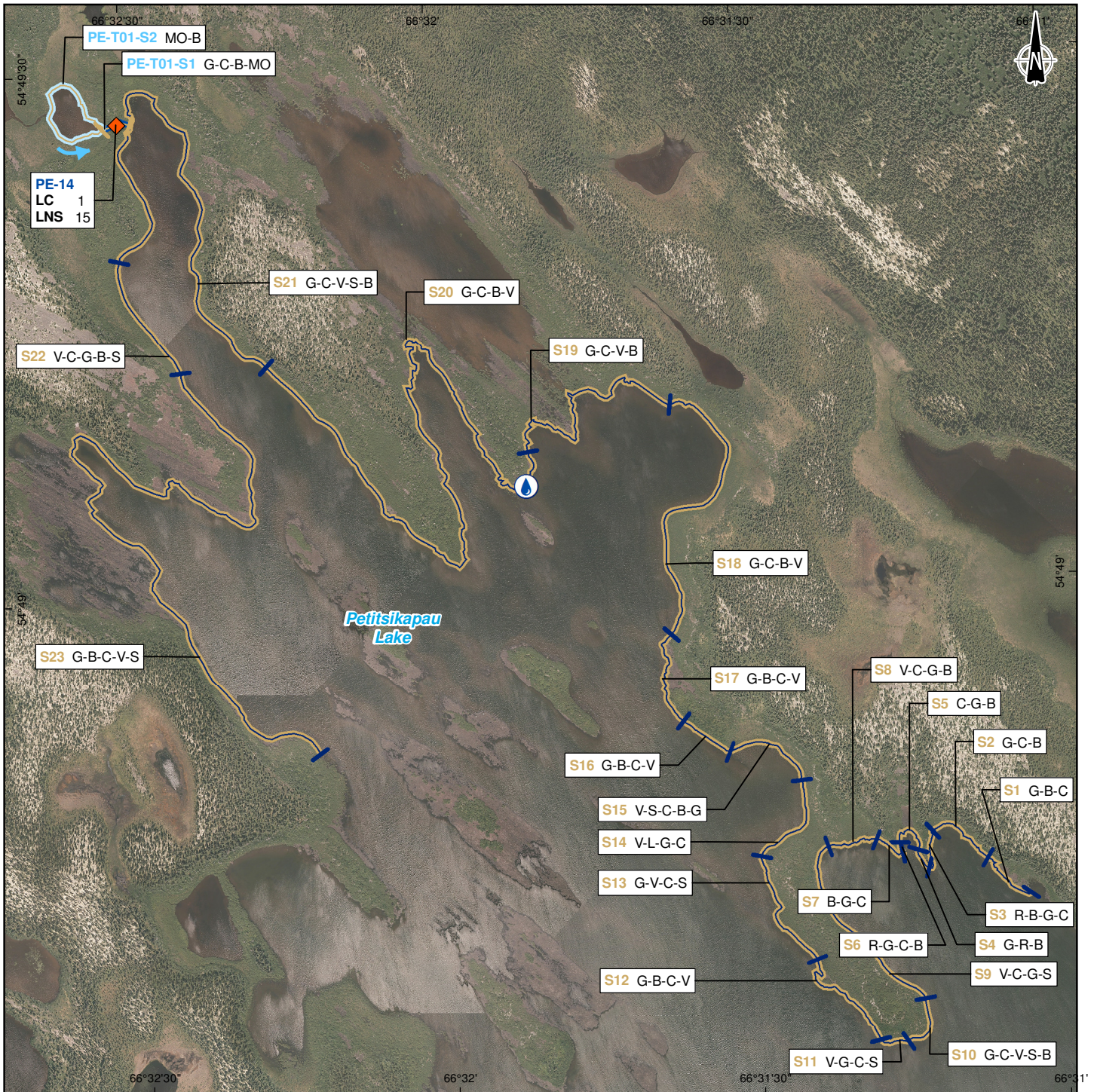
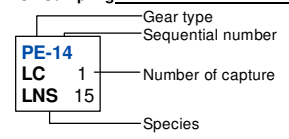


