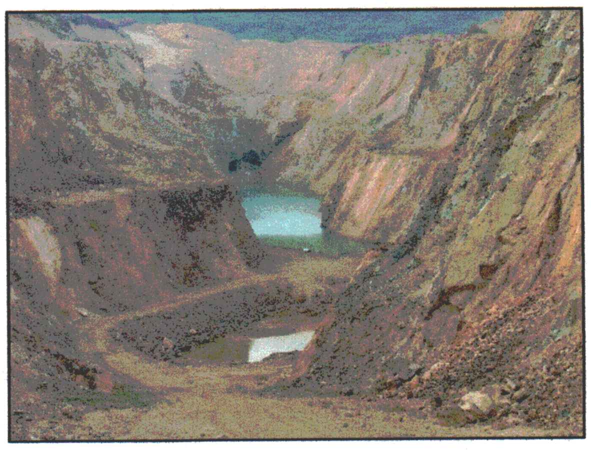
Phase I – Mt. Nansen Mine Site, Brown-McDade Pit Summer Monitoring, 2004 – Data Summary Report



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Energy, Mines and Resources
Abandoned Mines Project Office

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Gartner Lee Limited

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2 Energy, Mines and Resources
1 Gartner Lee Limited

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March 3, 2005

Hugh Copland, Project Manager
Energy, Mines and Resources
Abandoned Mines Project Office
Box 2703
Whitehorse, Yukon Y1A 2C6

Dear Mr. Copland:

Re: 40-568 – Phase I - Mt. Nansen Mine Site, Brown McDade Pit Summer Monitoring 2004 –Data Summary Report

We are pleased to present you with two copies of our report entitled "Mt. Nansen Mine Site, Brown McDade Pit Summer Monitoring 2004 –Data Summary Report". Please review at your earliest convenience and contact me to discuss your comments.

Please do not hesitate to contact me at ext. 24 should you have any questions. We thank you for the opportunity to complete this phase of the project and look forward to assisting you with future work at the site.

Yours very truly,
GARTNER LEE LIMITED

Martin Guilbeault, M.Sc., P.Eng.
Hydrogeologist
MG:mg

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1. Background

Site monitoring of the Mt Nansen mine Brown-McDade open pit and adjacent Pony Creek was undertaken in 2004 as a result of recommendations outlined by Gartner Lee (2004). The focus of the study was to develop an understanding of the pit water elevation behavior and the associated water quality. A more detailed description of site history and related care and maintenance issues is provided by Gartner Lee (2004). This work is outlined in phase I of the June 15 memo entitled "23669 – Mt Nansen, Brown McDade Pit Summer / Fall 2004 Revised Monitoring Plan". As outlined in the memo, phase I of the workplan consisted mainly of data acquisition over the summer of 2004. Consequently, the following consists mainly of a data presentation report with minimal interpretation. A more detailed review of the data should be conducted in order to determine and assess final closure options specifically as they relate to the Brown McDade open pit. This is outlined in phases II and III of the above mentioned memo.

2. Introduction

The main components of the 2004 pit water balance are shown in Figure 1. GLL (2004) noted that frozen seepage faces were observed in the northern end of the pit during field work in February. This was consistent with the overall water balance model that predicted significant seepage into the pit during the summer season. This is shown schematically in Figure 1. It was also anticipated that the rate of this seepage would be variable throughout all non-frozen conditions and seepage rates would likely depend on input source variability (i.e. Pony Creek drainage flow) and ground conditions (frozen ground or not and/or the nature of fractured rock).

The main relevant recommendations from the GLL (2004) report are:

Water Balance

- Continuous monitoring of pit lake water levels
- Continuous acquisition of site specific meteorological data
- Qualitative observations (photos, notes, videos) of site conditions:
    - Snowmelt
    - Runoff
    - Drainage patters
    - Pit seepage patterns
    - Streamflow
- Quantitative measurement of water balance components
    - streamgauging

- Seasonal monitoring of seasonal changes in water balance components
- Determine water table using boreholes and observation wells
- Determine elevation of Pony Creek adit
- Examine condition of Pony Creek adit
- Determine source of seepage to pit
- Examine pit walls during non-frozen conditions
- On-going calibration and refinement of model with new data

Water Quality

- Collect and monitor seasonally water quality of all water balance components
- Conduct seasonal profiles of pit lake quality
- Collect depth-discrete samples at several locations in pit
- Use a mass balance approach to model pit chemistry

