

**A Reconnaissance Inventory of
MINERVA LAKE**

**Watershed Code: 400-0182-02
Date Inventoried: October 2 to 4, 1996**

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1. INTRODUCTION

Triton Environmental Consultants Ltd. was retained by the British Columbia Ministry of Environment, Lands and Parks, Fisheries Branch to conduct a Reconnaissance Level Lake Inventory on Minerva Lake, within the North Coast Forest District. Minerva Lake is located approximately 24 km east of Prince Rupert by float plane and had not previously been surveyed. The purpose of the survey was to collect information on lake bathymetry, lake drainage, including stream surveys, terrain and vegetation, access, developments and land use, fish populations, limnology, aquatic plants and wildlife. The lake survey was conducted according to the Lake and Stream Inventory Standards and Procedures of the Resource Inventory Committee (MELP 1995). Stream information was entered into the Department of Fisheries and Oceans / Ministry of Environment Stream Survey Database. The reconnaissance level survey was completed October 2 to 4, 1996 by Kristine Mason, and Stacey Brown. Original field data and photos are included with the original copy of the lake report.

2. DATA ON FILE

Location	X	Individual Fish Data	X
Physical data	X	Fish Preserved	
Bench Mark	X	Stomach Analysis	
Lake Drainage	X	Scale and/or Otolith Reading	X
Stream Surveys	X	DO, Temperature and Conductivity Profiles	X
Terrain Features	X	Water Chemistry Summary	X
Terrestrial Vegetation	X	Aquatic Plants	X
Access	X	Wildlife Observations	X
Resorts and Campsites	X	Fishery Management Comments	X
Mining claims	X	Photograph Directory / Photos	X
Timber Harvest	X	Appendices	
Waste Permits	X	I. Bathymetric Data	X
Water Permits	X	Bathymetric Map	X
Recreation Values	X	II. Tributary Stream Data	X
Special Regulations and Restrictions	X	III. Catch Data	X
History of Previous Surveys	X	IV. Water Chemistry	X
Netting Record	X	V. Bottom Sediment Analysis	
Lake Catch Summary	X	VI. Fish Tissue Analysis	

3. GEOGRAPHIC AND MORPHOLOGIC INFORMATION

3.1 Location

Gazetted Name: Minerva Lake
Watershed Code: 400-0182-02
Location: Minerva Lake is 24 km east of Prince Rupert, north of the Skeena River.
Elevation: 213 m (Source: Topographic N.T.S. Map 103 I/5)
Latitude/Longitude: 54°16'3", 129°58'0"
U.T.M.: 09.436749, 6013594
N.T.S. Map #: 103 I/5
TRIM Map #: 103I 021
Air Photos: 30BCB92040.258,259 (June 27, 1992)
SEAM #: E223489
Management Unit: 6-14
Biogeoclimatic Zone: Coastal Western Hemlock
Forest Region: Prince Rupert Forest Region
Forest District: North Coast Forest District
Drainage: Minerva Lake⇒McNeil River⇒Skeena River
Date of Survey: October 2 to 4, 1996

3.2 Physical Data

Lake Drainage Area:	4.4 km ²	Volume:	3.24 x10 ⁷ m ³
Water Surface Area:	1.4 km ²	Number of Islands:	0
Area Above 6m Contour:	2850 m ²	Shoreline Perimeter:	6.4 km
Maximum Depth:	72 m	Mean Depth:	23 m
Secchi Depth:	3.5 m	Sounding Device:	Lowrance X-16

Minerva Lake is a relatively small lake, 2 km in length and 138 ha in area. The lake is at an elevation of 213 m and is surrounded by mountains rising from approximately 490 m to 975 m in elevation.