Figure 23: Fish Sampling Results in Lake F



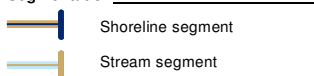
Fish Sampling



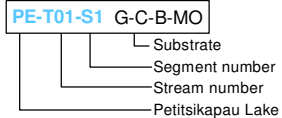
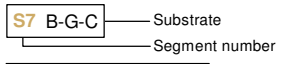
- Species**
- X No fish
 - LNS Longnose sucker
 - LC Lake chub

- Fishing Gear**
- ◆ Electrofishing (PE)

Segmentation



- Type of habitat**
- Slow water
 - Fast water



Substrate

- R Bedrock
- B Boulder (250 to 1,000 mm)
- G Rubble (140 to 250 mm)
- C Cobble (30 to 140 mm)
- V Gravel (2 to 30 mm)
- S Sand (0.006 to 2 mm)
- L Silt and Clay (<0.006 mm)
- MO Organic material

Habitat Characteristics

- Water physico-chemistry
- Flow direction



Joyce Lake Direct Shipping
Iron Ore Project

- Fish and Fish Habitat Baseline Study -

Bay 3 in Petitsikapau Lake

Sources:
Base: CanVec, 1/50 000, RNCan, 2010
Orthophoto: Mosaïque photo XEOS

Mapping and inventory: GENIVAR 2012
File: 121-18002-00_F24_FAQ_Petitsikapau_Lake_130619.mxd

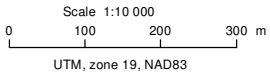


Figure 24

November 2013



islets. Therefore, no bathymetric survey was conducted in this area. The shoreline was characterized and electrofishing was conducted in one tributary.

Shoreline Characteristics and Water Chemistry

The shoreline presents, in general, a coarse substrate composed of cobble, rubble, and boulders (Appendix C). The bedrock is present in segment S3, S4 and S6. Gravel is found in smaller amounts and is predominant in segment S8, S9, S11, S14, S5, and S22. The gradient is generally low. Steep shorelines were observed in segment S1, S3, S4 and S6. No aquatic vegetation was observed during the field characterization. The riparian vegetation is almost non-existent as the banks are mostly composed of boulders.

Fish Population

Northern pike and lake trout remains (bones) were found along the shoreline of Petitsikapau Lake, which indicates that these two species are present in this waterbody. A lake trout was also captured using a fishing rod. In addition, one electrofishing station was sampled (Appendix G). In station PE-15, located in segment S1 of PE-T01, 15 longnose sucker and one lake chub were captured.

Connecting Streams

A small stream (PE-T01), fed by a wetland, discharges into Bay 3 (Figure 23). Segment S1 is a 50-m long fast water habitat (rapid/run) with substrate mainly composed of rubble and cobble (Appendix E). This segment has a mean width of 5 m and riparian vegetation is mostly composed of herbaceous species. Segment S2 is a small pond approximately 100 m long and 55 m wide. The substrate is composed of muck (70 %) and boulders (30 %). Submerged vegetation is present in the pond while sedges are found almost all around the shoreline. The upper part of this stream was not characterized, and is probably quite similar to segments S1 and S2 (Figure 24).

5.2.10 AT-T01

AT-T01 is a stream identified in the 1:50,000 topographic map that discharges into Attikamagen Lake (Figure 2). However, the field work and the aerial photographs indicate that there is no stream in this area. Only small ponds in wetlands and pockets of water were found. This could be an intermittent stream receiving water on rare occasions and some part could flow underground as observed in many streams in the Study Area.

5.2.11 HO-T02

HO-T02 is a stream located on Joyce Lake peninsula that connects to Hollinger Lake (Figure 25). HO-T02 upper part is fed by runoff from the upstream surrounding areas. Lake E also discharges into this stream. HO-T02 is a slow water habitat (flat) meandering through a vast wetland (fen) over approximately 2.4 km. The project does not include any physical components near this stream.

A small part of the stream, located upstream from the Lake E outlet, was characterized from the ground during the field work conducted in 2012 (Appendix E).