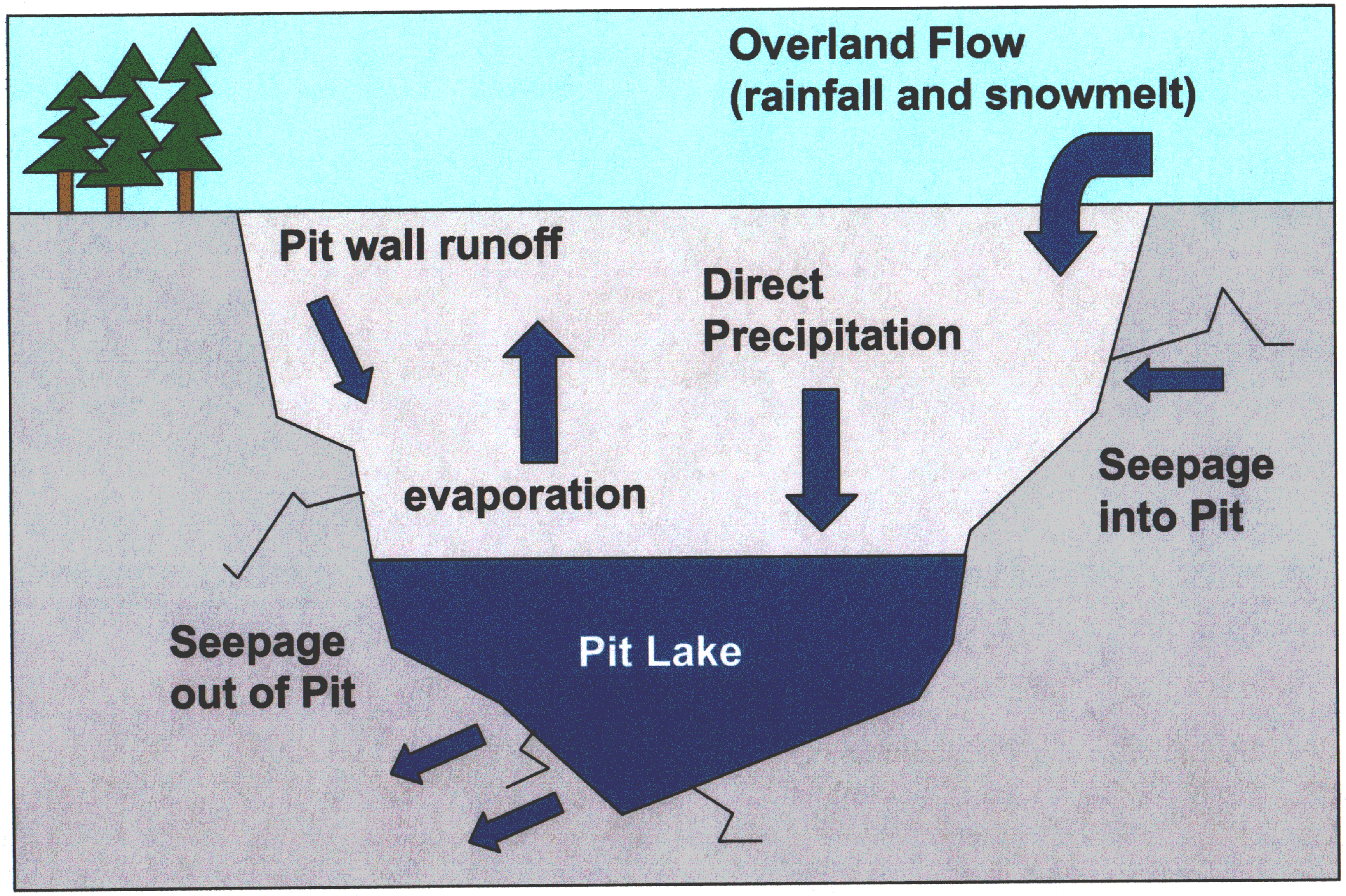


Figure 1. Conceptual Model of Pit Water Balance (GLL, 2004)

2.1 Study Goals and Approach

The main goals of the summer 2004 study were the following:

- make key observations (using digital photography and video) about the nature of surface water runoff to the pit, possible groundwater discharge points downgradient of pit, drainage patterns, runoff from pit wall benches and pit walls and seepage into the pit and establish possible monitoring locations and methods for water quality and flow.
- develop a sampling, monitoring and site instrumentation plan
- instrument the site in a manner that would facilitate temporal monitoring during summer/fall
- collect flow measurements and water quality for different water balance components such as seepage into the pit (from North end) and pit walls and observe temporal variations in site hydrology and hydrogeology.
- determine the evolution of chemical and thermal stratification in the pit during non-frozen periods

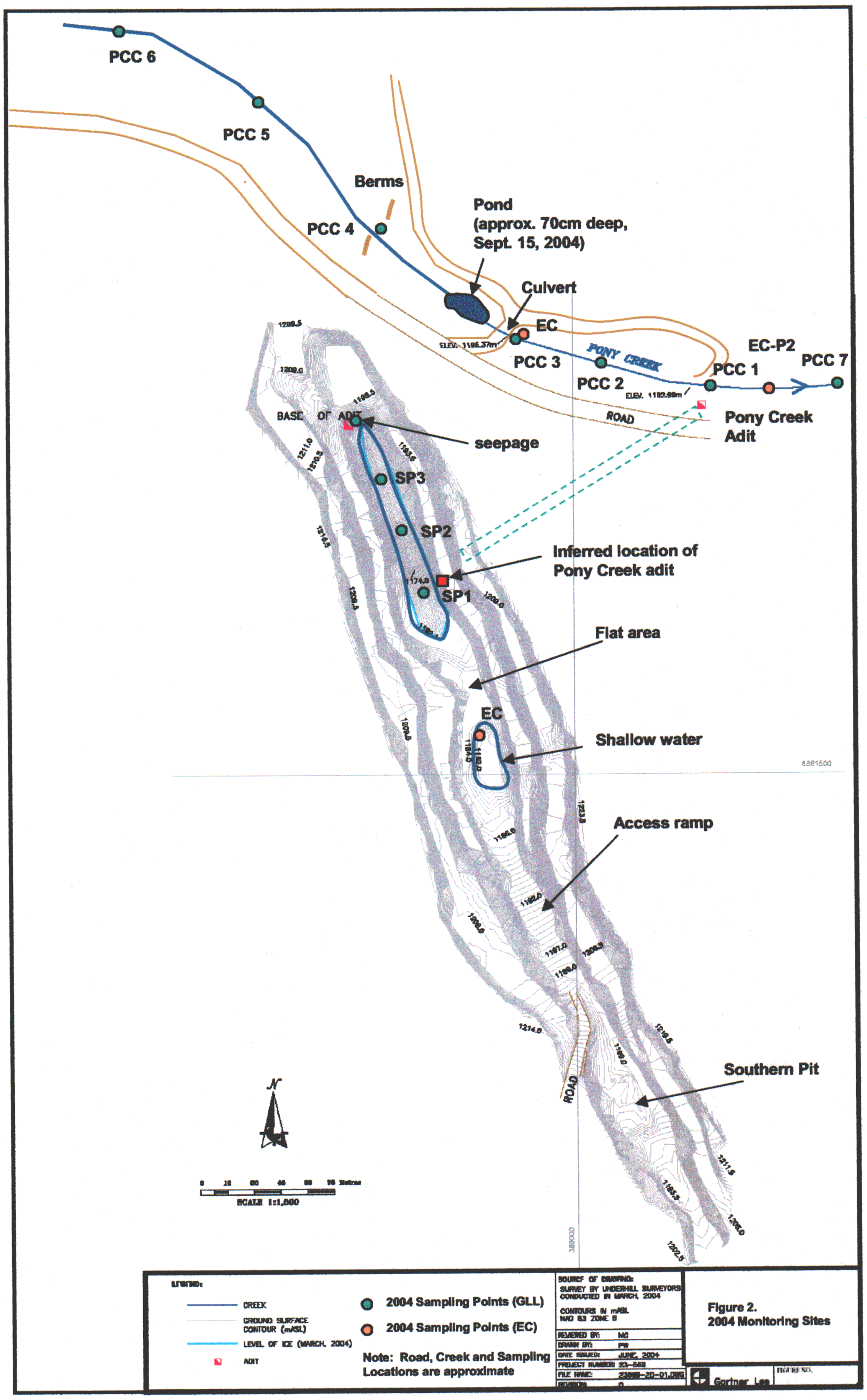
Field work was performed during 3 monitoring periods (July, August and September). During this time, the hydrological and hydrogeological conditions at the site were monitored by:

- surveying relevant locations of monitors and Pony Creek adit (not identified during frozen periods) using hand-held GPS and level
- establishing depth profiles of water quality parameters (dissolved oxygen, ORP, pH, Temp., Conductivity) at three or more locations
- collecting water quality samples for chemical analyses (both dissolved and total metals and other relevant parameters) at several locations within the pit
- collecting samples of seepage into the pit to determine water quality
- collecting samples of surface water in Pony Creek to establish background water quality upstream and downstream of the pit and Pony Creek adit
- collecting flow measurements to estimate water balance components

3. 2004 Summer Monitoring Work

3.1 Introduction

Gartner Lee personnel were present at the site on July 13th and 14th, August 18th and September 15th. Personnel from Environment Canada (EC) (Whitehorse) also accompanied GLL to the site on September 15th to perform flow and water quality measurements at the site. Analytical results collected by EC and relevant to this study are presented in this report. The July field episode consisted of establishing stream flow measurement and water quality monitoring sites along Pony Creek. These were installed at seven locations (PCC1 to PCC7) starting downstream of the Pony Creek adit and extending upstream of the pit (Figure 2). Locations SP1, SP2 and SP3 are monitoring locations within the pit lake. A permanent mark was painted along the pit wall a few meters above the surface of the water to allow sampling to occur at approximately the same locations throughout the monitoring period. Several samples were also collected from the north end of the pit near the adits.