3.3 Lake Morphometry

Minerva Lake has one main basin with a maximum depth of 72 m. There are two bays on the west side of the lake, one small and one quite large, relative to the size of the lake. Bathymetric information was collected during the survey according to the Bathymetric Standards for Lake Inventories (MELP 1996). A Lowrance X-16 electronic sounder was used in the field to provide paper traces of the depth soundings of the e-line and transects. The bathymetric map was created using manual procedures as outlined in the manual. Measurements were taken of distance and depth data from the paper traces and entered into a spreadsheet. The depth contours on the bathymetric map were calculated by linear interpolation of these depth data. The bathymetric map, raw bathymetric data and map of transect locations are included in Appendix I.

3.4 Benchmark

U.T.M.: 09.437100, 6013700

The benchmark was established at the south end of the lake on the east shore. A spike (centre of orange circle) was nailed into a mature shore pine 3.9 m from the water's edge at approximately 2.0 m above the water surface.

3.5 Lake drainage

Minerva Lake drains through the McNeil River to a smaller unnamed lake then continues to the Skeena River. The watershed drains approximately 4.4 km² (source: metric dot grid, 1:50 000 map). On the 1:50 000 N.T.S. Map 103 I/5 (Figure 1), the McNeil River is shown draining from the southwest corner of Minerva Lake (Photo 1). This survey revealed that the McNeil River actually drains from the southeast corner.

3.5.1 Stream surveys

The Stream Information Survey System (SISS) on the McNeil River records impassable rapids at 5 km above the first lake, upstream of the Skeena River. SISS records also indicate the presence of cutthroat trout in Minerva Lake.

3.5.1.1 *Major systems*

The location and flow direction of the outflow of Minerva Lake (McNeil River) are shown in Figure 2. The stream card for the outflow of Minerva Lake is located in Appendix II.

McNeil River (outlet) : Stream A

U.T.M.: 09.437100.6013600

Watershed Code: 400-0182-000

The McNeil River flows out of Minerva Lake at the southeast corner of the lake. The river was surveyed to 500 m, encompassing three reaches. Reach 1 and Reach 3 were very similar with an average channel width of 3.5 m and a gradient of 4%. The flow was dominated by riffle (55%), with 15% pool, 20% run, and 10% other. Downstream of reach 3 at 500 m, there was a 20 m long cascade impassable to all fish species (Photo 2). Debris was abundant, with 5 to 15% of the stream containing large woody debris. The total cover was 70%, primarily composed of overhanging vegetation (55%) and the rest consisting of pools (20%), large organic debris (10%), cutbank (10%), and boulder (5%). Larges and bedrock each provided 40% of the substrate, with gravels (15%) and fines (5%) making up the remainder. Rearing habitat is fair in reaches 1 and 3 while fair spawning habitat is limited to the first 100 m of the outflow. Reach 2 was a lower gradient reach (1%), with an average channel width of 7.3 m and a flow dominated by run (80%) and pool (20%) (Photos 3 and 4). Substrate consists of 60% fines, 30% gravel and 10% larges. Total cover available was 40% composed of 40% cutbank, 30% pool with the remaining consisting of large organic debris, instream and overhanging vegetation. Rearing habitat is good in this reach while spawning habitat is limited.

3.5.1.2 *Minor systems*

There are 2 small inflows at the north end of Minerva Lake. Both have a very small catchment area and were blocked by 1.5 m beaver dams. The inflow to the northwest bay (Photo 5) was blocked approximately 5 m from the lake, while the inflow to the southwest was blocked at 15 m and was composed of multiple beaver ponds (Photos 6 and 7). Both inflows were 0.5 to 1 m wide and approximately 1 to 1.5 m deep. Substrates in these two inflows were composed of fines and small gravel with grasses, sedges and cutbank for cover, providing good rearing habitat and some spawning habitat downstream of the dams.

Tributary *i*

This tributary flowing into the south end of the bay located on the west side of Minerva Lake does not provide any fish habitat. The wetted width of this intermittent stream was less than 1 m. The substrate was mud and muck, with abundant skunk cabbage growing nearby.

