INDIAN AND NORTHERN AFFAIRS CANADA
ABANDONED CLINTON CREEK
ASBESTOS MINE
CONDITION ASSESSMENT REPORT

APRIL, 2000

PREPARED BY
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April 13, 2000

Indian and Northern Affairs Canada
345 - 300 Main Street
Whitehorse, Yukon
Y1A 2B5

Attention: **Mr. Brett Hartshorne**

Dear Sir:

Reference: **Abandoned Clinton Creek Asbestos Mine
Condition Assessment Report**

Enclosed is our report describing the physical and environmental conditions at the abandoned Clinton Creek Asbestos Mine, Yukon Territory. Information presented in this report is based on observations documented in previous studies and information collected during recent investigations undertaken by UMA Engineering Ltd. and Royal Roads University in 1998 and 1999. It is important to recognize, however, that future changes in physical conditions can be expected as a result of ongoing movements of the waste rock dump and tailings piles and subsequent creek channel blockages.

Please contact Mr. Ken Skaftfeld, P.Eng. if you have any questions or require any additional information.

Yours truly,

UMA ENGINEERING LTD.

J. A. Terris
Vice President & Manager
Manitoba & Northwestern Ontario

T. Wingrove, P.Eng.
Director
Earth & Environmental Division

PB/dh

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1.0 INTRODUCTION

UMA Engineering Ltd. was retained Indian and Northern Affairs Canada to assemble a Condition Assessment Report for the abandoned Clinton Creek Asbestos Mine located at Clinton Creek, Yukon Territory. The overall objective of this project was to summarize the current status of the physical and environmental conditions at the Clinton Creek Mine Site based on available information. To achieve this objective, a desktop review of existing information was carried out including observations documented in previous reports and information collected during recent investigations undertaken by UMA and Royal Roads University (RRU) – Applied Research Division in 1998 and 1999 (Appendix A).

2.0 BACKGROUND

The abandoned Clinton Creek Asbestos Mine is located about 100 km north of Dawson City in the Yukon Territory, approximately thirteen kilometres east of the Yukon/Alaska border (Drawing 01). The mine was operated from 1968 to 1978 by the Cassier Mining Corporation. Following mine closure, the mill buildings were disposed of at auction in 1978 (P.Roach, 1998). The mine site is accessible via a gravel road from the former Clinton Creek Town-site along the north side of Clinton Creek near the base of the valley. A gravel airstrip is located to the north of the Mill Site. An overhead hydro transmission line was formerly located along the south edge of the access road between the mine and town-site.

Serpentine ore was extracted from the bedrock from three open pits (Porcupine, Snowshoe and Creek) located on the south side of Clinton Creek (Drawing 02). Ore was transported via a cable tramway to the mill site, which was located on a flat topped ridge on the north side of the Clinton Creek Valley. During the life of the mine approximately 12 million tonnes of serpentine ore was milled to produce one million tonnes of asbestos fibre. Approximately 60 million and 3 million tonnes of overburden and waste rock was deposited over the slopes adjacent to the open pits, within the Clinton Creek and Porcupine Creek valleys respectively. Approximately 10 million tonnes of tailings was placed over the west slope of the Wolverine Creek valley adjacent to the mill site.

Slope failures of the waste rock dump obstructed the Clinton Creek stream channel across the natural valley floor, leading to the formation of a 115 ha reservoir (Hudgeon Lake) immediately upstream (west) of the obstructed channel. The lake has a maximum depth estimated at 27 metres. A new creek channel was subsequently formed along the interface between the waste rock material and natural valley slope, some 25 metres above the original valley bottom. Outflow from Hudgeon Lake originally passed through four 1800 millimetre diameter culverts into an armoured section of the Clinton Creek channel at the mill site access road crossing. Two of the culverts have since been removed and the road crossing has washed out. Waste rock placement and instabilities also blocked natural drainage in Porcupine Creek creating a small un-named upstream reservoir. Failures of the north and south tailings lobes have blocked natural drainage through the Wolverine Creek valley forming a relatively small un-named reservoir.

In the spring of 1997, significant channel erosion occurred as the result of a large flow of water from Hudgeon Lake. The outflow at the toe of the waste rock dump destroyed the timber access road bridge and deposited coarse material eroded from the channel through the waste rock dump. Intermittent failures and erosion of the tailings blocking Wolverine Creek have also occurred. The eroded tailings have subsequently been transported downstream into the receiving creeks.

3.0 GEOLOGICAL SETTING

Clinton Creek is located in the discontinuous permafrost zone of the unglaciated Yukon-Tanana Upland. The asbestos ore bodies were located within westerly trending ridges along the south side of Clinton Creek. The ridges reach elevations of approximately 610 metres above sea level (A.S.L.) and the valley bottom is at about elevation 400 metres A.S.L.

The regional bedrock consists of two complex assemblages from the Yukon Cataclastic Complex. They are the sheared assemblage and the weakly deformed assemblage. The sheared assemblage consists of ultramafic, igneous and metamorphosed rocks, including serpentine, diorite, amphibolite, and schist, of which all but the ore rich serpentine rock exhibit a strong pervasive foliation. The weakly deformed assemblage consists of Triassic-aged shale, siltstone and sandstone with some phyllite and phyllonite strata. The asbestos ore body at Clinton Creek consisted of cross fibre chrysolite asbestos veinlets cutting jade green serpentine, believed to be a result of granitic intrusions or shearing and thrusting.

The Clinton Creek Mine site's structural geology is characterized by a series of steeply dipping normal faults and low angle thrust faults criss-crossing the area. The normal faults are near vertical and tend to bound the ore body. The low angle thrust faults occur near the contact of the two assemblages. The bedrock is mostly covered with overburden, however scattered outcrops are found throughout the lower portions of the Clinton and Wolverine Valleys. The overburden typically consists of silty sandy gravel (colluvium) deposits on the slopes and sand and gravel (alluvium) deposits in the valleys. The mill site ridge consists of fluvial-lacustrine granular deposits.

4.0 DRAINAGE AND HYDROLOGY

The mine site is located along Clinton Creek approximately nine kilometres upstream from Forty Mile River. Two main tributaries, Wolverine and Porcupine Creeks, join with Clinton Creek within the mine site area as shown on Drawing 02. Their respective drainage areas are approximately 28.6 and 4.7 square kilometres. The drainage area of Clinton Creek is approximately 116.6 square kilometres upstream of the confluence with Wolverine Creek, increasing to 203.8 square kilometres at the junction with Forty Mile River. Forty Mile River flows into the Yukon River two kilometres downstream of the Clinton Creek confluence. The Yukon River flows towards the north west and enters Alaska approximately seventy kilometres downstream of the former Clinton Creek Townsite.

5.0 PHYSICAL CONDITIONS

5.1 CLINTON CREEK WASTE ROCK DUMP

The waste rock from the Porcupine Pit placed along the south slope of the Clinton Creek valley is referred to as the Clinton Creek Waste Rock Dump (Drawing 03). The waste rock dump consists of overburden and argillite waste rock consisting of sand, gravel and cobble sizes containing occasional boulder size material. Significant lateral spreading of the rock fill, in particular at the west end of the dump towards Hudgeon Lake, has occurred as a consequence of instabilities associated with the placement of waste rock during the mining operation. Active movement of the waste rock dump has continued since the mine closure as seen in Photo 1(1986).

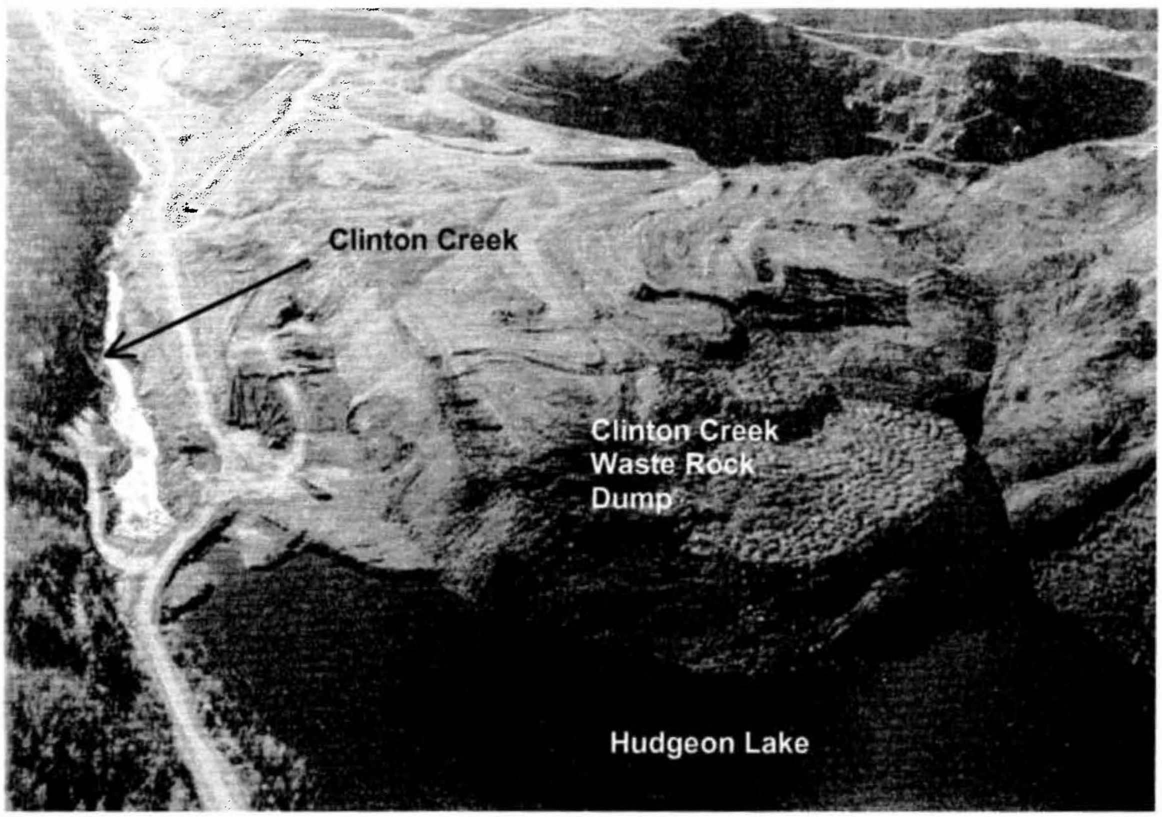


Photo 1
Clinton Creek Waste Rock Dump

The surface of the waste rock dump is hummocky with a series of benches, slump blocks and tension cracks resulting from the on-going displacements (Photo UMA 9-9 and 9-4). Ground vegetation in the areas of the waste rock dump is extremely scarce and plant diversity very low. Ground vegetation species at the waste rock site was similar to that found at the tailings site. Nevertheless, the re-establishment of trees and vegetation in general has been much greater at the waste rock site than on the tailings lobes.

Photo UMA 9-9
Slumping of Waste Rock Dump (1998)

Photo UMA 9-4
Tension Cracks West End of Waste Rock Dump (1998)

During the operation of the mine, ground movement monitoring monuments were installed to monitor the movement of the waste rock dump slope. The survey monuments were surveyed for horizontal and vertical movements annually from 1977 (just prior to the closure of the mine) to 1986. The devices consisted of survey prisms mounted on steel rods which are driven into the waste rock. Most of the monuments are identified with conical sheet metal markers. During the site reconnaissance several of the monuments were observed. Monument locations at the waste rock dump are shown on Drawing 03 and a typical marker (shown on the tailings pile) is shown in Photo UMA 5-12.

Photo UMA 5-12
Typical Ground Movement Monitoring Monument (1998)

Several cross-channel reference lines were also established along Clinton Creek to monitor vertical and horizontal waste rock movements towards and into the creek channel. The cross-channel reference lines consist of steel bars driven into the waste rock along the north edge of the road on the south side of the creek. At each reference line, corresponding survey prisms are mounted on steel rods driven into the north valley slope. Six cross-channel reference lines were re-established during UMA's 1999 site surveys (Drawing 03). Based on surveys completed in July 1999, on-going waste rock movements are evident.