AM-S1 is the uppermost segment that was characterized and corresponds to a flat/steady type of habitat. This segment is 217 m long and approximately 1.2 m wide. The water depth ranged from 0.1 to 0.32 m. The riparian vegetation cover was only 15 % (overhanging) and mostly composed of herbaceous species. The substrate was composed of muck (100 %) and submergent aquatic vegetation was found along approximately 15 % of the segment.

AV-S1 is a 70-m long segment (flat) downstream from AM-S1 and was approximately 1.0 m wide. During the field work, the flow velocity was 0.1-0.2 m/s. The water depth was not measured. The riparian vegetation cover was 10 % overhead and composed of herbaceous species. The substrate was composed of muck (100 %) and submerged aquatic vegetation was found in the stream (10 %).

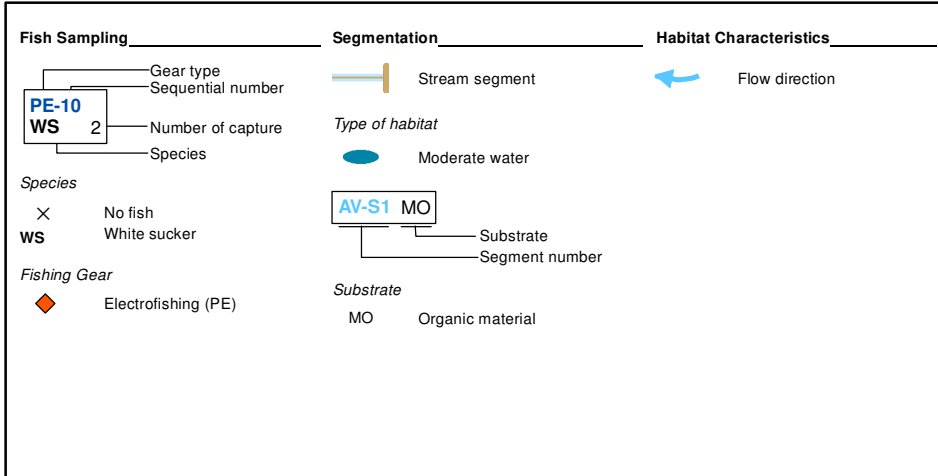
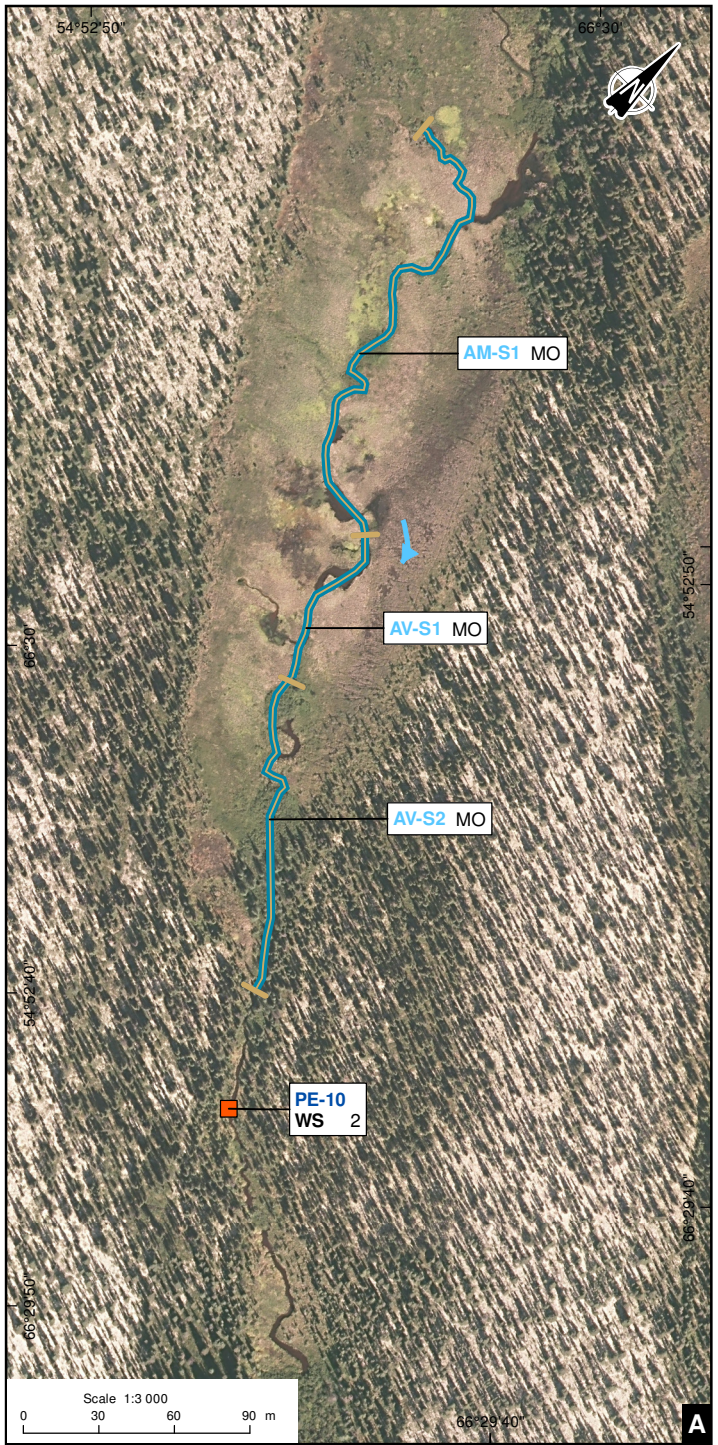
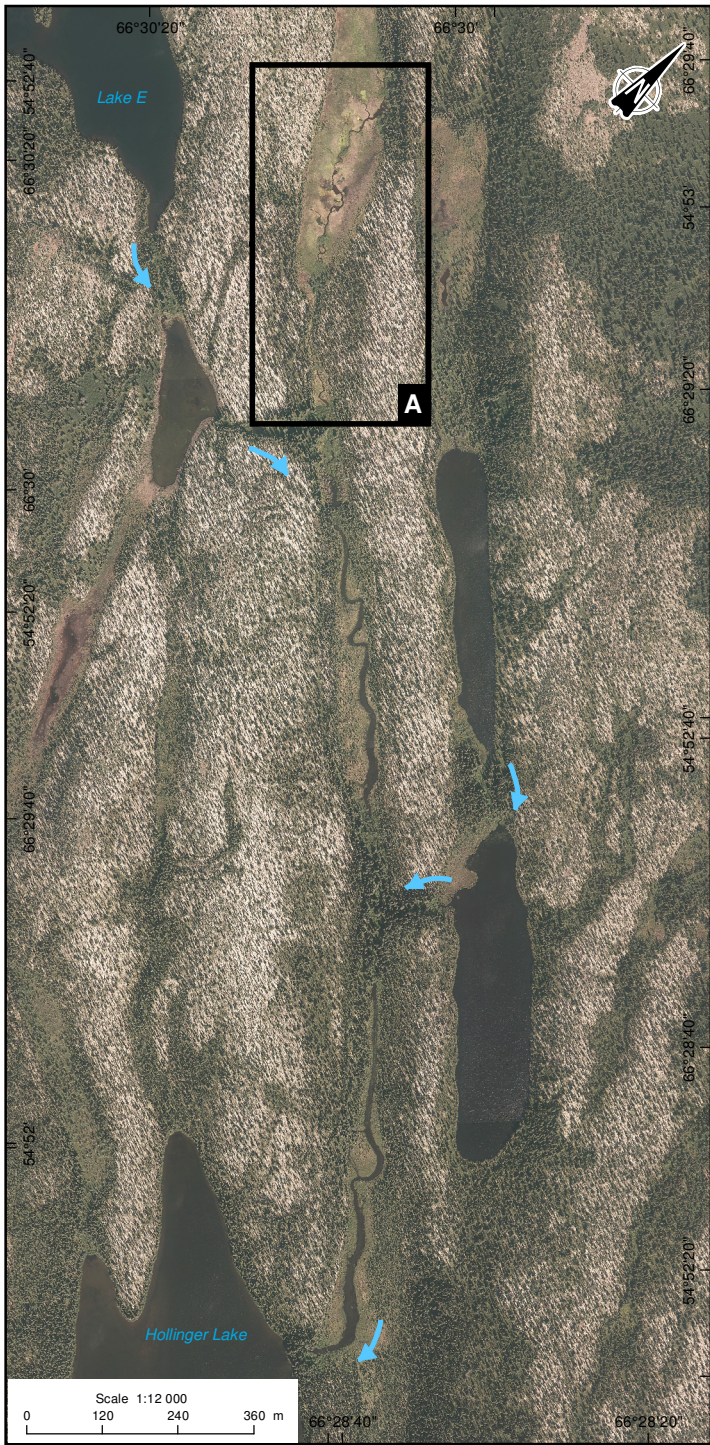
The lowermost segment characterized is AV-S2 and is 135 m long with an approximate width of 1.2 m. The water depth was approximately 0.35 m and the flow velocity ranged from 0.1 to 0.2 m/s (flat habitat type). The riparian vegetation is more abundant in this segment and covered 70 % of the stream (60 % overhanging; 10 % overhead). The riparian vegetation was mostly composed of shrubs (60-70 %) and herbaceous species (20-30 %). The substrate was also made of muck (100 %) and aquatic vegetation was found in the stream (15 %).