3.6 Terrain and vegetation

3.6.1 Immediate Shoreline

The shoreline of Minerva Lake is predominantly rocky with marshy areas in the many small bays. The substrate is composed of angular rocks interspaced with organic muck and there are no beaches. Wetland areas with beaver ponds, muddy areas and sedges exist at the ends of both of the bays at the north end. Snags are abundant at the north end of the lake and along the shoreline, with several of them supporting terrestrial and aquatic plant communities. The shoreline drops off quickly except at the north and south end where it is shallow (<3m) for approximately 30 m.

The perimeter of Minerva Lake is fairly irregular with many small bays. Snags present the only significant navigation hazard. The north and south ends of the lake are marshy and *Sphagnum* moss is a dominant riparian species. Minerva Lake is located in an open valley area, with a north south orientation and is very exposed to the southwesterly winter storms. Photo 8 shows a view of the south end of Minerva Lake.

3.6.2 Surrounding Country

Minerva Lake is within the Coastal Western Hemlock biogeoclimatic zone, Very Wet Hypermaritime subzone (CWHvh) (Ministry of Forests 1988). This subzone is characterised by mild, wet summers (mean temperature of warmest month 13.9°C, mean precipitation of driest summer month 96 mm) and cool, wet winters (mean temperature of coldest month 3.0°C, mean precipitation of wettest winter month 431 mm) (Meidinger and Pojar 1991).

At Minerva Lake, there are areas of dense forest cover at the water's edge, as well as areas of scrubby vegetation. The surrounding forest is dominated by mature western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*) with stunted trees on the southwest shore. Shore pine (*Pinus contorta*) and red alder (*Alnus rubra*) are also present. The eastern shore has been thoroughly logged with a lake side zone remaining of approximately 2 to 20 m (Photo 9). Shrub and plant species in the riparian zone at the north end of the lake include buckbean (*Menyanthes trifoliata*), bunchberry (*Cornus canadensis*) and skunk cabbage (*Lysichiton americanum*). At the south end of the lake and by the outlet stream, there was devil's club (*Oplopanax horridus*), Labrador tea (*Ledum groenlandicum*), huckleberry (*Vaccinium* sps.), salal (*Gaultheria shallon*), Sitka burnet (*Sanguisorba canadensis*), deer cabbage (*Fauria crista-galli*) and buckbean (*Menyanthes trifoliata*). Grass and sedge communities occur in the bays and along the east shore. Unknown trees, bushes and wildflowers were identified using Pojar and MacKinnon (1994).

Minerva Lake is surrounded by mountains rising from approximately 490 m to 975 m in elevation. Minerva Lake is located in the Western System of British Columbia (Holland 1976), in the Coast Mountains, within the Kitimat Ranges. These granitic mountains are characteristically round-topped, dome-like mountains rising to peaks between 1980 and 2285 m in elevation (Holland 1976).

4. DEVELOPMENTS AND LAND USE

4.1 Access

Minerva Lake was accessed by float plane, a trip of approximately 24 km east of Prince Rupert. Flying time is approximately 12 minutes. A rough, partially deactivated logging road runs to just east of Minerva Lake. From Highway 16 north, there is approximately 5 km of loose surface, dry weather road and then 3 km of rough logging road. It would be possible to hike through clearcut areas to access Minerva Lake.

4.2 Development and land use

The land surrounding Minerva Lake has been used for forestry practices in the past, as large clearcut areas exist. The lake does not appear to have been used for agricultural land use. Recreational use of the lake is limited by the difficulty in access, the lack of camping facilities and the absence of a sport fishery. No major sources of pollution were observed at Minerva Lake. However, pollutants, such as garbage, gasoline, oil, and lubricants, would have entered the Minerva Lake watershed during logging operations.

4.2.1 Resorts and campsites

There are no established campsites on Minerva Lake and the poor drainage of the surrounding shoreline makes most clear areas very wet for camping. The remains of an iron wood burning stove and some garbage were found by the northwest beaver dam.