5.2 CLINTON CREEK CHANNEL

The road crossing at the lake outlet has been washed out and only two of the original four-1.8m diameter corrugated metal pipe (CMP) culverts remain, one of which (north) was only partially intact. Outflow from Hudgeon Lake passes through the culverts and between the north culvert and the north bank (Photo UMA 8-9). The inlet of the south culvert is not visible and is blocked by debris, limiting flow. Water depths in the open channel were estimated at 0.5 metres in September 1998 and 0.1 metres in July 1999 (Photo UMA 15-0/1). The north culvert is badly out of round. A CMP section visible in the channel through the waste rock dump a considerable distance downstream is believed to be a missing section of this culvert.

Photo UMA 8-9
Hudgeon Lake Outlet and Access Road Culverts (1998)

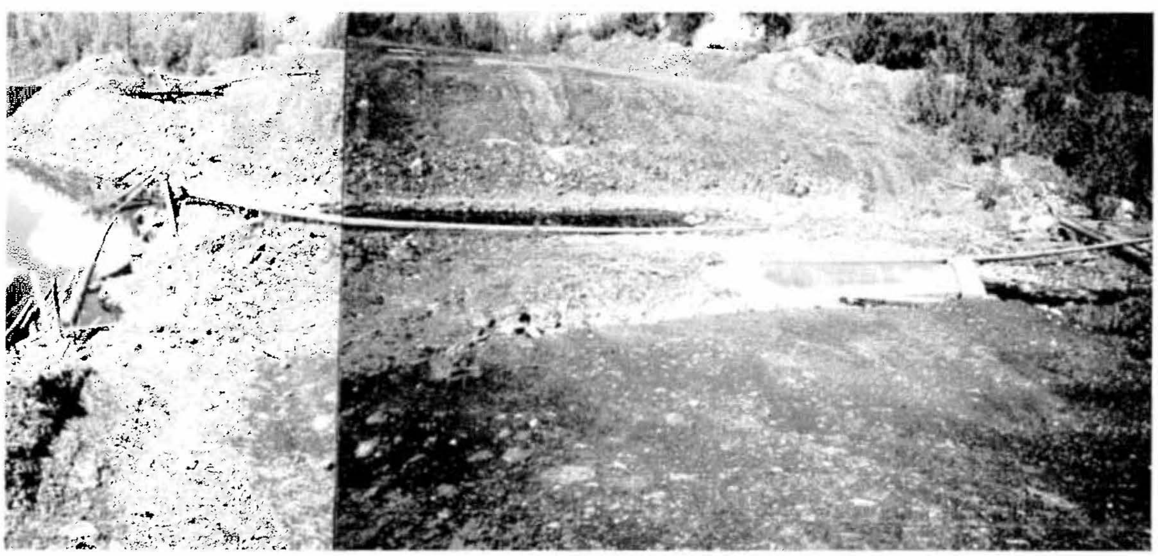


Photo UMA 15-0/1
Hudgeon Lake Outlet and Access Road Culverts (1999)

Previous erosion control works (rip rap armouring) constructed in 1979 were almost completely destroyed in the spring of 1997 (Photo RRU-1).

Photo RRU-1
Clinton Creek Channel Immediately Downstream of Outlet (1998)

Since 1986, down-cutting near the Hudgeon Lake outlet has occurred (Photo UMA 7-24). Up to 2 to 3 metres of incising has occurred immediately downstream of the outlet where the channel bed is bounded to the south by waste rock and to the north by natural colluvial soils overlying bedrock on the valley slope. Two springs discharge from the waste rock just downstream of the lake outlet. Water from both springs is clear with no evidence of fines. Brown slime was growing over the rocks at the downstream spring and the water had a noticeable hydrogen sulphide odour.

Photo UMA 7-24
Channel Down-cutting Immediately Downstream of Hudgeon Lake Outlet

Channel widening and incising is evident throughout the waste rock dump where both waste rock and valley material is being actively eroded (Photo UMA 7-17).

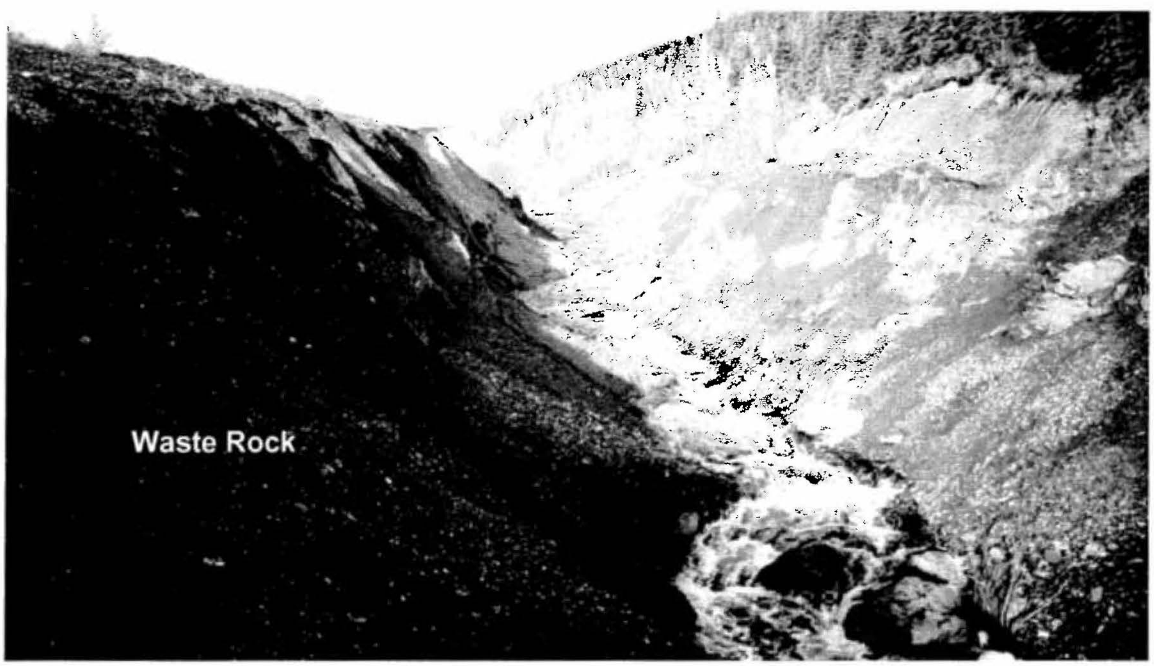


Photo UMA 7-17
Channel Erosion (1998)

Numerous slumps and localized slope failures are occurring on both the waste rock and valley slopes (Photo UMA 7-6) as a result of channel erosion and incising. These localized instabilities have lead to meandering of the stream bed which has impacted the integrity of the access road along the waste rock dump. Tension cracks are visible along the north shoulder of the access road (Photo UMA 7-14) and narrowing of one section of the access road has occurred as a result of a slope failure into the channel (Photos UMA 14-18/19 and UMA 2-8).

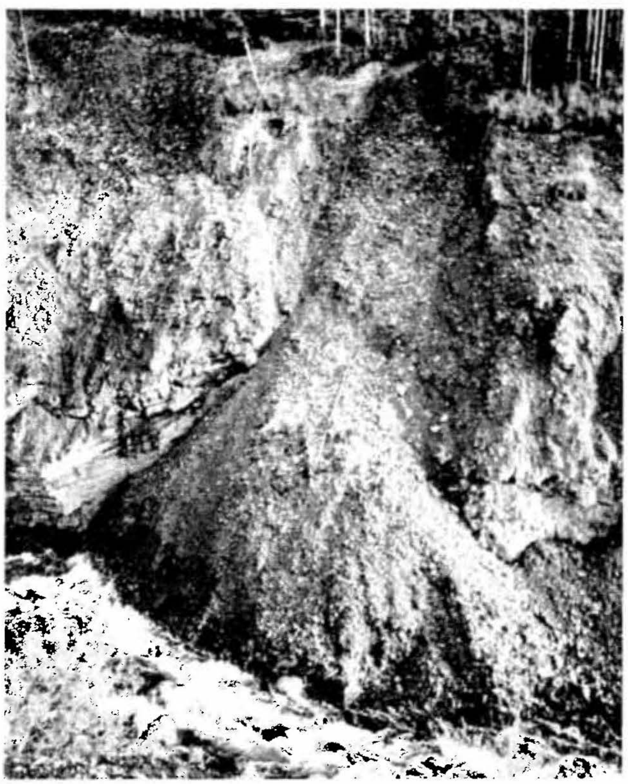


Photo UMA 7-6
Slumping of Valley Slope(1998)

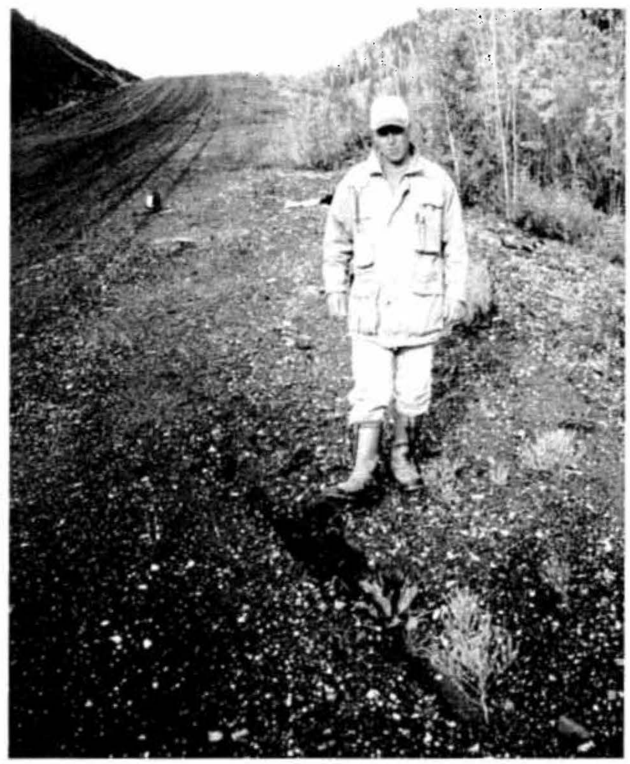
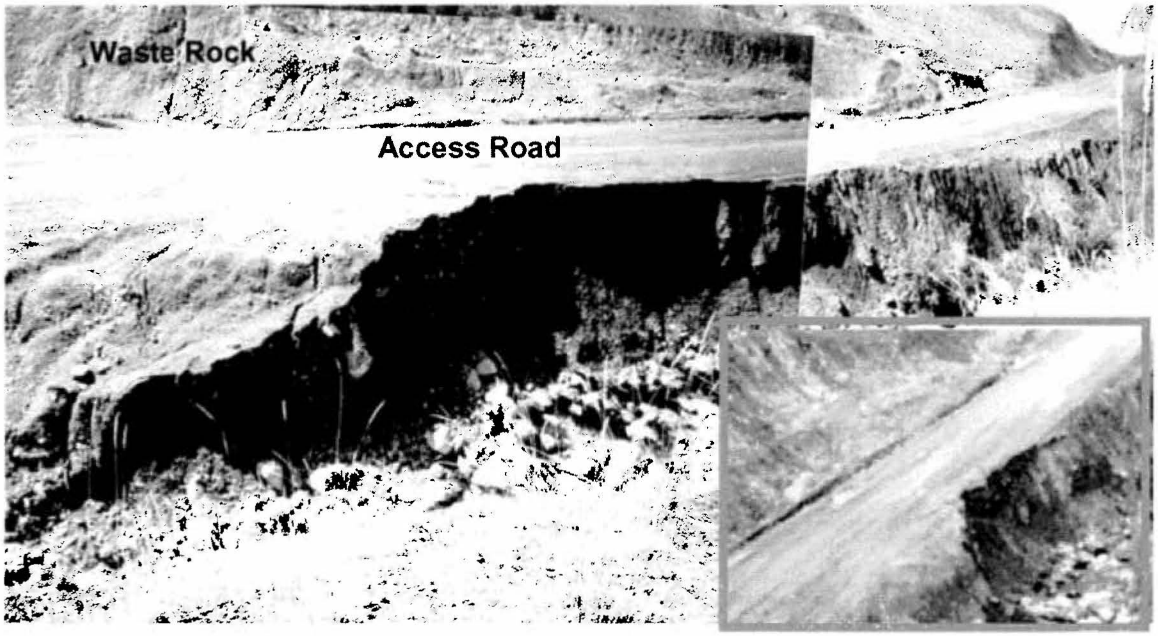


Photo UMA 7-14
Tension Cracks in Waste Rock Along Access Road (1998)



Photos UMA 14-18/19 and UMA 2-8 (Insert)
Slope Failure Along Access Road (1998 &1999)

Downstream portions of the creek channel through the waste rock slope have been cut into the weathered argillite bedrock on the valley slope (Photo UMA 14-15). At these locations, the bedrock consists of a weathered weaker bedrock unit overlying a stronger more competent bedrock unit with horizontal to slightly dipping bedding planes.