Note: Road, Creek and Sampling Locations are approximate

SOURCE OF DRAWING:
SURVEY BY UNDERHILL SURVEYORS CONDUCTED IN MARCH, 2004

CONTOURS IN mASL
NAD 83 ZONE 8

REVIEWED BY: MC
DRAWN BY: PW
DATE ISSUED: JUNE, 2004
PROJECT NUMBER: 23-569
FILE NAME: 23569-20-01.DWG
REVISION: 0

Gartner Lee

FIGURE NO.

Figure 2.
2004 Monitoring Sites

3.2 Field Methodology and Data

A summary of field activities and samples collected is presented in Table 2.

3.2.1 Flow Measurements in Pony Creek and Seepage Rate Estimates

Photographs of Pony Creek flow and measurements are included in Appendix A. Pony Creek has one main small channel of approximately a few feet in width as it flows past the pit. The streambed consists mostly of sand and gravel and in some cases organic material. The stream channel meanders throughout the drainage area flows through a culvert beneath an access road as it passes the pit (PCC3). There is a small pond of approximately 70cm in depth (July 2004) upstream of the roadway. A few other areas of ponded water were observed further upstream of the roadway and upstream of large earth berms that cross perpendicular to the floodplain where frozen surface water was observed in February 2004. Due to the nature of the stream (narrow, shallow, small waterfalls), flow in Pony Creek was measured by using a stopwatch and graduated container (Table 1). During all three monitoring days (July, Aug., Sept.), surface water flowed past PCC1 and quickly disappeared to groundwater as the Creek flows over sand and gravel fill that was emplaced near the Pony Creek adit during operational times. Flow reappears a few hundred meters downstream before PCC7. Results in Table 1 show that flow is variable between locations likely due to the heterogeneous nature of the drainage areas (i.e. stream inflows from the side-valleys, flow through the hyporheic zone into pools and riffles). Also, the lowest flows were observed in July and the highest in September. This could be due to a combination of factors such as July being an extremely dry month and more rainfall and snowmelt occurring in September.

Table 1. Summary of 2004 Flow measurements in Pony Creek (L/s)

Location	July	August	September
PCC6	0.47	0.9	1.9
PCC5	0.81		
PCC4	0.76		
PCC3	0.64	1.0	2.6
PCC2	0.30		
PCC1	0.03	0.3	1.1
EC-P2			0.7
PCC7	0.70	1.0	2.6

Table 2. Summary of 2004 Field Activities

Date	Description of Activities	Details	Samples Collected
4-Feb-04	photo documentation of Pony Creek and pit conditions		
	sampling of Pit water quality through the ice	3 locations (SP1, SP2, SP3)	SP1-1m
		duplicate of SP1-1m	SP1-1m-D
			SP1-4m
			SP1-8m
			SP2-1m
			SP2-3.5m
			SP3-1m
			SP3-3m
16-Jun-04	grab sample (from surface) of Pit water	YG Water Resources	
29-Jun-04	grab sample (from surface) of Pit water	YG Water Resources	
July 13-14, 2004	Set-up of monitoring locations		
	Stream flow measurements of Pony Creek	7 locations	
	Inspection of Pony Creek Adit		
	Sampling of Pony Creek Water Quality	2 locations	PCC6
			PCC7
	photo and video documentation of Pony creek and pit conditions		
	Qualitative pit water quality profiling (DO, Temp, ORP, pH, sp. Cond.)	3 locations (SP1, SP2, SP3) (>35 depth discrete measurements)	
	sampling of Pit water quality	3 locations (SP1, SP2, SP3) (7 samples)	SP1-0m
			SP1-3m
			SP1-5.5m
			SP2-0m
			SP2-5.5m
			SP3-0m
			SP13-3.5m
	sampling of seepage water quality	from eastern adit in north end	SEE1
		duplicate of SEE1	SEE1-D
		from ponded water	SEE-PO
	flow estimates of seepage rates		
14-Jul-04	grab sample (from surface) of Pit water	YG Water Resources	
28-Jul-04	grab sample (from surface) of Pit water	YG Water Resources	
11-Aug-04	grab sample (from surface) of Pit water	YG Water Resources	
19-Aug-04	Stream flow measurements of Pony Creek	4 locations	
	Sampling of Pony Creek Water Quality	1 location	PCC7
	photo and video documentation of Pony Creek and pit conditions		
	Qualitative pit water quality profiling (DO, Temp, ORP, pH, sp. Cond.)	3 locations (SP1, SP2, SP3) (>35 depth discrete measurements)	
	sampling of Pit water quality	1 locations	SP3-0m
	sampling of seepage water quality	ponded water at bottom of adit	SEE-PO
	flow estimates of seepage rates		
26-Aug-04	grab sample (from surface) of Pit water	YG Water Resources	
8-Sep-04	grab sample (from surface) of Pit water	YG Water Resources	
Sept 10 - 15, 2004	Pit Dewatering by YTG personnel	3249 m^3 removed within 120 hours using continuous pumping	
16-Sep-04	Stream flow measurements of Pony Creek	5 locations (PCC7, PCC1, EC-P2, PCC6 and PCC3)	
	Sampling of Pony Creek Water Quality	3 locations	PCC6
			PCC7
			PCC1
	Sampling of Pony Creek Water Quality (Env. Canada)	2 locations	PCC3
			EC-P2
	photo and video documentation of Pony creek and pit conditions		
	Qualitative pit water quality profiling (DO, Temp, ORP, pH, sp. Cond.)	3 locations (SP1, SP2, SP3) (>35 depth discrete measurements)	
	sampling of Pit water quality	3 locations (SP1, SP2, SP3) (7 samples)	SP1-0m
			SP1-2m
			SP1-4.5
			SP2-0m
			SP2-3.5m
			SP3-0m
			SP3-4m
		Env. Canada. from pond near parking area	EC-SPIT
	sampling of seepage water quality	ponded water at bottom of adit	SEE-PO
		duplicate of SEE-PO	SEE-PO-D
	flow estimates of seepage rates		
	inspection of lower Dome Creek valley		
5-Oct-04	Data Downloading by YTG personnel	pit observed to be frozen	

The only evident source of seepage into the pit was noted in the north end where icicles had been observed in February. Two adit ends (east and west adits) penetrate the pit wall at this location. Flow through the fractured rock into the east adit was evident from significant amounts of water dripping from the ceiling of the east adit and from the rock matrix surrounding the adit. In July, flow was estimated at between 10 and 20 L/s. Field personnel made the flow estimates by measuring the flow rates of the largest and most accessible drips by applying the volume-time method. A large container with a known volume was placed to collect the water from an area of flowing water and the time required to fill the container was noted. The rock walls of the adit were also completely wet and staining from precipitation was observed along fracture planes. This flow contributes a significant input to the overall pit water balance. Seepage from this adit location does not flow directly into the pit but accumulates in a shallow pond in the bottom of the adit. The water level in this pond is a few meters above the pit lake surface. Ice was also observed in this adit in July. This ice had melted by August but the ponded water was still present. Seepage rates into the north-end adit were significantly lower in August and again in September. A soil and rock dam formed by the accumulation of collapsing material at the base of the adit entrance blocks water from running directly into the pit lake. Water from the ponded area likely flows toward the pit through groundwater. This is shown in Figure 3.