4.2.2 Mining claims

There are no mining claims within the Minerva Lake watershed.

4.2.3 Timber harvest

Minerva Lake is located in the Boyle and Dean district, forest licence number A16838. There has been extensive clearcut logging along the entire east shore of Minerva Lake and the valley northeast of the lake has also been logged along both sides. The logging in the Minerva Lake watershed occurred in 1987 and has since been left to naturally regenerate. The logging road running in the valley on the east side of the lake is in poor condition and is mostly washed out. Minerva Lake is not on a Boyle and Dean Five Year Development Plan and no logging activity is anticipated in the Minerva Lake watershed in the near future.

4.2.4 Waste permits

There are no waste permits held for Minerva Lake.

4.2.5 Water permits

There are no water licenses held for Minerva Lake.

4.2.6 Recreation values

The logging along the east side of Minerva Lake severely limits the aesthetic value of the lake. Although access may be possible via the logging road, the small size of the Dolly Varden sampled in the lake limit its appeal for sport fishing. Camping sites and hiking opportunities are limited and the blackflies are abundant due to the marshy conditions of the shore.

4.2.7 Special regulations and restrictions

According to the B.C. Freshwater Fishing Regulations, there were no special restrictions at the time of the survey, beyond those limitations applying to the region for catch limits and gear.

5. FISH POPULATION SAMPLING

5.1 Fish species composition

Gill netting and minnow trapping in Minerva Lake captured only Dolly Varden (*Salvelinus malma*). Table 1 shows the site characteristics of the gill nets and minnow traps set in Minerva Lake.

5.2 Relative abundance

Table 2 shows the catch for each trap type by species caught in Minerva Lake. The raw catch data are presented in Appendix III. There were 82 Dolly Varden caught in the floating net and 5 in the sinking net. The catch per unit effort (CPUE) of the floating net was 5.65 Dolly Varden per hour compared with only 0.30 Dolly Varden per hour in the sinking net. The sinking net was fished with only five panels due to irreparable damage to the 64 mm panel and CPUEs reported for the sinking net were adjusted for the missing panel (CPUE x 5/6).

Juvenile Dolly Varden were abundant with 101 caught in 5 lake set minnow traps, 4 in the outlet minnow trap, and 3 from the beaver pond at the northeast end of the lake.

5.3 Size, age and growth

5.3.1 Salmonids

Dolly Varden from the Minerva Lake watershed ranged in size from 61 to 270 mm in fork length (FL), with an average of 133 mm and a standard deviation of 36 mm (± 36 mm). The weight of the fish sampled ranged from 1.9 to 187.8 g with an average of 46.6 ± 49.9 g. Ageing of the otoliths from the five largest char indicate that these fish were from 8 to 10 years of age. Figure 3 shows the length weight regression, Figure 4 shows the length frequency distribution and Figure 5 shows the age frequency distribution for Dolly Varden in Minerva Lake. Otoliths from Dolly Varden were aged by AMC Technical Services Ltd., Lantzville, B.C.

5.3.2 Non-salmonid species

There were no non-salmonid species captured in Minerva Lake or the McNeil River.

5.4 Sexual maturity and condition

Of the 35 Dolly Varden sampled at Minerva Lake, 20 were female (12 immature, 7 mature, and 1 maturing) and 6 were males, all immature. Dolly Varden spawn in the fall, from September to early November (Scott and Crossman 1973). The 12 fish classified as immature were probably not going to spawn that fall. Sexual maturity is usually achieved in Dolly Varden in years 3 - 6, but inland, high-altitude and northern populations are often stunted and not all adults spawn every year (Scott and Crossman 1973). The fish that were maturing (ovaries and testes beginning to fill out and take up a large part of the body cavity), or mature would have be preparing to spawn during that season. The 5 Dolly Varden that were aged were all sexually mature (mature or maturing), between the ages of 8 and 10 years. The fish in Minerva Lake appeared healthy and no parasites were observed in the fish sampled.