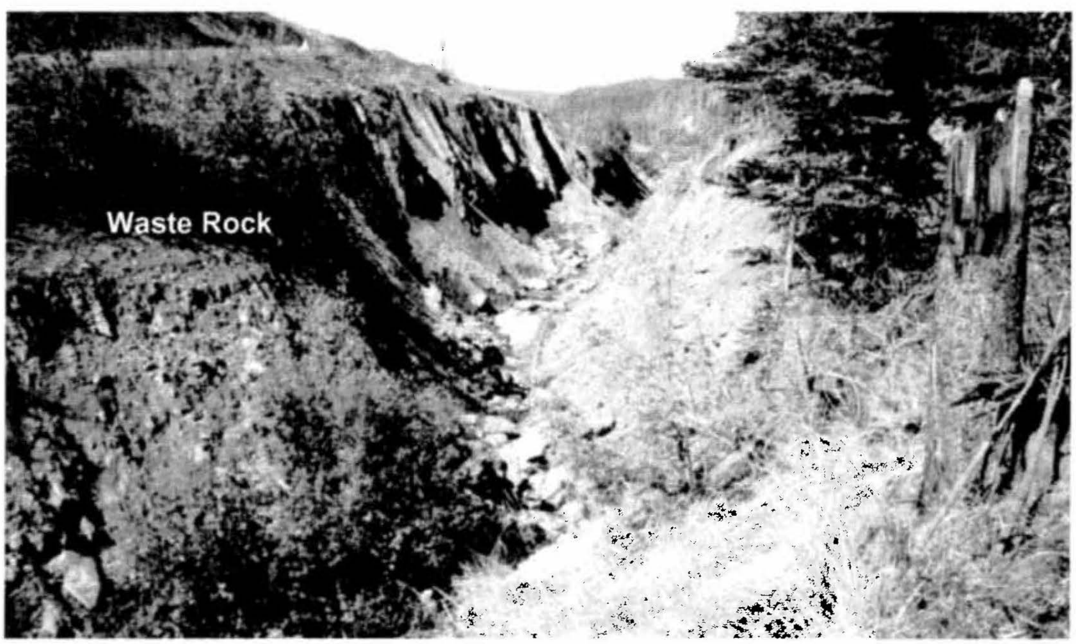


Photo UMA 14-15
View Upstream Along Creek Channel (1998)

The timber access road bridge at the downstream toe of the waste rock dump was washed out in the spring of 1997 (Drawing 03). The creek valley in the area of the bridge was infilled with out-wash material where a new creek channel was incised (Photo UMA 14-20/21/22). The out-wash (flow debris) material consists of gravel and cobbles up to 200 millimetres in diameter. Several channel remnants and evidence of significantly wider historic channel flow are visible. High water marks on trees immediately downstream of the waste rock dump are about 0.6 metres above the ground surface, or about 1.5 to 2 metres higher than the existing creek channel. At locations as far as 200 metres downstream of the bridge, trees and brush have trapped debris.

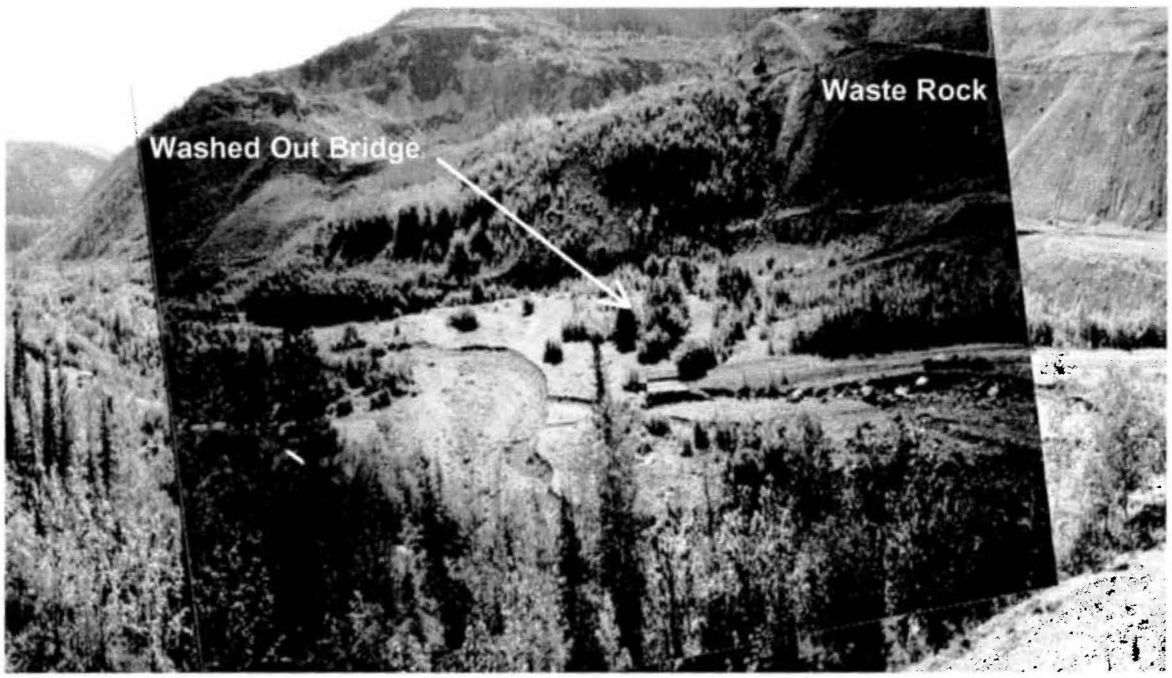


Photo UMA 14-20/21/22
Clinton Creek Channel at Washed Out Bridge Location (1998)

The confluence of Clinton Creek and Wolverine Creek is approximately 500 metres downstream of the washed out bridge. Under normal flow conditions, Wolverine Creek drops approximately two metres into Clinton Creek through a 1600 millimetre diameter steel plate (19 millimetre thick) culvert under the access road. As seen in Photo UMA 2-6, a significant amount of tailings out-wash material has been deposited within the Wolverine Creek channel just upstream of the culverts. Beaver dams several hundred metres downstream of the bridge have flooded a large area near the junction of Wolverine and Clinton Creek.

Photo UMA 2-6
Confluence of Wolverine Creek and Clinton Creek (1998)

The access road culvert is in good condition. The outlet of a second culvert (corrugated metal pipe) located at a lower elevation was submerged in the Clinton Creek stream bed (Photo UMA 15-10 and 15-8). The invert of a third 1200 millimetre diameter culvert, located immediately south of the Wolverine Creek outlet culvert, is set about 1 metre higher.

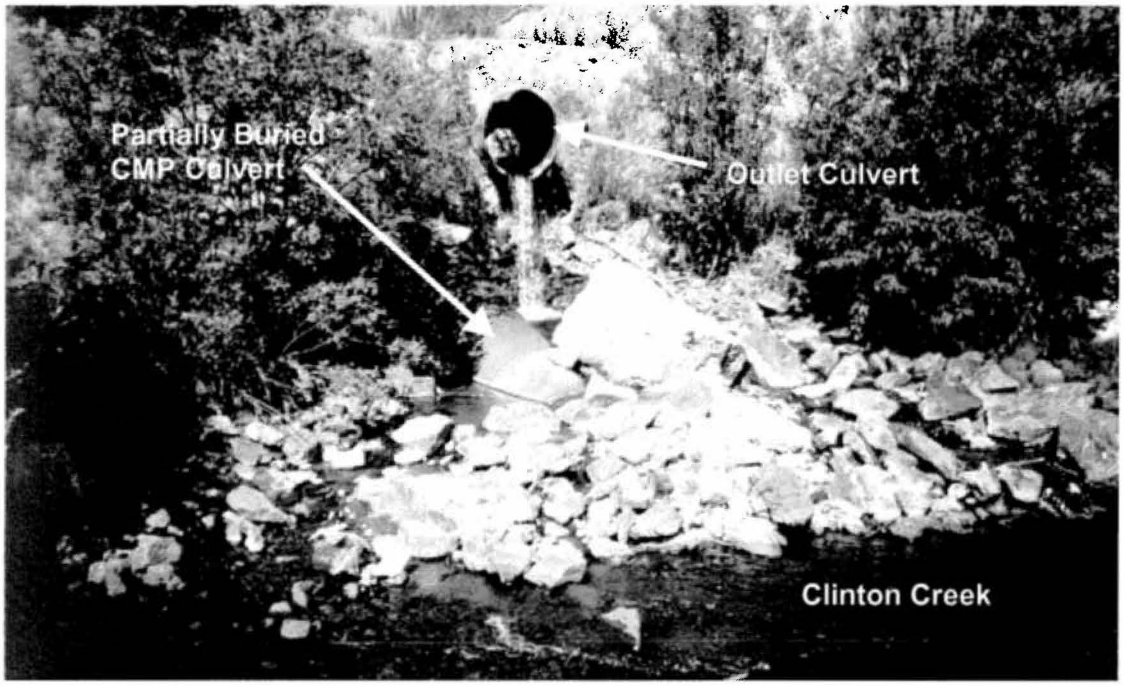


Photo UMA 15-10
Wolverine Outlet Culvert at Clinton Creek (1999)

Photo UMA 15-8
Wolverine Creek Outlet Culvert (1999)

5.3 HUDGEON LAKE

The deepest point of the lake (approximately 27 metres) occurs at the east end near the confluence of Bear Creek. The surface area and volume of Hudgeon Lake are estimated to be approximately 115 ha and 12 million cubic metres respectively. The results of a bathymetric survey carried out by Royal roads University are summarized in Figure 3-1.