The rest of the stream was characterized from the helicopter and can be described as a meandering channel with a width of 6 m upstream, reaching 20 m downstream near Hollinger Lake. The stream runs through a fen and aquatic vegetation can be found on the stream bed for almost the entire length of the stream. Besides Lake E that discharges into HO-T02, there are two nameless small ponds connected to each other that discharge also into HO-T02. There is no barrier to fish passage in HO-T02 and therefore the stream is accessible from Hollinger Lake.

Electrofishing was conducted at station PE-10 downstream AV-S2 (Appendix G). The surface area covered was 60 m² for a 502-second period. The station was characterized by a moderate flow pattern (flat), muck, water depth of 0.37 m and a flow velocity of 0.3 m/s. This station was located approximately 130 m upstream of the confluence with the Lake E outlet. Two white sucker were caught by the electrofishing and one brook trout was found dead at the station.

5.3 Stream Crossings

During the summer of 2012, a total of 23 stream sections were characterized based on the initial stream crossings identified or proposed (potential). Considering the revised project layout, some of these crossings do not exist anymore since some were relocated while in other case there was no stream found at the crossing identified. Table 7 summarizes this information for each stream crossing identified and also indicates if there is a fish habitat at the revised stream crossing location. Detailed information on each stream crossing is given in the following sections.



Joyce Lake Direct Shipping Iron Ore Project

- Fish and Fish Habitat Baseline Study -

Connecting Stream HO-T02

Sources:
 Base: CanVec, 1/50 000, RNCan, 2010
 Orthophoto: Mosaïque photo XEOS

Mapping and inventory: GENIVAR 2012
 File: 121-18002-00_F25_FAQ_HO-T02_130619.mxd

UTM, zone 19, NAD83

Figure 25

November 2013

Table 7: Identification of the Stream Crossings that no Longer Exist and Presence of Potential or Confirmed Fish Habitat

Stream Crossing ID	Crossing no Longer Exists	Revised Layout Changed	Presence of a Watercourse	Fish Habitat
CR01	X	No	No	No
CR02	X	No	No	No
CR03	X	Yes	Yes	Confirmed
CR04	X	Yes	Yes	Potential
CR05	X	Yes	Yes	Potential
CR06	X	No	No	No
CR07		Yes	Underground	Potential
CR08	X	Yes	Yes	Potential
CR09	X	No	No	No
CR10		Yes	Yes	Potential
CR10A		No	Yes	Confirmed
CR10B	X	Yes	Yes	Confirmed
CR11		Yes	Yes	Potential
CR12		Yes	Yes	Potential
CR13	X	Yes	Yes	Confirmed
CR14		Yes	Yes	Potential
CR15		Yes	Yes	Confirmed
CR16		Yes	Yes	Potential
CR17		No	Yes	Confirmed
CR17A		Yes; new crossing	Yes	Potential
CR18	X	Yes	Yes	Confirmed
CR19	X	No	No	No
CR20		No	Yes	Confirmed
CR21	X	Yes	No	No
CR22	X	Yes	Yes	Potential
CR23		Yes	Yes	Potential