6. LIMNOLOGICAL SAMPLING

6.1 Water sampling

Table 3 shows a summary of all limnological sampling performed at Minerva Lake. The limnology site was in the middle of the north end of the lake, at 72 m in depth.

Water samples from depths of 0.5 m and 30 m (labelled surface and bottom, respectively) were collected from Minerva Lake on October 4, 1996 at 10:30 a.m. These samples were analysed for general water chemistry and metals by Northern Laboratories Ltd., Prince Rupert, B.C. The full report from the laboratory is included in Appendix IV. Due to damage to the pH meter, field pH measurements were not performed.

6.2 Stratification

Table 4 and Figure 6 show the dissolved oxygen, temperature and conductivity profiles performed at Minerva Lake on October 4, 1996. The lake was thermally stratified with the thermocline at approximately 9 m in depth. The temperature in the epilimnion was 10.9°C at the surface, with the temperature in the hypolimnion dropping to 4.6 °C at 30 m. The dissolved oxygen readings range from 8.93 to 9.90 mgL⁻¹. The oxygen concentration increases slightly with depth, indicating that there is not significant oxygen depletion in the hypolimnion.

The conductivity profile for Minerva Lake shows values ranging from 6.5 µmhoscm⁻¹ at the surface to 6.0 µmhoscm⁻¹ at 30 m. There is a slight decrease in conductivity with depth, corresponding with a decrease in temperature. Conductivity measurements are highest from the surface to 9 m (6.5 µmhoscm⁻¹) which corresponds with the upper limit of the metalimnion.

7. OTHER FLORA AND FAUNA

7.1 Aquatic plants

Yellow pond-lilies (*Nuphar polysepalum*), buckbean (*Menyanthes trifoliata*) and communities of several species of grasses and sedges were present in the many bays around Minerva Lake. In rocky areas, no plants were observed. Many snags hosted aquatic/terrestrial communities. Aquatic plants were identified in the field using Pojar and MacKinnon (1994) and Warrington (1994).

7.2 Wildlife observations

Minerva Lake provides habitat for a variety of bird species. Steller's Jays (*Cyanocitta stelleri*), bald eagles (*Haliaeetus leucocephalus*), black-capped chickadees (*Parus atricapillus*), common loons (*Gavia immer*) and a belted kingfisher (*Ceryle alcyon*) were all observed at the lake. The chattering of red squirrels was heard. The beaver dam at the

northeast inflow appears to have been recently active and a neotenus salamander was captured in a minnow trap (MT7) set in the northwest beaver pond. A giant water bug (Hemiptera) was observed near the field camp (Photo 10). There is also a thriving blackfly (Diptera) population present at Minerva Lake. Although there was no apparent sign, the surrounding habitat appears ideal for moose, deer and black bear. Unknown birds were identified using Udvardy and Farrand Jr. (1994).

7.3 Summary of Rare and Endangered Species

The bald eagle observed at Minerva Lake is a yellow-listed species (B.C. Conservation Data Centre: Rare Vertebrate Animal Tracking List, North Coast Forest District (FD #28), June 10, 1996) meaning that the species is not considered at risk, but is actively managed at a population level. The bald eagle is ranked as S4 (apparently secure), that is, uncommon but not rare, and usually widespread. There is possibly cause for long-term concern. No rare vascular plants were noted at Minerva Lake (B.C. Conservation Data Centre: Rare Vascular Plant Tracking List, North Coast Forest District (FD #28), June 10, 1996).