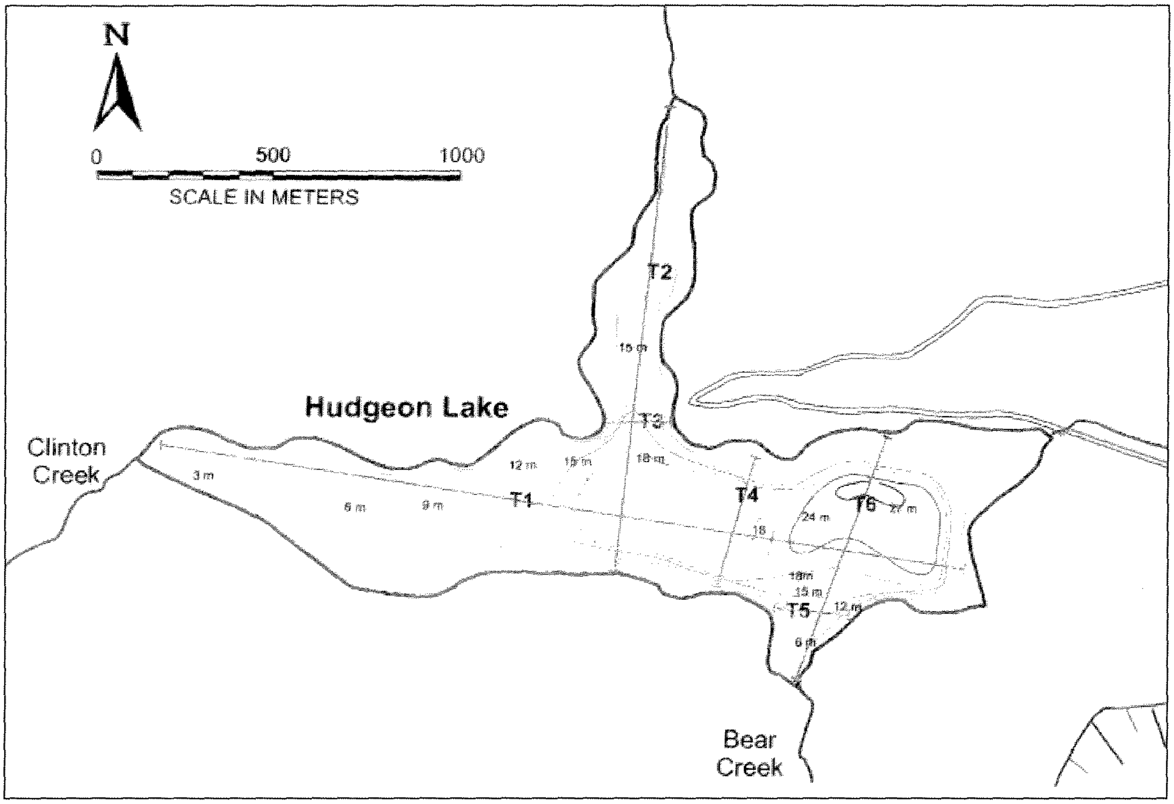


Figure 3-1
Bathymetry of Hudgeon Lake (Royal Roads University, 1998)

5.4 PORCUPINE PIT

Porcupine pit walls are a maximum height of about 200 metres inclined at approximately 45 to 50 degrees (Photo UMA 11-1). Water is currently ponded in the bottom of the pit at approximately elevation 385 metres. Instabilities of the pit walls are evident, in particular along the north and west sides. The instabilities range from ravelling and small wedge failures along the remnants of the pit benches to deep seated movements along the west side where back scarps and tension cracks well back from the edge of the pit wall are visible. Sloughing of the pit walls is clearly evident and debris could be heard falling into the water during the reconnaissance in the area.

Photo UMA 11-1
View East at Porcupine Pit (1998)

The former Crusher Building is situated near the crest between Porcupine Pit and Creek Pit, across the valley from the mill site (Drawing 04, Photo RRU-3 and Photo RRU-4). Large sections of the metal roofing and metal siding are missing and there is scattered debris in the general area. Remnants of what may have been the hydro sub-station are located at the base of the Creek Pit Road.

Photo RRU-3
Crusher Building (1998)

Photo RRU-4
Crusher Building (1998)

Abandoned equipment, including a drag line excavator and a drill rig, are located down slope, north of the Crusher Building (Photo RRU-5 and Photo RRU-6).

Photo RRU-5
Abandoned Equipment (1998)

Photo RRU-6
Excavator (1998)

5.5 PORCUPINE CREEK WASTE ROCK DUMP

Waste rock material placed on the north east side of Porcupine Pit has resulted in blockages of natural drainage along Porcupine Creek (Drawing 04 and Photo UMA 10-2) and the formation of a small unnamed reservoir. The two northeasterly blockages are relatively stable with no signs of active movement. The southwestern section of the waste rock dump has undergone extensive movement, however, resulting in numerous tension cracks and back scarps as shown in Photo UMA 11-0.

Photo UMA 10-2
Porcupine Creek Northern Waste Rock Blockage (1998)

Photo UMA 11-0
Porcupine Creek Waste Rock Failure Backscarp (1998)

An above ground storage tank is visible on the aerial photography on Drawing 04 at the top of the ridge west of Porcupine Pit in an area believed to have formerly housed a fertilizer storage facility.

5.6 PORCUPINE CREEK CHANNEL

Impounded water upstream of the waste rock dump continues to flow either below or through the waste rock or along the east valley slope in subterranean channels. The majority of flow occurs via a drainage channel incised through the slide debris from the unstable southern portion of the waste rock where it enters the waste rock pile (Drawing 04 and Photo UMA 10-9).

Photo UMA 10-9
Inlet into Waste Rock (1998)

Water draining internally through the waste rock discharges through the waste rock about 5 metres above the toe of the north slope, approximately 550 metres to the north of the inlet (Spring A). In September 1998, discharge at Spring A was estimated to be in the order of 10 l/s approximately 5 m above ground surface. Localized slumping of the waste rock is evident at the discharge point as illustrated in Photo UMA 11-3. Water is subsequently conveyed along a drainage channel incised along the south edge of the road where it eventually spills into the Creek Pit.

Photo UMA 11-3
Spring A at Porcupine Creek Waste Rock Dump (1998)

Discharge is also occurring via subterranean flow along the toe of the waste rock and east valley slope where flowing water is visible below the organic mat on the valley slope (Photo UMA 9-24, Drawing 04). Discharge from the subterranean flow system occurs as a spring (Spring B) near the northwest corner of the waste rock dump (Drawing 04). Some fine grained material has been deposited at the discharge point.

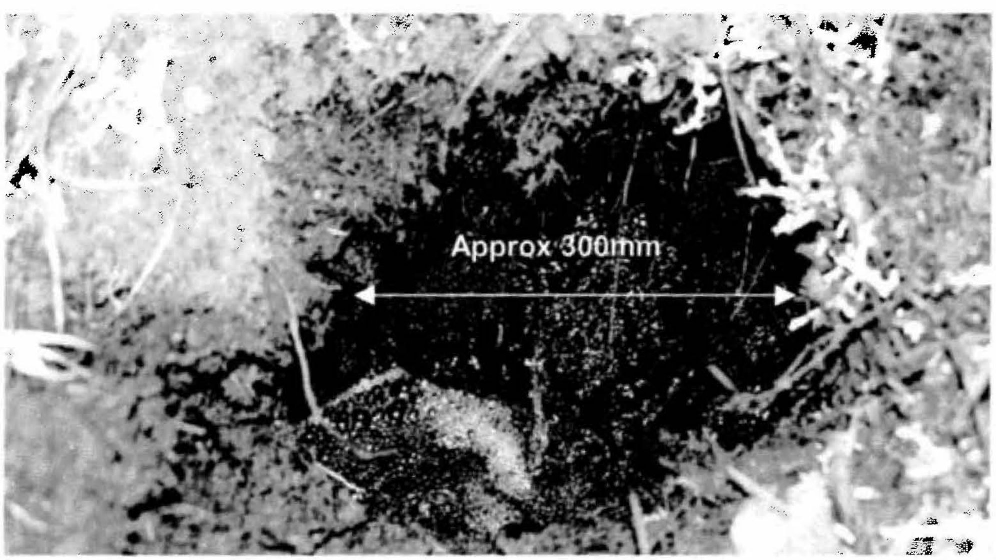


Photo UMA 9-24
Subterranean Flow at SE Edge of Waste Rock (1998)

5.7 TAILINGS PILES

The tailings from the milling process were originally deposited with a stacker conveyor over the valley crest on the west slope of Wolverine Creek (Drawing 05). The mill tailings generally consist of well graded 25 millimetre down crushed serpentine rock with some asbestos fibre not removed during milling. In 1974, a sudden failure of the tailings pile (referred to as the south lobe) lead to a complete blockage of Wolverine Creek. Following the failure of the south lobe, tailings were deposited further north along the west slope of Wolverine Creek. This area is referred to as the north lobe. Gradually, failure of the north lobe lead to another blockage of the creek channel just upstream of the south lobe (Photo UMA 1-3).

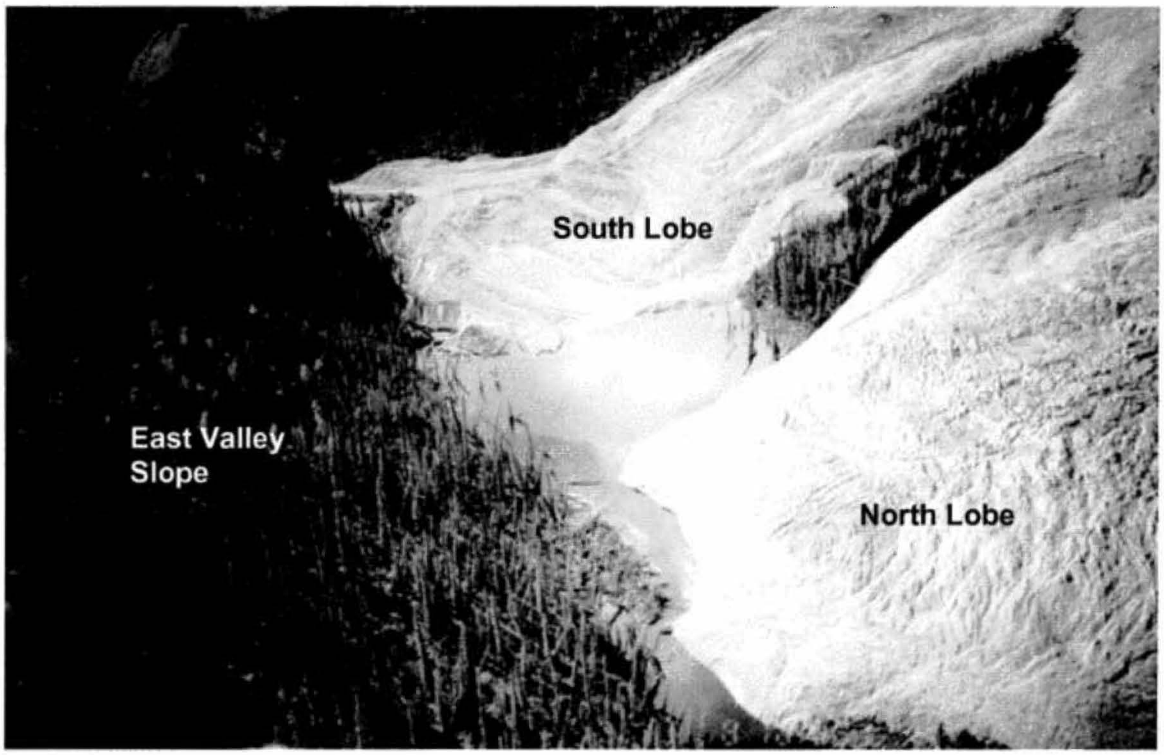


Photo UMA 1-3
North and South Tailing Lobes (1998)

Continued instabilities of the south and north lobes are evident with numerous tension cracks and slump blocks between the crest and toe (Photo UMA 3-6 and 1-6). As a result of the on-going instabilities, the leading edge of the lobes gradually advance into the Wolverine Creek channel where the tailings are eroded and transported downstream (Photo UMA 5-20).

Photo UMA 3-6
View West at Failed Tailings Pile(1998)

Photo UMA 1-6
Tension Cracks and Slumping at Top of Tailings Pile (1998)

Photo UMA 5-20
Erosion at Toe of Advancing Tailings (1998)

In addition to the channel obstruction created by the advancing tailings, heaving of the valley floor directly in the path of the advancing north lobe is evident (Photo RRU-10). A small reservoir is located upstream of the tailings lobes on Wolverine Creek creating by the blockage of the creek channel as shown on Drawing 05.