There was clear evidence that flow in the east adit resulted from flow through a fracture network not connected to the west adit, located within a few meters. The latter was almost completely dry with only a few drops of water coming from the ceiling of the adit. No ice was present at the bottom of the adit and no significant flow occurred during the three monitoring periods. See Appendix A for a photograph of the adits.

3.2.2 Profiling of Pit Lake

Profiles of Electrical Conductivity (EC), Temperature (T), Dissolved Oxygen (DO), pH and Oxidation Reduction Potential (ORP) were obtained from the pit at three locations (SP1, SP2 and SP3). Measurements were made every 50cm from the water surface to the pit bottom using a YSI 560 MDS datalogger and multiprobe. The instrument was calibrated prior to each field episode. Results are shown in Figure 4, Figure 5, Figure 6, and Figure 7. The data are included in Table 3, Table 4, and Table 5 There is clear evidence of stratification in the pit as suggested by the EC and specific conductance results with higher readings near the bottom of the pit lake. These results are consistent with results from discrete depth sampling in February, which also showed stratification in the pit.

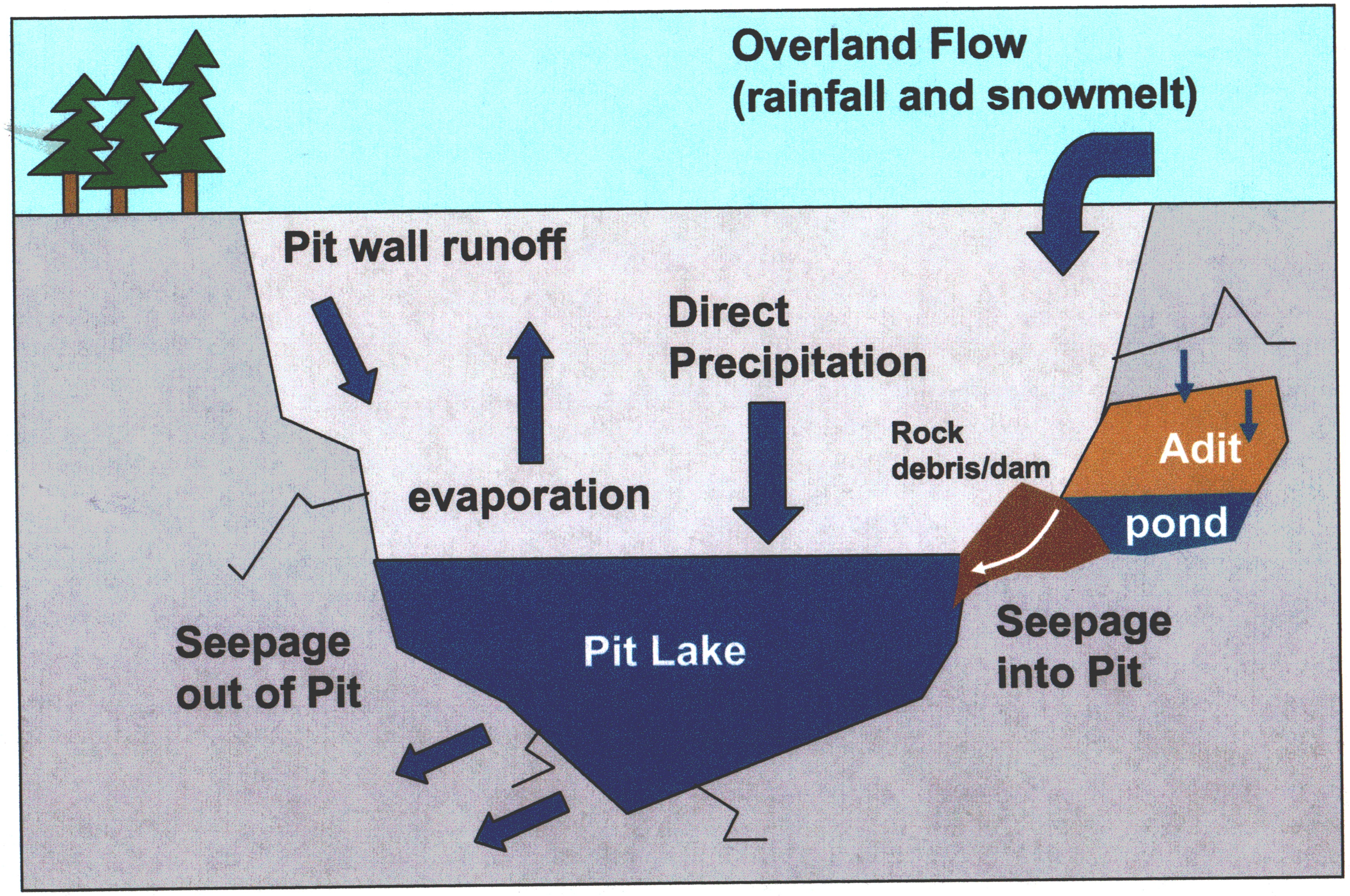


Figure 3. Revised Conceptual Model of Pit Water Balance Showing Seepage of Water into Adit (not Pony Creek Adit) and through soil material and into pit.