8. MANAGEMENT COMMENTS

The only fish captured in gill nets and minnow traps set in Minerva Lake were small-sized Dolly Varden. However, SISS records also indicate that cutthroat trout are present in Minerva Lake. Minerva Lake is an oligotrophic lake (low in nutrient inputs, with low organic production, Wetzel 1983). Phosphorus concentrations and conductivity measurements are low ($< 0.05 \text{ mgL}^{-1}$ and $6.0 - 6.5 \text{ } \mu\text{mhoscm}^{-1}$, respectively), indicating that the fish populations are likely slow growing. Fish production in Minerva Lake could conceivably be increased through autochthonous fertilization of the lake. Nitrogen and phosphorus additions can increase zooplankton and benthic production, which in turn can increase salmonid production (Hyatt and Stockner 1985, Johnston et al. 1990, Ashley et al. 1994). However, it would not be advantageous to manipulate the Minerva Lake ecosystem at the present time, as it is not a salmon producing lake and is subject to low fishing pressure.

Spawning habitat is limited in Minerva Lake and would likely be vulnerable to habitat degradation, especially sediment accumulation during logging and road construction. The inflows at the north end of the lake and the first 100 m of the outlet stream provide the minimal gravel substrate necessary for spawning. As well, the littoral areas of the lake, especially those bays with sedge, grass and macrophyte communities, provide fish rearing habitat. These sensitive areas should be protected from sediment accumulation and riparian modification to allow successful reproduction of the fish population in the future.

Existing angling regulations are adequate because of the low fishing pressure at the present time. Minerva Lake is reasonably close to Prince Rupert by float plane, but it is unlikely to become a significant angling destination due to the apparent lack of large-sized fish, the lack of adequate camping sites and the unattractiveness of the surroundings.

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Table 1: Table showing the time and date set and collected, as well as the site characteristics, for each gill net (GL) and minnow trap (MT) set in Minerva Lake. Monofilament gill nets had six panels of mesh sizes: 25 mm, 51 mm, 76 mm, 89 mm, 89 mm, 38 mm and 64 mm. Due to irreparable damage, the sinking net had the 76 mm and 64 mm panels removed, with one 76 mm floating net panel attached. Minnow traps were baited with salmon roe. The orientation of the gill nets and the locations of all sample sites can be seen on the aerial photo (Figure 2).

Method	Number	Date Set	Time Set	Date Coll.	Time Coll.	Time Fished (h:min)	Location
GL	01	3-Oct-96	19:00	4-Oct-96	9:30	14:30	floating net, set perpendicular to shore
GL	02	3-Oct-96	19:30	4-Oct-96	9:55	14:25	sinking net, 12 to 24 m in depth
MT	01	3-Oct-96	14:01	4-Oct-96	15:15	25:14	lake, rock
MT	02	3-Oct-96	17:00	4-Oct-96	15:40	22:40	outlet stream (A), 85 m downstream
MT	03	3-Oct-96	18:15	4-Oct-96	15:37	21:22	lake, rock
MT	04	4-Oct-96	13:27	5-Oct-96	11:10	21:43	beaver swamp muck
MT	05	4-Oct-96	13:31	5-Oct-96	11:05	21:34	lake, angular cobble
MT	06	4-Oct-96	13:47	5-Oct-96	10:55	21:08	lake, cobble/gravel, overhanging vegetation
MT	07	4-Oct-96	14:12	5-Oct-96	11:25	21:13	beaver pond
MT	08	4-Oct-96	14:44	5-Oct-96	11:38	20:54	lake, rocks, algae

Table 2: Data for gill netting and minnow trapping in Minerva Lake. Species are Dolly Varden (DV). CATCH is a count of each species of fish caught in the net or trap.

Sum of CATCH		SPP	
METHOD	LOCATION	DV	Total
Gill net	Floating	82	82
	Sinking	5	5
Gill net Total		87	87
Minnow trap	Lake (5)	101	101
	Outlet	4	4
	Pond (2)	3	3
Minnow trap Total		108	108
Grand Total		195	195

Table 3: Limnology summary for Minerva Lake, showing the method used and the date and time of each measurement. Due to equipment damage, field pH measurements were not taken. Field conditions were recorded for limnology sampling.