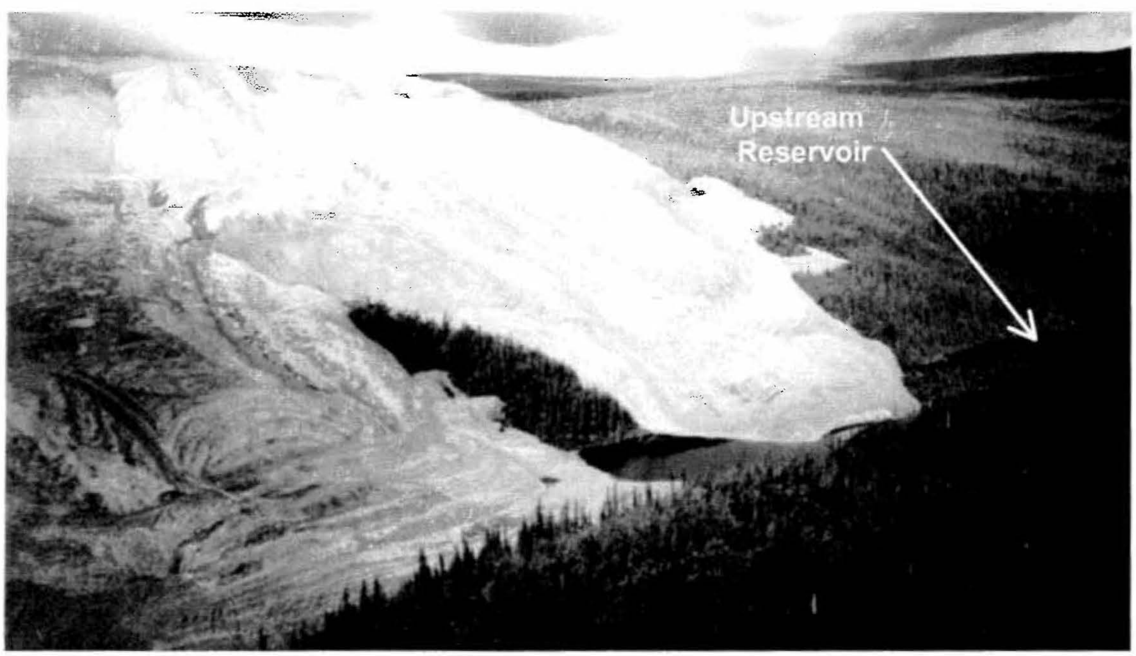


Photo RRU-10
View North West at Tailings Pile (1998)

Several ground movement monitoring monuments with conical sheet metal markers, similar to those found at the waste rock dump site, are located on both the north and south tailings lobes.

5.8 WOLVERINE CREEK CHANNEL

Four beaver dams (numbered 1 to 4) are located between the upstream side of the north lobe and the downstream side of the south lobe as shown on Drawing 05. Beaver dam 1 is located at the north end of the north lobe where the valley floor has heaved. The first beaver dam has raised the water level in the upstream reservoir about 1 metre higher than would occur from the overburden blockage at this location. High water marks on the trees in the upstream reservoir suggest water levels have been about 0.5 metres higher than were observed in September 1998. Surficial slumping of the east valley slope is also occurring opposite from beaver dam 1.

The second beaver dam, located between the upstream side of a small channel island and the toe of the north tailings lobe, does not impound a significant amount of water. The third beaver dam is located at the upstream end of the south lobe as shown in Photo UMA 5-18 and is responsible for raising the water level in the pond between the two tailings lobes by at least one metre. Beaver dam 4 is located immediately downstream of dam 3.

Photo UMA 5-18
Beaver Dam 3, Wolverine Creek (1998)

The four beaver dams have reduced channel velocities and erosion of the channel where the tailings piles meet the toe of the valley slope. Downstream of the beaver dams however, velocities increase significantly as the channel narrows and the gradient steepens. Within this stretch, the channel has down-cut into the underlying weathered argillite bedrock resulting in surficial slumping of the overburden soils (Photo UMA 5-23). A series of rock weirs line the channel immediately downstream of the south lobe. Flow is contained within the channel with no significant erosion or down-cutting observed. Ground vegetation in the areas of the tailings lobes is extremely scarce and plant diversity very low. Mats of chrysotile asbestos were observed in the lower branches of trees at a height corresponding to that of the snow pack.

Photo UMA 5-23
View Upstream Along Wolverine Creek *(1998)*

5.9 MILL SITE

The former Clinton Creek Asbestos Mine mill was located on the crest of the north slope of Clinton Creek west of Wolverine Creek, as shown on Drawing 05 and shown in the background of Photo RRU-7. Physical remnants of the mill include the following:

- concrete foundations and floor slabs of the former service building and former fibre building,
- two conveyor shafts,
- two large above ground diesel storage tanks (ASTs),

- two small structures near the location of the former office building and
- the terminus and intermediate foundation structures for the overhead tram (Photo RRU-8).

Sump pits within the foundation slab of the service building are debris filled with a noticeable hydrocarbon odour. Hydrocarbon staining was visible on the surface of the foundation slab which is extensively cracked. A large volume of fill material (likely tailings) has been deposited on the east side of the former fibre building, south of the former dryer building as shown in Photo RRU-9. Demolition debris is scattered throughout the mill site area.

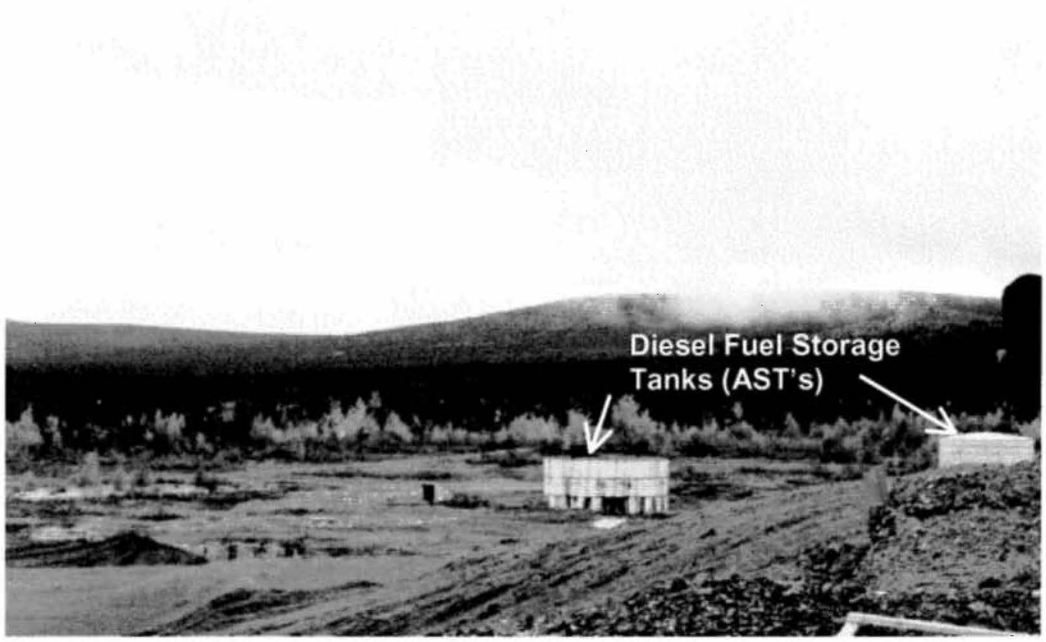


Photo RRU-7
View of Mill Site From Tailings Pile (1998)

The former aerial tramline terminated at a large steel tower on a suspected concrete footing or piles (Photo RRU-8). Seven intermediate towers are located between the terminus and the Crusher Building as seen in Photo RRU-9 and on Drawing 02. The intermediate towers are steel and are also likely founded on concrete footings or piles.

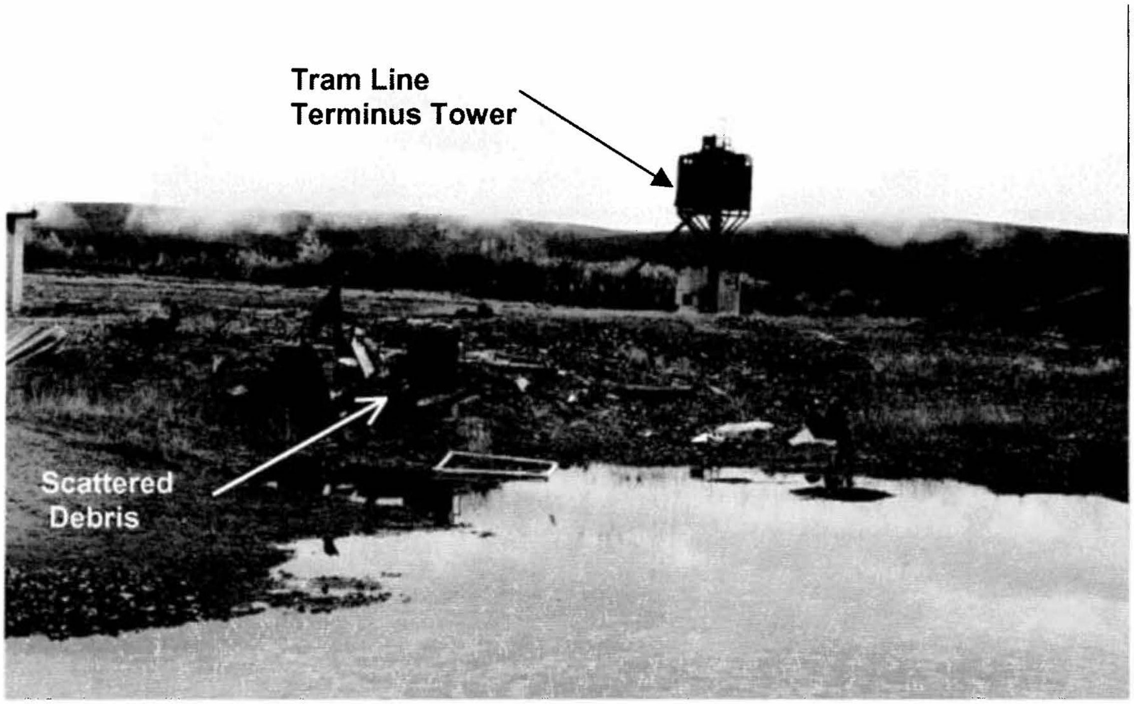


Photo RRU-8
Mill Site Area(1998)

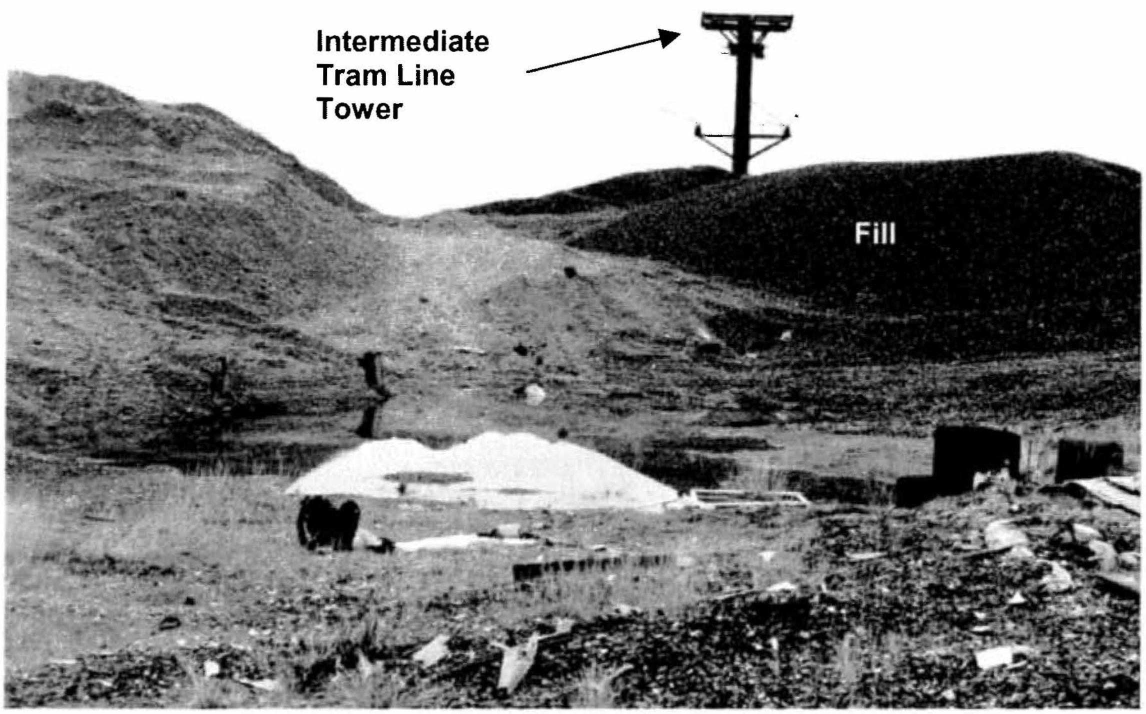


Photo RRU-9
Fill Material Above Fibre Building Foundation (1998)

6.0 GEOCHEMICAL SAMPLING RESULTS

A total of 32 soil samples were collected from the site for Royal Roads University's geochemical assessment of the waste rock and tailings materials. In addition, 27 water and 23 sediment samples were taken from Hudgeon Lake and Wolverine Creek, Forty Mile River and three reference locations. Sampling locations are shown in Figure 4-1 and laboratory analyses of select soil and water samples is provided as Appendix B.