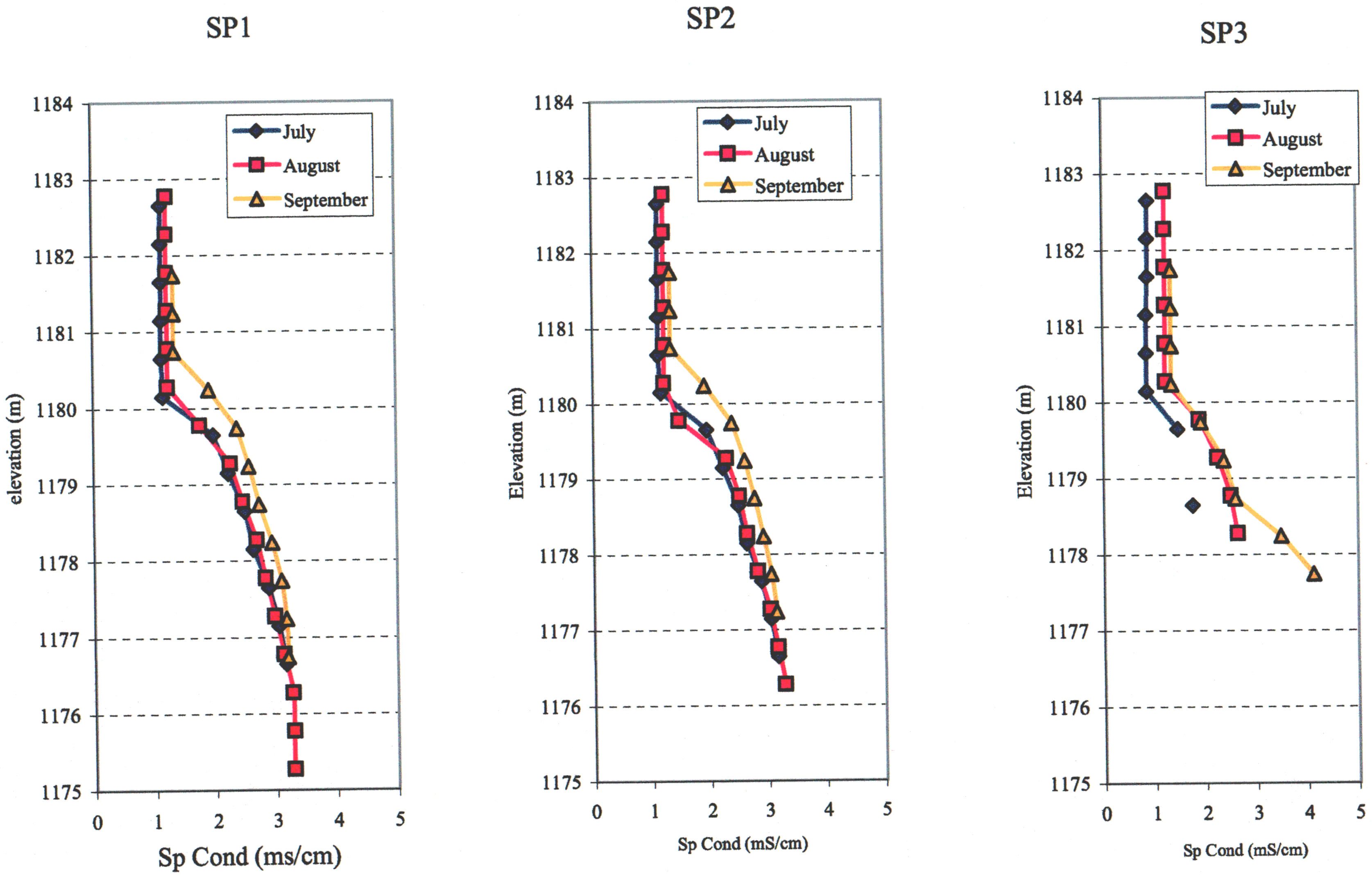


Figure 4. Profiles of Specific Conductance in Pit Lake (2004)

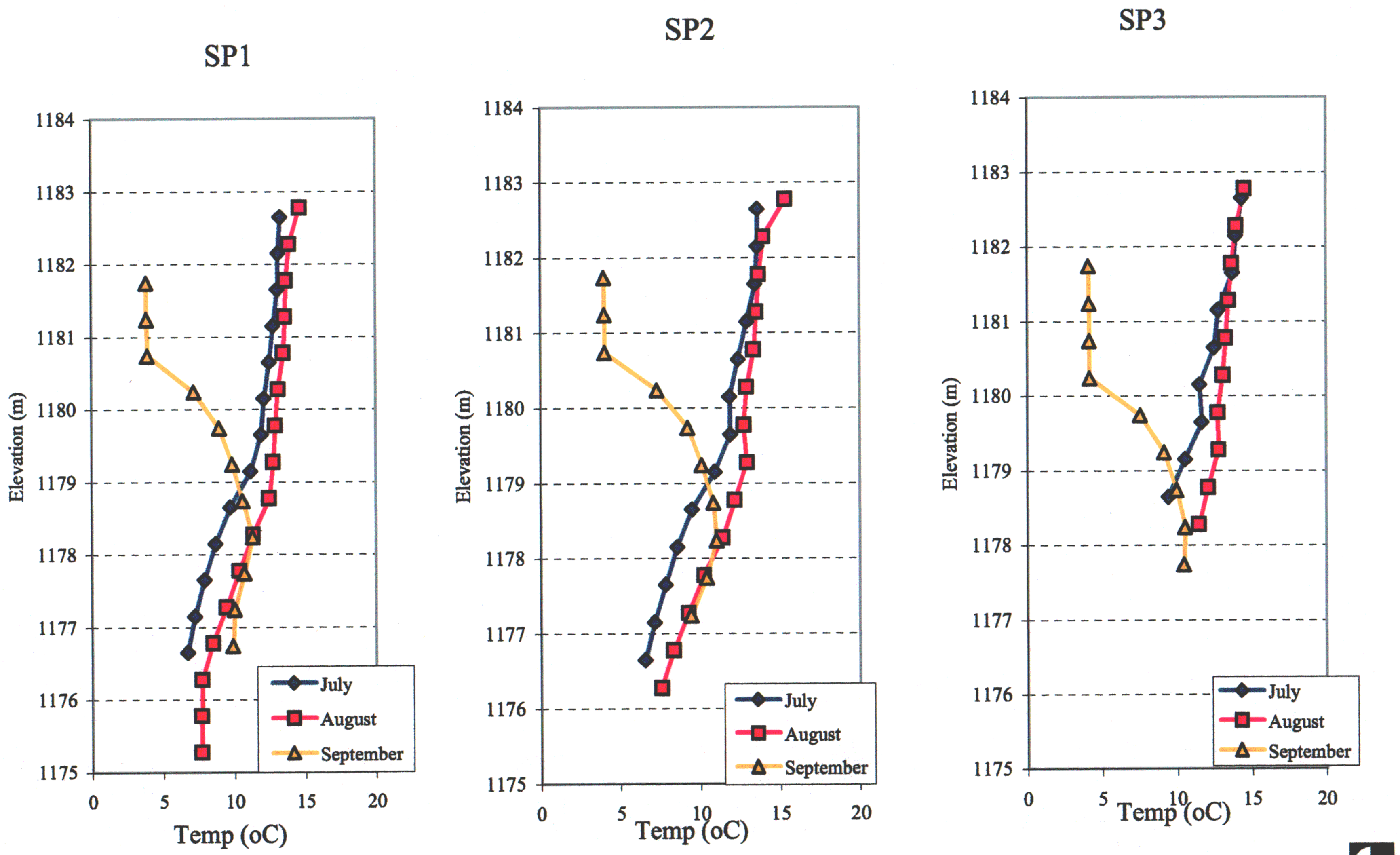


Figure 5. Profiles of Temperature in Pit Lake (2004)