SEAM #: E223489

Measurement	Data	Method	Date	Time
bottom depth	72 m	X - 16 Sounder	4-Oct-96	10:30
water clarity	3.5 m	Secchi disk	4-Oct-96	10:30
pH at surface				
air temperature	8.9°C	alcohol field thermometer	4-Oct-96	10:30
wind velocity	0 km/h	estimate	4-Oct-96	10:30
wind direction	n/a	estimate	4-Oct-96	10:30
surface condition	flat	estimate	4-Oct-96	10:30
cloud cover	10/10 occluded	estimate	4-Oct-96	10:30
water colour	green/brown	estimate	4-Oct-96	10:30
weather	rain		4-Oct-96	10:30
description				
water temperature	Table 4, Fig. 6	YSI 85	4-Oct-96	10:30
dissolved oxygen	Table 4, Fig. 6	YSI 85	4-Oct-96	10:30
conductivity	Table 4, Fig. 6	YSI 85	4-Oct-96	10:30
water sampling	Appendix IV	Van Doren bottle	4-Oct-96	10:30

Table 4: Dissolved oxygen, temperature and conductivity measurements for Minerva Lake taken at increments from the surface to a depth of 30 m. Profiles were taken on October 10, 1996. SEAM site number is E223489.

Depth	Dissolved oxygen	Temperature	Conductivity
(m)	(mg/L)	(°C)	(µmhos/cm)
0	8.93	10.9	6.5
1	9.01	11.0	6.5
2	9.00	11.0	6.5
3	9.07	11.0	6.5
4			
5	9.02	10.9	6.5
6			
7	9.03	10.3	6.5
8			
9	9.08	9.4	6.5
10	9.41	7.9	6.4
11	9.56	7.0	6.3
12	9.67	6.2	6.1
13			
14	9.80	5.8	6.1
15			
16	9.90	5.4	6.0
17			
18	9.99	5.2	6.0
19			
20	9.87	5.0	6.0
21			
22	9.97	4.9	5.9
23			
24	9.88	4.8	6.0
25			
26	9.88	4.8	6.0
27			
28	9.81	4.7	6.0
29			
30	9.81	4.6	6.0

Figure 1: Location of Minerva Lake on 1:50 000 N.T.S. Map 103I/5

Figure 2: Air photo of Minerva Lake

Figure 3: Length weight regression for Dolly Varden in Minerva Lake.

Figure 4: Length frequency distribution for Dolly Varden in Minerva Lake.

Figure 5: Age frequency for Dolly Varden in Minerva Lake.

Figure 6: Limnological profiles for Minerva Lake.

Photo 1: View of the southwest corner of Minerva Lake where the N.T.S. map shows the McNeil River outflow (*Roll 20, #3*)

Photo 2: Upstream view of cascades in the McNeil River (A) 400-0182-000, 500 m downstream of Minerva Lake (*Roll 19, #19*)

Photo 3: Upstream view of McNeil River 400-0182-000, reach 2 (*Roll 19, #21*)

Photo 4: Downstream view of McNeil River 400-0182-000, reach 2 (*Roll 19, #22*)

Photo 5: View towards lake from beaver dam at the northwest end of Minerva Lake (*Roll 20, #11*)

Photo 6: View towards lake from beaver dam at the northeast end of Minerva Lake (*Roll 20, #7*)

Photo 7: View of beaver ponds above the beaver dam at the northeast inlet (*Roll 20, #6*)

Photo 8: View of south end of Minerva Lake (*Roll 19, #23*)

Photo 9: View of clearcut on east shore of Minerva Lake (*Roll 20, #1*)

Photo 10: View of large aquatic beetle found near shore of Minerva Lake (*Roll 20, #4*)

Appendix I: BATHYMETRIC DATA

Appendix II: STREAM CARDS

Appendix III: RAW CATCH DATA

Appendix IV: WATER SAMPLING REPORT

Appendix V: RAW FIELD NOTES