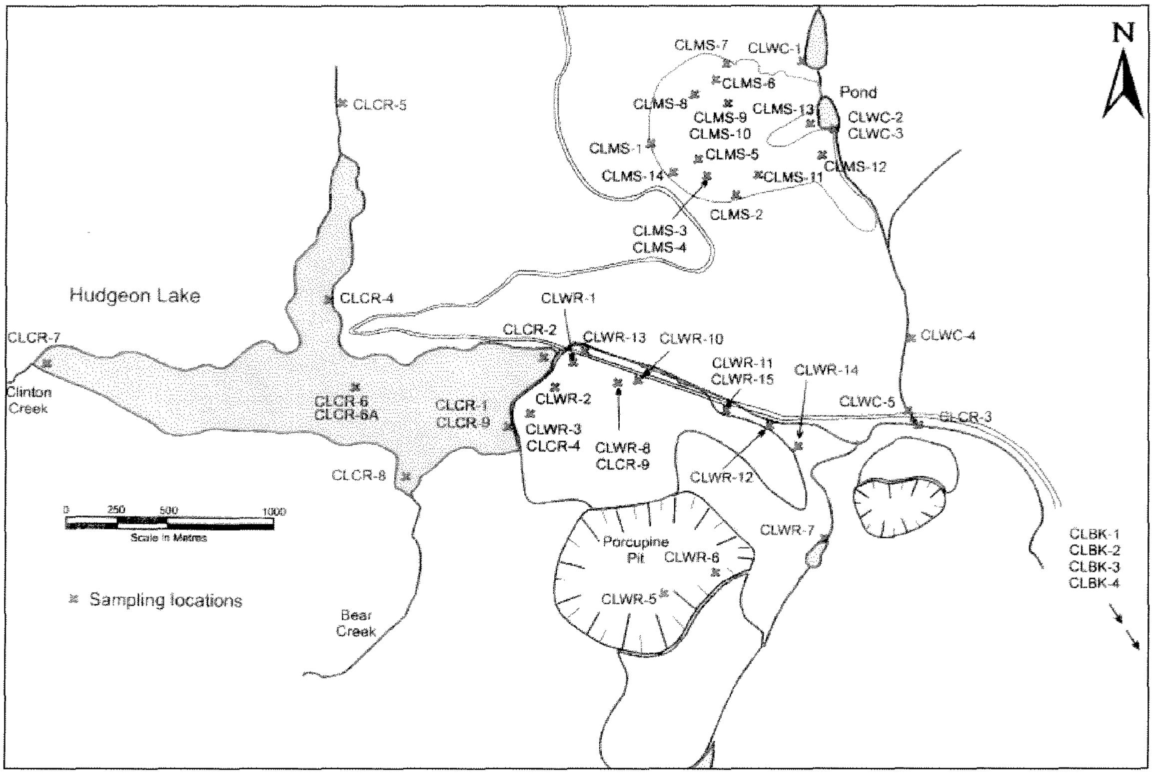


Figure 4-1
Geochemical Sample Location (Royal Roads University, 1998)

The soil, sediment and water samples were analyzed for metals, metalloids and asbestos. Inorganic non-metallic parameters were also determined in the water samples. The soil and water samples constantly demonstrated elevated pH indicating alkaline conditions. Antimony, lead, molybdenum, silver, and tin were generally below the detection limits in soil/sediment samples. Detection limits for these elements, however, were high due to matrix interference caused by elevated chromium and nickel concentrations found in the samples. Concentrations of arsenic, barium, chromium and nickel exceeded the CCME guidelines for residential parkland land use in substrate samples. These elements were not detected in the water samples. Asbestos concentrations in water were elevated. An anoxic condition was noted in a sample collected from the lower depths of Hudgeon Lake.

Thank you for the opportunity to provide continued assistance on this project. Should you have any questions or require additional information, please contact either of the undersigned.

Yours Truly,

UMA ENGINEERING LTD.

Peter R. Bohonos
Project Engineer

K.Skaftfeld, P.Eng
Senior Project Engineer

PROFESSIONAL
YUKON
K. M. SKAFTFELD
TERRITORY
06-28-00
ENGINEER

APPENDIX A
LIST OF REFERENCES

REFERENCES

Golder Associates (1977). Report to Cassiar Asbestos Corporation Ltd. on Stabilization Measures for Mine Closure.

Golder Associates (July 1978). Report to Cassiar Asbestos Corporation Ltd., Re: Mine Waste Dump and Tailings Pile, Clinton Creek Operations.

Hardy Associates Ltd. (1977). Report on Requirements for Development of a Rehabilitation Plan - Clinton Creek Mine, Cassiar Asbestos Corporation.

Hardy Associates Ltd. (1984). Rehabilitation Recommendations for Clinton Creek Asbestos Mine.

Klohn Leonoff Consulting Engineers (1984). Clinton Creek Waste Dump and Tailings Piles - 1984 Site Visit.

Klohn Leonoff Consulting Engineers (1986). Clinton Creek Asbestos Mine Abandonment Plan.

Roach, P. (1988). A Water Contaminants Evaluation - Abandoned Clinton Creek Asbestos Mine.

Royal Roads University (1999). An Environmental Review of the Clinton Creek Abandoned Asbestos Mine, Yukon, Canada for Indian and Northern Affairs Canada.

Royal Roads University (1998). Video of Site Reconnaissance.

UMA (1999). Abandoned Clinton Creek Asbestos Mine 1998 Site Reconnaissance for Indian and Northern Affairs Canada.

UMA (1998). Video of Site Reconnaissance.

UMA (1999). Video of Site Reconnaissance.

UMA (2000). Clinton Creek Risk Assessment (Draft)

APPENDIX B
GEOCHEMICAL SAMPLING
LABORATORY RESULTS

RESULTS OF ANALYSIS - Water

File No. J8624

			CLCR-1	CLCR-2	CLCR-3	CLCR-4	CLCR-5
			98 09 13 10:15	98 09 10 11:05	98 09 11 16:30	98 09 10 14:20	98 09 10 16:10
Dissolved Anions							
Alkalinity-Total		CaCO3	-	105	-	-	101
Bromide	Br		-	<0.5	-	-	<0.5
Chloride	Cl		-	<0.5	-	-	<0.5
Fluoride	F		-	0.13	-	-	0.19
Sulphate	SO4		-	110	-	-	61
Nutrients							
Nitrate Nitrogen		N	-	0.2	-	-	<0.1
Nitrite Nitrogen		N	-	<0.1	-	-	<0.1
Total Metals							
Aluminum	T-Al		0.059	0.067	0.061	0.063	0.066
Antimony	T-Sb		<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic	T-As		<0.2	<0.2	<0.2	<0.2	<0.2
Barium	T-Ba		0.05	0.05	0.05	0.05	0.03
Beryllium	T-Be		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	T-B		<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	T-Cd		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Calcium	T-Ca		46.8	46.7	48.3	45.4	32.1
Chromium	T-Cr		<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	T-Co		<0.01	<0.01	<0.01	<0.01	<0.01
Copper	T-Cu		0.02	<0.01	<0.01	<0.01	<0.01
Iron	T-Fe		0.23	0.25	0.27	0.24	0.17
Lead	T-Pb		<0.001	<0.001	<0.001	<0.001	<0.001
Magnesium	T-Mg		26.0	27.1	27.7	26.3	21.9
Manganese	T-Mn		0.110	0.118	0.108	0.107	0.010
Mercury	T-Hg		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum	T-Mo		<0.03	<0.03	<0.03	<0.03	<0.03
Nickel	T-Ni		<0.05	<0.05	<0.05	<0.05	<0.05
Selenium	T-Se		0.0014	<0.001	0.0012	0.0009	<0.001
Silver	T-Ag		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Thallium	T-Tl		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Uranium	T-U		0.00141	0.00151	0.00149	0.00150	0.00159
Zinc	T-Zn		<0.005	<0.005	<0.005	<0.005	<0.005

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

RESULTS OF ANALYSIS - Water File No. J8624

			CLCR-6	CLCR-6A	CLCR-7	CLCR-9	CLCR-Z6
			98 09 10 17:00	98 09 11 11:00	98 09 10 17:15	98 09 13 10:20	98 09 11 14:05
Dissolved Anions							
Alkalinity-Total		CaCO3	102	337	98	-	120
Bromide	Br		<0.5	<0.5	<0.5	-	<0.5
Chloride	Cl		<0.5	2.2	<0.5	-	0.7
Fluoride	F		0.14	0.26	0.17	-	0.18
Sulphate	SO4		111	307	106	-	148
Nutrients							
Nitrate Nitrogen		N	0.2	<0.1	0.2	-	0.2
Nitrite Nitrogen		N	<0.1	<0.1	<0.1	-	<0.1
Total Metals							
Aluminum	T-Al		0.062	0.08	0.123	0.059	0.220
Antimony	T-Sb		<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic	T-As		<0.2	<0.2	<0.2	<0.2	<0.2
Barium	T-Ba		0.05	0.11	0.05	0.05	0.05
Beryllium	T-Be		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	T-B		<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	T-Cd		<0.0002	<0.0004	<0.0002	<0.0002	<0.0002
Calcium	T-Ca		45.0	122	45.7	44.9	53.5
Chromium	T-Cr		<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	T-Co		<0.01	<0.01	<0.01	<0.01	<0.01
Copper	T-Cu		<0.01	<0.01	<0.01	<0.01	<0.01
Iron	T-Fe		0.24	0.94	0.26	0.21	0.42
Lead	T-Pb		<0.001	<0.002	<0.001	<0.001	<0.001
Magnesium	T-Mg		26.3	67.7	25.8	25.7	35.8
Manganese	T-Mn		0.117	2.70	0.112	0.111	0.149
Mercury	T-Hg		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum	T-Mo		<0.03	<0.03	<0.03	<0.03	<0.03
Nickel	T-Ni		<0.05	<0.05	<0.05	<0.05	<0.05
Selenium	T-Se		<0.001	<0.002	0.0011	0.0013	0.0011
Silver	T-Ag		<0.0001	<0.0002	<0.0001	<0.0001	<0.0001
Thallium	T-Tl		<0.0001	<0.0002	<0.0001	<0.0001	<0.0001
Uranium	T-U		0.00148	0.00231	0.00145	0.00141	0.00142
Zinc	T-Zn		<0.005	<0.005	<0.005	<0.005	<0.005

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

1988 Triumph Street, Vancouver, B.C., Canada V5L 1K5

analytical service laboratories ltd.