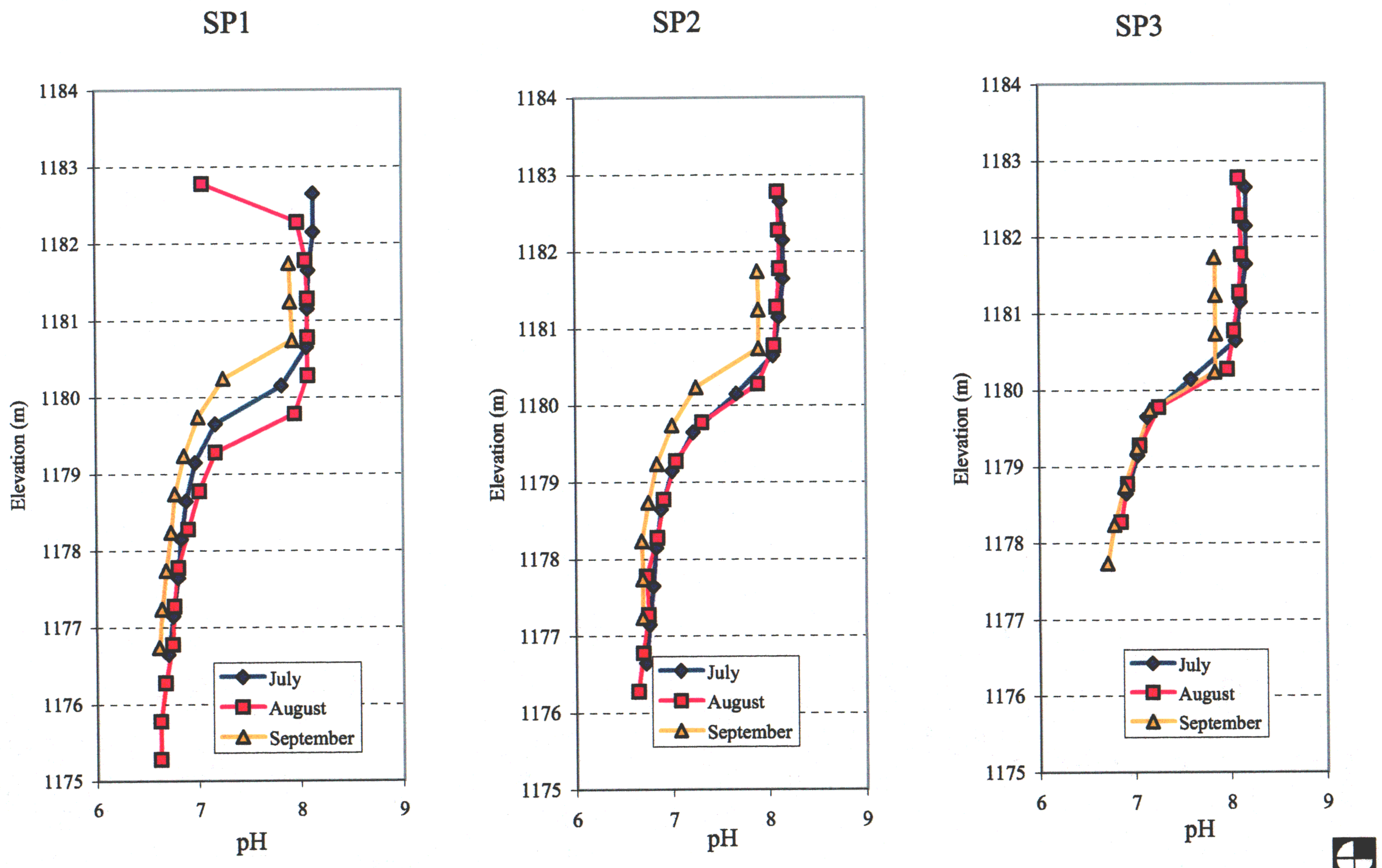


Figure 6. Profiles of pH in Pit Lake (2004)

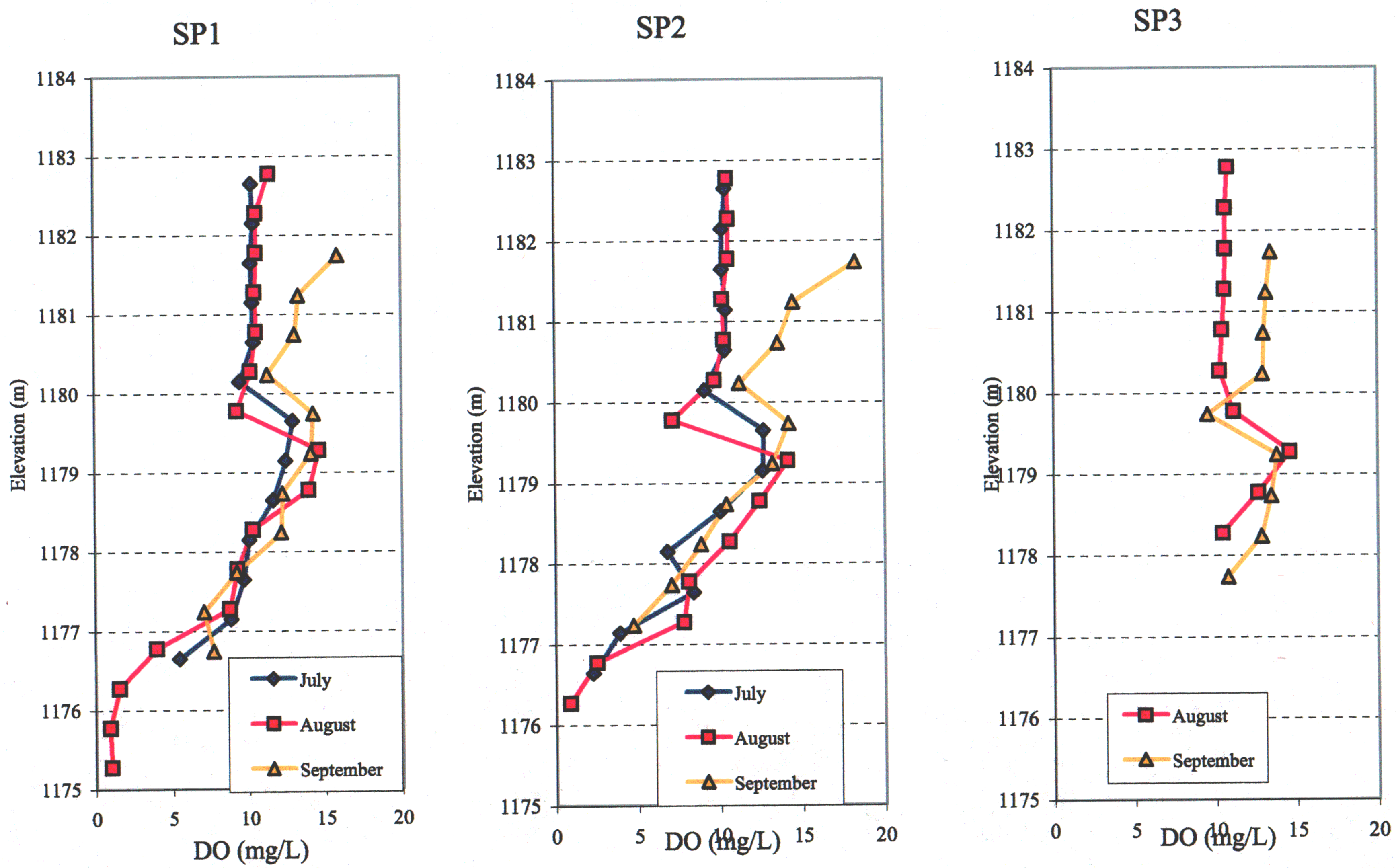


Figure 7. Profiles of Dissolved Oxygen in Pit Lake (2004)