CR01

The topographic map shows a small branch that discharges into the stream section characterized during the field work in 2012. This small branch was not found and therefore, there is no fish habitat on the area of the revised layout (Figure 26).

The small stream characterized takes its source from spring water and does not connect to any other watercourse or waterbody (Photo 35, Appendix D). The upstream and downstream parts are both underground and no tributary was found during the field work (August 2012).

This small reach was approximately 116 m long and had a mean width of 0.9 m (Appendix H). The type of habitat was predominantly riffle. Flow velocities ranged from 0.3 to 0.8 m/s. The substrate was composed of muck (90 %) and boulders (10 %), and was moderately compacted. The riparian vegetation provided a good cover with 60 % overhanging and 15 % overhead, mainly composed of shrubs and herbaceous species.

No electrofishing was conducted in this small stream since there is no connection to any stream or waterbody. This small stream is not considered as being fish habitat. During the field work, the water conductivity was 43.9 $\mu\text{S}/\text{cm}$ and the pH was 6.96 (Table 8).

Table 8: Temperature, Dissolved Oxygen, pH and Conductivity Measured in Stream Crossings during the 2012 Field Survey

Stream Crossing ID	Date	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity ($\mu\text{S}/\text{cm}$)	pH
CR01	2012-08-04	10.9	9.56	43.9	6.96
CR02	2012-08-04	10.8	8.15	38.9	6.71
CR03	2012-07-31	16.5	8.21	19.2	6.46
CR04	2012-07-31	16.8	7.87	15.2	5.77
CR05	2012-07-31	16.8	7.95	6.0	6.39
CR06	2012-07-31	<i>Intermittent; dry during field campaign</i>			
CR07	2012-07-31	16.9	8.09	-	5.84
CR08	2012-08-01	20.0	8.07	20.3	7.00
CR09	2012-07-31	<i>Intermittent; dry during field campaign</i>			
CR10	2012-08-01	16.5	7.83	-	6.78
CR10A	2012-08-01	15.6	5.97	42.4	6.39
CR10B	2012-08-01	17.3	8.87	33.3	6.83
CR11	2012-08-03	12.0	9.05	24.4	6.60
CR12	2012-08-02	10.1	11.37	24.7	6.97
CR13	2012-08-02	19.8	8.14	28.9	7.19
CR14	2012-08-04	11.0	8.78	20.9	6.31
CR15	2012-08-04	14.1	9.37	100.8	7.79
CR16	2012-08-04	10.6	8.90	153.7	7.47
CR17	2012-08-05	15.4	9.38	81.2	7.79
CR18	2012-08-05	14.2	9.42	103.7	7.60
CR19	2012-07-31	<i>Intermittent; few water pockets</i>			
CR20	2012-07-31	17.1	8.78	-	6.47
CR21	2012-07-31	<i>Intermittent; dry during field campaign</i>			
CR22	2012-08-03	16.5	8.61	10.2	7.12
CR23	2012-08-04	15.2	8.58	24.9	6.55

CR02

CR02 was characterized from the lowermost part of the stream beginning in a pond and up until the stream became underground (Figure 27; Photos 36 to 38, Appendix D). The road is located much more on the north and passes near a small peatland with no outlet. Therefore there is no stream crossing at this station.

The downstream part of the existing stream (CR02-AV-S2) has slow moving water and along a distance of approximately 100 m (Appendix H). The maximum width is approximately 15 m. The substrate is muck and aquatic vegetation is found over 10 % of the stream bed. The upper part of the stream (AV-S1) is narrower with a mean width of 1.5 and a mean water depth of 0.26 m. The flow pattern is flat and the