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CHEMICAL ANALYSIS REPORT

Date: October 1, 1998

ASL File No. J8625

Report On: Yukon Sediment Analysis

Report To: **Royal Roads University**
Applied Research Division
2005 Sooke Road
Victoria, BC
V9B 5Y2

Attention: **Dr. Matthew Dodd**, Professor

Received: September 16, 1998

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Frederick Chen, B.Sc. - Manager, Special Projects
Brent A. Makelki, B.Sc. - Supervisor, Client Services

REMARKS File No. J8625

Please note that the detection limits for several metals parameters have been increased due to matrix interferences caused by elevated chromium and nickel concentrations found in the samples.

RESULTS OF ANALYSIS - Sediment/Soil

File No. J8625

		CLMS-1S	CLMS-2S	CLMS-3S	CLMS-5S	CLMS-9S
		98 09 12 10:45	98 09 12 11:30	98 09 12 12:10	98 09 12 12:35	98 09 12 16:00
Physical Tests						
Moisture	%	43.4	27.0	9.8	15.5	15.4
pH		8.86	9.08	8.59	7.93	8.43
Total Metals						
Antimony	T-Sb	<100	<100	<100	<40	<80
Arsenic	T-As	74	14	3.2	160	265
Barium	T-Ba	981	207	279	502	228
Beryllium	T-Be	<3	<3	<3	<1	<2
Cadmium	T-Cd	<0.1	<0.1	<0.1	2.0	<0.1
Chromium	T-Cr	1410	1380	1650	771	928
Cobalt	T-Co	103	81	87	60	76
Copper	T-Cu	7	<5	<5	30	<4
Lead	T-Pb	<300	<300	<300	<100	<200
Mercury	T-Hg	0.109	0.018	0.018	0.172	0.409
Molybdenum	T-Mo	<20	<20	<20	<8	<20
Nickel	T-Ni	2210	2030	2140	1150	1740
Selenium	T-Se	<0.1	<0.1	<0.1	3.5	<0.1
Silver	T-Ag	<10	<10	<10	<4	<8
Tin	T-Sn	<50	<50	<50	<20	<40
Vanadium	T-V	26	21	11	34	<8
Zinc	T-Zn	30	13	14	133	6

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.

RESULTS OF ANALYSIS - Sediment/Soil

File No. J8625

		CLMS-10S	CLMS-11S	CLMS-12S	CLMS-13S	CLWC-1S
		98 09 12 16:05	98 09 12 16:50	98 09 12 17:20	98 09 12 18:30	98 09 12 16:05
Physical Tests						
Moisture	%	13.3	7.7	10.6	9.5	45.5
pH		8.52	9.55	8.56	7.02	6.46
Total Metals						
Antimony	T-Sb	<60	<40	<100	<20	<20
Arsenic	T-As	321	2.4	2.4	7	11
Barium	T-Ba	588	5	346	270	223
Beryllium	T-Be	<2	<1	<3	0.8	<0.5
Cadmium	T-Cd	<0.1	<0.1	<0.1	0.4	0.6
Chromium	T-Cr	1430	1530	1470	36	62
Cobalt	T-Co	99	65	111	19	11
Copper	T-Cu	3	<2	<5	42	26
Lead	T-Pb	<200	<100	<300	<50	<50
Mercury	T-Hg	0.444	<0.005	0.034	0.057	0.080
Molybdenum	T-Mo	<20	<8	<20	<4	5
Nickel	T-Ni	2200	1640	2300	54	70
Selenium	T-Se	<0.1	<0.1	0.1	1.1	1.6
Silver	T-Ag	<6	<4	<10	<2	<2
Tin	T-Sn	<30	<20	<50	<10	<10
Vanadium	T-V	19	8	20	43	30
Zinc	T-Zn	12	9	14	122	97

Remarks regarding the analyses appear at the beginning of this report.
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< = Less than the detection limit indicated.

RESULTS OF ANALYSIS - Sediment/Soil

File No. J8625

		CLWC-2S	CLWC-3S	CLMS-14	CLWR-3S	CLWR-4S
		98 09 12 19:15	98 09 12 19:20	98 09 10 10:40	98 09 13 12:00	98 09 13 12:05
Physical Tests						
Moisture	%	29.2	27.2	-	8.1	7.8
pH		8.53	8.37	-	7.92	8.03
Total Metals						
Antimony	T-Sb	<100	<100	-	<20	<20
Arsenic	T-As	11	9	-	13	14
Barium	T-Ba	41	49	-	84	103
Beryllium	T-Be	<3	<3	-	0.5	0.7
Cadmium	T-Cd	<0.1	<0.1	-	2.3	2.5
Chromium	T-Cr	1580	1670	-	19	22
Cobalt	T-Co	88	89	-	15	15
Copper	T-Cu	<5	5	-	58	62
Lead	T-Pb	<300	<300	-	<50	<50
Mercury	T-Hg	0.011	0.016	-	0.299	0.343
Molybdenum	T-Mo	<20	<20	-	14	16
Nickel	T-Ni	1920	1860	-	65	64
Selenium	T-Se	0.1	0.2	-	8	8
Silver	T-Ag	<10	<10	-	<2	<2
Tin	T-Sn	<50	<50	-	<10	<10
Vanadium	T-V	14	21	-	30	36
Zinc	T-Zn	19	25	-	248	238
Polychlorinated Biphenyls						
Total Polychlorinated Biphenyls		-	-	<0.05	-	-

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.

RESULTS OF ANALYSIS - Sediment/Soil

File No. J8625

		CLWR-5S	CLWR-6S	CLWR-7S	CLWR-10S	CLWR-11S
		98 09 13 13:50	98 09 13 14:25	98 09 13 15:20	98 09 13 16:00	98 09 13 16:25
Physical Tests						
Moisture	%	18.7	17.6	29.7	6.6	16.5
pH		8.44	7.86	8.42	8.38	8.01
Total Metals						
Antimony	T-Sb	<80	<100	<100	<80	<20
Arsenic	T-As	28	13	17	15	18
Barium	T-Ba	65	397	1060	10	296
Beryllium	T-Be	<2	<3	<3	<2	0.8
Cadmium	T-Cd	0.2	<0.1	0.5	<0.1	1.6
Chromium	T-Cr	1110	1810	625	1180	486
Cobalt	T-Co	55	105	46	76	49
Copper	T-Cu	25	10	21	14	48
Lead	T-Pb	<200	<300	<300	<200	<50
Mercury	T-Hg	0.046	0.142	0.167	0.197	0.297
Molybdenum	T-Mo	<20	<20	<20	<20	12
Nickel	T-Ni	1230	852	867	1710	834
Selenium	T-Se	0.3	0.1	1.2	<0.1	4.4
Silver	T-Ag	<8	<10	<10	<8	<2
Tin	T-Sn	<40	<50	<50	<40	<10
Vanadium	T-V	23	66	47	<8	38
Zinc	T-Zn	29	27	71	8	143

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.

RESULTS OF ANALYSIS - Sediment/Soil

File No. J8625

		CLWR-5S	CLWR-6S	CLWR-7S	CLWR-10S	CLWR-11S
		98 09 13 13:50	98 09 13 14:25	98 09 13 15:20	98 09 13 16:00	98 09 13 16:25
Physical Tests						
Moisture	%	18.7	17.6	29.7	6.6	16.5
pH		8.44	7.86	8.42	8.38	8.01
Total Metals						
Antimony	T-Sb	<80	<100	<100	<80	<20
Arsenic	T-As	28	13	17	15	18
Barium	T-Ba	65	397	1060	10	296
Beryllium	T-Be	<2	<3	<3	<2	0.8
Cadmium	T-Cd	0.2	<0.1	0.5	<0.1	1.6
Chromium	T-Cr	1110	1810	625	1180	486
Cobalt	T-Co	55	105	46	76	49
Copper	T-Cu	25	10	21	14	48
Lead	T-Pb	<200	<300	<300	<200	<50
Mercury	T-Hg	0.046	0.142	0.167	0.197	0.297
Molybdenum	T-Mo	<20	<20	<20	<20	12
Nickel	T-Ni	1230	852	867	1710	834
Selenium	T-Se	0.3	0.1	1.2	<0.1	4.4
Silver	T-Ag	<8	<10	<10	<8	<2
Tin	T-Sn	<40	<50	<50	<40	<10
Vanadium	T-V	23	66	47	<8	38
Zinc	T-Zn	29	27	71	8	143

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.

Westmont, NJ (609) 858-1260 | Piscataway, NJ (908) 981-0550 | Carle Place, NY (516) 997-7251 | Smyrna, GA (404) 333-6066 | Melbourne, FL (407) 253-4224 | Ann Arbor, MI (313) 668-6810 | San Mateo, CA (415) 570-5401

EMSL

Thursday, October 1, 1998

Royal Roads University
2005 Sooke Road
Victoria, BC V9B 5Y2

Project: Canada
Attention: Matt Dodd
Ref Number: CA986778
Date Sampled 9-10-98 - 9-12-98

Asbestos Analysis in Water by Transmission Electron Microscopy (TEM) Performed by Method EPA/600/R-94/134 - (100.2)

"Determination of Asbestos Structures Over 10µm In Length in Drinking Water"; by Brackett, Clark & Millette

SAMPLE ID	#ASBESTOS STRUCTURES >10µm	#ASBESTOS STRUCTURES ≤10µm	#NON-ASBESTOS FIBROUS STRUCTURES	TYPE(S) OF ASBESTOS	CONCENTRATION OF ASBESTOS STRUCTURES (MILLIONS/LITER) >10µm	CONCENTRATION (MILLIONS/LITER) Total	95% Confidence Limits (Lower-Upper) (MILLIONS/LITERS) >10 µm	95% Confidence Limits Total	DETECTION LIMIT (MFL)
CLCR-Z3B	0	4	0	Chysotile	<1.07	4.29	0.02-5.98	1.17-10.99	1.07
CLCR-Z8	0	1	1	Chysotile	<1.07	1.07	0.02-5.98	0.02-5.98	1.07
CLCR-2 wc	0	22	0	Chysotile	<1.07	22.62	0.02-5.98	14.8-35.76	1.07
CLCR-3 wc	0	9	0	Chysotile	<1.07	9.66	0.02-5.98	4.43-18.34	1.07
CLCR-5	0	8	1	Chysotile	<1.07	8.59	0.02-5.98	3.71-16.92	1.07
CLCR-7	0	5	0	Chysotile	<1.07	5.36	0.02-5.98	1.74-12.51	1.07
CLCR-8	0	0	2	Chysotile	<1.07	<1.07	0.02-5.98	0.02-5.98	1.07
CLCR-Z6	14	128	5	Chysotile	15.03	152.45	8.2-25.22	119.9-191.52	1.07
CLCR-6	0	10	9	Chysotile	<1.07	10.73	0.02-5.98	5.15-19.74	1.07
CLCR-2	2	103	1	Chysotile	2.15	112.73	0.03-7.75	89.13-143.06	1.07
CLCR-6A	1	12	2	Chysotile	1.07	13.96	0.02-5.98	7.43-23.87	1.07
EMSL Blank	0	0	0	None Detected	<0.18	<0.18	0-0.68	0-0.68	0.18

***Samples that contain high levels of particulate which require the laboratory to filter a dilution less than the minimum recommended method volume of 50 ml, will necessarily have higher detection limits. Refer to EPA/600/R-94/134 Method 100.2, Sections 11.10 and 13.6.**

Analyst

Approved Signatory

ACCREDITATIONS: NVLAP #101048-03 and CA STATE ELAP #1620

North West Environmental
Project Number: 1012
Royal Roads University - Bulk Sample Results

15/10/98

NO.	DATE	SAMPLE INFORMATION	DESCRIPTION	ASBESTOS		OTHER	ANALYST
1	07/10/98	CLMS-13 Sediment	1 sediment (100%)	None Detected		cellulose(3%), nf(97%)	RC
2	07/10/98	CLWC-1 Sediment	1 sediment (100%)	None Detected		cellulose(25%), nf(75%)	RC
3	07/10/98	CLWC-2 Sediment	1 sediment (100%)	Chrysotile	10%	nf(90%)	RC
4	07/10/98	CLWC-3 sediment	1 Sediment (100%)	Chrysotile	3-5%	cellulose(2%), nf(93%)	RC
5	07/10/98	CLWR-3 sediment	1 Sediment (100%)	Chrysotile	1-2%	cellulose(2%), nf(97%)	RC
6	07/10/98	CLWR-4 sediment	1 Sediment (100%)	Chrysotile	< 1%	cellulose(1%), nf(99%)	RC

NF = Non-Fibrous material; SS = Small Sample size
PLEASE NOTE: Due to space limitations, these sample(s) will be disposed of after 3 months, unless we are instructed otherwise by our client.