Table 3. Summary of Profiles at SP1 (2004)

July

DateTime	depth (m)	Temp	SpCond	DO Conc	pH	ORP	elevation (m)
M/D/Y	(m)	C	mS/cm	mg/L		mV	**1182.65**
7/14/2004 12:33	0	13.3	1.128	10.27	8.14	217	1182.65
7/14/2004 12:34	0.5	13.13	1.128	10.38	8.14	216	1182.15
7/14/2004 13:04	1	13.08	1.128	10.23	8.09	152	1181.65
7/14/2004 12:37	1.5	12.76	1.126	10.31	8.08	217	1181.15
7/14/2004 12:38	2	12.48	1.126	10.38	8.07	217	1180.65
7/14/2004 12:40	2.5	12.09	1.15	9.45	7.82	223	1180.15
7/14/2004 12:43	3	11.91	1.977	12.94	7.17	242	1179.65
7/14/2004 12:45	3.5	11.15	2.22	12.47	6.97	247	1179.15
7/14/2004 12:48	4	9.72	2.497	11.63	6.88	250	1178.65
7/14/2004 12:50	4.5	8.69	2.631	10.04	6.83	252	1178.15
7/14/2004 12:53	5	7.9	2.884	9.69	6.8	250	1177.65
7/14/2004 12:56	5.5	7.25	3.05	8.82	6.75	248	1177.15
7/14/2004 13:02	6	6.71	3.165	5.43	6.7	175	1176.65

August

DateTime	Depth	Temp	SpCond	DO Conc	pH	ORP	elevation (m)
M/D/Y	(m)	C	mS/cm	mg/L		mV	**1182.78**
8/18/2004 12:21	surface	4.55	0.554	12.13	7.05	86	
8/18/2004 14:23	0	14.67	1.22	11.42	7.98	136	1182.78
8/18/2004 14:25	0.5	13.91	1.218	10.55	8.06	141	1182.28
8/18/2004 14:27	1	13.67	1.218	10.56	8.08	142	1181.78
8/18/2004 14:28	1.5	13.6	1.219	10.45	8.08	143	1181.28
8/18/2004 14:29	2	13.48	1.223	10.54	8.08	146	1180.78
8/18/2004 14:30	2.5	13.11	1.223	10.16	7.95	151	1180.28
8/18/2004 14:33	3	12.9	1.755	9.24	7.17	182	1179.78
8/18/2004 14:35	3.5	12.76	2.249	14.64	7.01	189	1179.28
8/18/2004 14:36	4	12.47	2.455	13.98	6.9	192	1178.78
8/18/2004 14:38	4.5	11.31	2.684	10.28	6.8	194	1178.28
8/18/2004 14:39	5	10.37	2.826	9.25	6.76	195	1177.78
8/18/2004 14:40	5.5	9.44	2.981	8.75	6.74	195	1177.28
8/18/2004 14:42	6	8.48	3.124	3.96	6.67	194	1176.78
8/18/2004 14:44	6.5	7.71	3.265	1.51	6.62	173	1176.28
8/18/2004 14:45	7	7.67	3.28	0.9	6.62	164	1175.78
8/18/2004 14:46	7.5	7.66	3.278	0.99	6.62	159	1175.28

September

DateTime	Depth	Temp	SpCond	DO Conc	pH	ORP	elevation (m)
M/D/Y	(m)	C	mS/cm	mg/L		mV	**1181.74**
9/15/2004 15:30	0	3.86	1.334	15.9	7.9	161	1181.74
9/15/2004 15:31	0.5	3.88	1.334	13.34	7.91	160	1181.24
9/15/2004 15:33	1	3.93	1.335	13.06	7.93	158	1180.74
9/15/2004 15:34	1.5	7.18	1.908	11.28	7.25	179	1180.24
9/15/2004 15:36	2	8.96	2.368	14.29	7	183	1179.74
9/15/2004 15:37	2.5	9.87	2.566	14.13	6.86	184	1179.24
9/15/2004 15:39	3	10.59	2.732	12.26	6.77	184	1178.74
9/15/2004 15:41	3.5	11.28	2.94	12.16	6.73	182	1178.24
9/15/2004 15:42	4	10.69	3.097	9.22	6.68	181	1177.74
9/15/2004 15:44	4.5	10.03	3.175	7.06	6.64	178	1177.24
9/15/2004 15:45	5	9.88	3.195	7.68	6.61	173	1176.74

Table 4. Summary of Profiles at SP2 (2004)

July							
DateTime	**depth (m)**	**Temp**	**SpCond**	**DO Conc**	**pH**	**ORP**	**elevation (m)**
M/D/Y	**(m)**	**C**	**mS/cm**	**mg/L**		**mV**	**1182.65**
7/14/2004 13:37	0	13.62	1.129	10.36	8.13	-67.2	1182.65
7/14/2004 13:38	0.5	13.59	1.129	10.18	8.16	-68.5	1182.15
7/14/2004 13:40	1	13.45	1.129	10.18	8.16	-68.4	1181.65
7/14/2004 13:42	1.5	12.92	1.128	10.4	8.11	-66.1	1181.15
7/14/2004 13:43	2	12.36	1.121	10.33	8.05	-62.5	1180.65
7/14/2004 13:46	2.5	11.84	1.171	9.07	7.67	-42.8	1180.15
7/14/2004 13:48	3	11.88	1.954	12.66	7.22	-19.4	1179.65
7/14/2004 13:54	3.5	10.91	2.226	12.61	7	-8	1179.15
7/14/2004 13:56	4	9.47	2.492	10.04	6.88	-1.8	1178.65
7/14/2004 13:58	4.5	8.54	2.635	6.79	6.83	0.8	1178.15
7/14/2004 14:02	5	7.82	2.885	8.37	6.8	2.4	1177.65
7/14/2004 14:06	5.5	7.13	3.048	3.9	6.76	4.3	1177.15
7/14/2004 14:08	6	6.53	3.165	2.27	6.72	6.5	1176.65
7/14/2004 14:10	6.5	5.99	3.254	2.88	6.68	8.4	1176.15
August							
DateTime	**depth (m)**	**Temp**	**SpCond**	**DO Conc**	**pH**	**ORP**	**elevation (m)**
M/D/Y	**(m)**	**C**	**mS/cm**	**mg/L**		**mV**	
8/18/2004 14:57	0	15.35	1.229	10.46	8.1	140	**1182.78**
8/18/2004 14:58	0.5	13.97	1.226	10.54	8.11	140	1182.28
8/18/2004 14:59	1	13.67	1.224	10.51	8.12	139	1181.78
8/18/2004 15:00	1.5	13.53	1.223	10.18	8.09	139	1181.28
8/18/2004 15:01	2	13.35	1.222	10.26	8.06	139	1180.78
8/18/2004 15:02	2.5	12.9	1.218	9.67	7.89	146	1180.28
8/18/2004 15:04	3	12.73	1.474	7.11	7.31	168	1179.78
8/18/2004 15:06	3.5	12.92	2.284	14.15	7.04	175	1179.28
8/18/2004 15:07	4	12.15	2.506	12.42	6.91	177	1178.78
8/18/2004 15:08	4.5	11.37	2.64	10.57	6.84	178	1178.28
8/18/2004 15:09	5	10.23	2.82	8.09	6.73	180	1177.78
8/18/2004 15:11	5.5	9.25	3.033	7.78	6.75	177	1177.28
8/18/2004 15:12	6	8.31	3.158	2.5	6.69	176	1176.78
8/18/2004 15:13	6.5	7.55	3.276	0.88	6.64	173	1176.28
September							
DateTime	**depth (m)**	**Temp**	**SpCond**	**DO Conc**	**pH**	**ORP**	**elevation (m)**
M/D/Y	**(m)**	**C**	**mS/cm**	**mg/L**		**mV**	
9/15/2004 16:12	0	3.99	1.335	18.28	7.89	152	**1181.74**
9/15/2004 16:14	0.5	4.02	1.336	14.49	7.9	152	1181.24
9/15/2004 16:15	1	4.04	1.337	13.56	7.9	153	1180.74
9/15/2004 16:16	1.5	7.29	1.92	11.21	7.25	173	1180.24
9/15/2004 16:18	2	9.22	2.387	14.2	7	180	1179.74
9/15/2004 16:19	2.5	10.09	2.607	13.21	6.84	182	1179.24
9/15/2004 16:21	3	10.82	2.772	10.4	6.75	183	1178.74
9/15/2004 16:23	3.5	11.01	2.925	8.84	6.68	184	1178.24
9/15/2004 16:26	4	10.39	3.055	7.03	6.69	182	1177.74
9/15/2004 16:28	4.5	9.42	3.145	4.73	6.69	181	1177.24