North West Environmental
Project Number: 1012
Royal Roads University - Bulk Sample Results

15/10/98

NO.	DATE	SAMPLE INFORMATION	DESCRIPTION	ASBESTOS		OTHER	ANALYST
7	07/10/98	CLWR-1 sediment	1 Sediment (100%)	Chrysotile	3-5%	cellulose(1%), nf(95%)	RC
8	07/10/98	CLWR-11 sediment	1 Sediment (100%)	Chrysotile	7%	cellulose(1%), nf(92%)	RC
9	07/10/98	CLWR-15 sediment	1 Sediment (100%)	Chrysotile	6%	cellulose(1%), nf(93%)	RC
10	07/10/98	CLBK-1 sediment	1 Sediment (100%)	Chrysotile	3-5%	cellulose(2%), nf(95%)	RC
11	08/10/98	CLCR-27 Sediement	1 sediment (100%)	None Detected		cellulose(4%), nf(96%)	RC
12	08/10/98	CLCR-28 Sediment	1 sediment (100%)	None Detected		cellulose(10%), nf(90%)	RC

NF = Non-Fibrous material; SS = Small Sample size
PLEASE NOTE: Due to space limitations, these sample(s) will be disposed of after 3 months, unless we are instructed otherwise by our client.

North West Environmental
Project Number: 1012
Royal Roads University - Bulk Sample Results

15/10/98

NO.	DATE	SAMPLE INFORMATION	DESCRIPTION	ASBESTOS		OTHER	ANALYS
13	08/10/98	CLCR-29 Sediment	1 sediment (100%)	None Detected		cellulose(2%), nf(98%)	RC
14	08/10/98	CLMS-1 Sediment	1 sediment (100%)	Chrysotile	35%	nf(65%)	RC
15	08/10/98	CLMS-2 Sediment	1 sediment (100%)	Chrysotile	40%	nf(60%)	RC
16	09/10/98	CLMS-3 Sediment	1 sediment (100%)	Chrysotile	15%	nf(85%)	RC
17	09/10/98	CLMS-4 Sediment	1 sediment (100%)	Chrysotile	15%	nf(85%)	RC
18	09/10/98	CLMS-6 Sediment	1 sediment (100%)	Chrysotile	10%	cellulose(2%), nf(88%)	RC

NF = Non-Fibrous material; SS = Small Sample size
PLEASE NOTE: Due to space limitations, these sample(s) will be disposed of after 3 months, unless we are instructed otherwise by our client.

NO.	DATE	SAMPLE INFORMATION	DESCRIPTION	ASBESTOS		OTHER	ANALYST
19	09/10/98	CLMS-9 Sediment	1 sediment (100%)	Chrysotile	40%	nf(60%)	RC
20	09/10/98	CLMS-10 Sediment	1 sediment (100%)	Chrysotile		nf(70%)	RC
21	09/10/98	CLCR-2 Sediment	1 sediment (100%)	Chrysotile	3-5%	cellulose(1%), nf(94%)	RC
22	09/10/98	CLCR-3 Sediment	1 sediment (100%)	Chrysotile	3-5%	nf(97%)	RC
23	09/10/98	CLCR-4 Sediment	1 sediment (100%)	Chrysotile	1-2%	cellulose(1%), nf(98%)	RC
24	09/10/98	CLCR-5 Sediment	1 sediment (100%)	Chrysotile	1-2%	cellulose(3%), nf(96%)	RC

NF = Non-Fibrous material; SS = Small Sample size
PLEASE NOTE: Due to space limitations, these sample(s) will be disposed of after 3 months, unless we are instructed otherwise by our client.

North West Environmental
Project Number: 1012
Royal Roads University - Bulk Sample Results

15/10/98

NO.	DATE	SAMPLE INFORMATION	DESCRIPTION	ASBESTOS		OTHER	ANALYS
25	09/10/98	CLCR-7 Sediment	1 sediment (100%)	None Detected		cellulose(1%), nf(99%)	RC
26	09/10/98	CLCR-23 Sediment	1 sediment (100%)	None Detected		cellulose(1%), nf(99%)	RC
27	09/10/98	CLCR-23B Sediment	1 sediment (100%)	None Detected		cellulose(1%), nf(99%)	RC
28	09/10/98	CLCR-24 Sediment	1 sediment (100%)	Chrysotile	1-2%	nf(98%)	RC
29	09/10/98	CLCR-25 Sediment	1 sediment (100%)	Chrysotile	< 1%	nf(99%)	RC
30	09/10/98	CLCR-26 Sediment	1 sediment (100%)	Chrysotile	< 1%	nf(99%)	RC

NF = Non-Fibrous material; SS = Small Sample size
PLEASE NOTE: Due to space limitations, these sample(s) will be disposed of after 3 months, unless we are instructed otherwise by our client.

RESULTS OF ANALYSIS - Water

File No. J8624

			CLCR-Z3B	CLCR-Z8	CLMS-1	CLWC-1	CLWC-2
			98 09 11 15:45	98 09 11 07:45	98 09 12 10:45	98 09 12 18:05	98 09 12 19:00
Dissolved Anions							
Alkalinity-Total		CaCO3	-	-	-	87	88
Bromide	Br		-	-	-	<0.5	<0.5
Chloride	Cl		-	-	-	0.6	0.6
Fluoride	F		-	-	-	0.14	0.14
Sulphate	SO4		-	-	-	124	128
Nutrients							
Nitrate Nitrogen		N	-	-	-	<0.1	<0.1
Nitrite Nitrogen		N	-	-	-	<0.1	<0.1
Total Metals							
Aluminum	T-Al		0.98	0.28	0.006	0.246	0.193
Antimony	T-Sb		<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic	T-As		<0.2	<0.2	<0.2	<0.2	<0.2
Barium	T-Ba		0.08	0.04	0.04	0.05	0.05
Beryllium	T-Be		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	T-B		<0.1	<0.1	0.6	<0.1	<0.1
Cadmium	T-Cd		<0.0002	<0.0002	<0.0004	<0.0002	<0.0002
Calcium	T-Ca		41.8	21.4	6.69	45.2	41.7
Chromium	T-Cr		<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	T-Co		<0.01	<0.01	<0.01	<0.01	<0.01
Copper	T-Cu		<0.01	<0.01	<0.01	<0.01	<0.01
Iron	T-Fe		0.66	0.36	<0.03	0.39	0.34
Lead	T-Pb		<0.001	<0.001	<0.002	<0.001	<0.001
Magnesium	T-Mg		14.8	6.6	150	29.0	28.3
Manganese	T-Mn		0.040	0.017	<0.005	0.091	0.070
Mercury	T-Hg		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum	T-Mo		<0.03	<0.03	<0.03	<0.03	<0.03
Nickel	T-Ni		<0.05	<0.05	<0.05	<0.05	<0.05
Selenium	T-Se		0.0023	<0.001	0.0024	<0.001	<0.001
Silver	T-Ag		<0.0001	<0.0001	<0.0002	<0.0001	<0.0001
Thallium	T-Tl		<0.0001	<0.0001	<0.0002	<0.0001	<0.0001
Uranium	T-U		0.00078	0.00059	<0.00002	0.00184	0.00176
Zinc	T-Zn		<0.005	<0.005	<0.005	<0.005	<0.005

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

RESULTS OF ANALYSIS - Water

File No. J8624

			CLWC-3	CLWR-13	CLWR-7
			98 09 12 19:05	98 09 13 17:00	98 09 13 15:15
Dissolved Anions					
Alkalinity-Total		CaCO3	86	-	223
Bromide	Br		<0.5	-	<0.5
Chloride	Cl		0.6	-	0.7
Fluoride	F		0.14	-	0.30
Sulphate	SO4		127	-	900
Nutrients					
Nitrate Nitrogen		N	<0.1	-	0.5
Nitrite Nitrogen		N	<0.1	-	<0.1
Total Metals					
Aluminum	T-Al		-	0.010	0.006
Antimony	T-Sb		-	<0.2	<0.2
Arsenic	T-As		-	<0.2	<0.2
Barium	T-Ba		-	0.06	0.02
Beryllium	T-Be		-	<0.005	<0.005
Boron	T-B		-	<0.1	<0.1
Cadmium	T-Cd		-	<0.001	<0.001
Calcium	T-Ca		-	141	270
Chromium	T-Cr		-	<0.01	<0.01
Cobalt	T-Co		-	<0.01	<0.01
Copper	T-Cu		-	<0.01	<0.01
Iron	T-Fe		-	1.21	<0.03
Lead	T-Pb		-	<0.005	<0.005
Magnesium	T-Mg		-	130	123
Manganese	T-Mn		-	1.18	<0.005
Mercury	T-Hg		-	<0.00005	<0.00005
Molybdenum	T-Mo		-	<0.03	<0.03
Nickel	T-Ni		-	<0.05	<0.05
Selenium	T-Se		-	<0.005	0.0081
Silver	T-Ag		-	<0.0005	<0.0005
Thallium	T-Tl		-	<0.0005	<0.0005
Uranium	T-U		-	0.00040	0.00467
Zinc	T-Zn		-	<0.005	<0.005

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RESULTS OF ANALYSIS - Water

File No. J8624

		CLCR-1	CLCR-2	CLCR-9	CLCR-Z6
		98 09 13 10:15	98 09 10 11:05	98 09 13 10:20	98 09 11 14:05
Dissolved Metals					
Aluminum	D-Al	0.103	0.050	0.092	0.048
Antimony	D-Sb	<0.2	<0.2	<0.2	<0.2
Arsenic	D-As	<0.2	<0.2	<0.2	<0.2
Barium	D-Ba	0.05	0.05	0.05	0.05
Beryllium	D-Be	<0.005	<0.005	<0.005	<0.005
Boron	D-B	<0.1	<0.1	<0.1	<0.1
Cadmium	D-Cd	<0.0002	<0.0002	<0.0002	<0.0002
Calcium	D-Ca	45.2	47.8	46.1	53.2
Chromium	D-Cr	<0.01	<0.01	<0.01	<0.01
Cobalt	D-Co	<0.01	<0.01	<0.01	<0.01
Copper	D-Cu	<0.01	<0.01	<0.01	<0.01
Iron	D-Fe	0.25	0.23	0.22	0.23
Lead	D-Pb	<0.001	<0.001	<0.001	<0.001
Magnesium	D-Mg	26.2	27.7	26.4	35.7
Manganese	D-Mn	0.110	0.130	0.111	0.130
Mercury	D-Hg	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum	D-Mo	<0.03	<0.03	<0.03	<0.03
Nickel	D-Ni	<0.05	<0.05	<0.05	<0.05
Selenium	D-Se	0.0012	<0.001	0.0011	0.0010
Silver	D-Ag	<0.0001	<0.0001	<0.0001	<0.0001
Thallium	D-Tl	<0.0001	<0.0001	<0.0001	<0.0001
Uranium	D-U	0.00147	0.00156	0.00147	0.00142
Zinc	D-Zn	<0.005	<0.005	<0.005	<0.005

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.