Table5. Summary of Profiles at SP3 (2004)

July							
DateTime	depth (m)	Temp	SpCond	DO Conc	pH	ORP	elevation (m)
M/D/Y	(m)	C	mS/cm	mg/L		mV	**1182.65**
14-Jul-04	0	14.35	0.891	102.4	8.17	231.2	1182.65
14-Jul-04	0.5	13.95	0.881	100.4	8.17	227.3	1182.15
14-Jul-04	1	13.71	0.876	98.7	8.17	224.8	1181.65
14-Jul-04	1.5	12.77	0.854	97.5	8.11	219.5	1181.15
14-Jul-04	2	12.49	0.847	93.1	8.06	220	1180.65
14-Jul-04	2.5	11.5	0.856	83.3	7.59	232.2	1180.15
14-Jul-04	3	11.66	1.456	113.5	7.13	241.6	1179.65
14-Jul-04	3.5	10.54		101.4	7.03	239.6	1179.15
14-Jul-04	4	9.44	1.751	76.2	6.91	241.2	1178.65

August							
DateTime	depth (m)	Temp	SpCond	DO Conc	pH	ORP	elevation (m)
M/D/Y	(m)	C	mS/cm	mg/L		mV	**1182.78**
8/18/2004 15:21	0	14.52	1.223	10.79	8.09	162	1182.78
8/18/2004 15:22	0.5	13.98	1.224	10.65	8.11	158	1182.28
8/18/2004 15:23	1	13.66	1.224	10.64	8.12	157	1181.78
8/18/2004 15:24	1.5	13.44	1.222	10.59	8.1	155	1181.28
8/18/2004 15:25	2	13.25	1.22	10.42	8.04	155	1180.78
8/18/2004 15:26	2.5	13.06	1.217	10.27	7.97	157	1180.28
8/18/2004 15:28	3	12.72	1.884	11.12	7.25	182	1179.78
8/18/2004 15:29	3.5	12.78	2.24	14.61	7.05	185	1179.28
8/18/2004 15:30	4	12.08	2.492	12.64	6.92	187	1178.78
8/18/2004 15:32	4.5	11.46	2.629	10.41	6.85	187	1178.28

September							
DateTime	depth (m)	Temp	SpCond	DO Conc	pH	ORP	elevation (m)
M/D/Y	(m)	C	mS/cm	mg/L		mV	**1181.74**
9/15/2004 16:59	0	4.12	1.34	13.45	7.84	169	1181.74
9/15/2004 17:00	0.5	4.16	1.341	13.17	7.85	169	1181.24
9/15/2004 17:01	1	4.18	1.342	12.99	7.85	169	1180.74
9/15/2004 17:03	1.5	4.19	1.343	12.94	7.84	169	1180.24
9/15/2004 17:04	2	7.57	1.917	9.52	7.16	192	1179.74
9/15/2004 17:05	2.5	9.15	2.365	13.8	7.02	193	1179.24
9/15/2004 17:06	3	9.97	2.588	13.45	6.89	195	1178.74
9/15/2004 17:07	3.5	10.53	3.486	12.85	6.78	196	1178.24
9/15/2004 17:09	4	10.46	4.125	10.76	6.71	196	1177.74

3.2.3 Water Quality Sampling

Water quality samples were collected for Pony Creek (Table 6), the pit lake (Table 7), and seepage (Table 8) in the north end of the pit. All dissolved metals samples were filtered in the field using syringes and filters and all metals samples (total and dissolved) were preserved in the field. One sample bottle was also collected for general chemistry and nutrient analysis. All samples were collected by flushing the sample bottles with a few volumes of surface water prior to sampling. Samples in Pony Creek were collected in areas of flowing water. Sampling was performed starting with the most downstream sampling point to eliminate the possibility of disturbing the creek bottom upstream of sampling points. Pit seepage samples were collected either from dripping water (pit wall runoff/seepage) or by dipping the sample bottles in the ponded water. A photo of seepage sampling locations relative to the adit is included in Appendix A. Yukon Government Water Resources has also performed routine water sampling from the Pit Lake surface during the summer of 2004. These data have not been examined in the context of this study but are included in Appendix D.

A preliminary assessment of seepage water quality results from Table 8 suggests that there is little or no difference in the water quality of seepage that is dripping from the rock face in the north end of the pit and the ponded water accumulated at the bottom of the adit. There are also no evident differences in water quality from the ponded seepage water quality between sampling episodes from July to September.

Pony Creek samples show relatively uniform water quality at sampling locations PCC1 and PCC6 and PCC3 (P2 – EC) located upstream of PCC7. However, at the most downstream sampling location (PCC7) there is a marked increase in total metals concentrations such as zinc, copper, magnesium, calcium, cadmium, potassium and antimony. Sulfate concentrations and conductivity were also elevated. At PCC7, concentrations of arsenic, cadmium, copper, potassium and zinc exceeded the CCME water quality guidelines (CCME, 2003) during all three sampling rounds (July, Aug, Sept). As described earlier, location PCC7 is located within 50m of the Pony Creek adit where flow from Pony Creek was observed to temporarily disappear to groundwater flow through some fill material consisting of waste rock. This is likely the cause of change in water chemistry.

A detailed interpretation of water quality results was not included in the scope of this study and should be completed as a separate phase of work.

Table 6. Water Quality of Pony Creek

Field Parameters	Site Sample Date	PCC1 9/15/2004	PCC6 7/14/2004	PCC6 9/15/2004	PCC7 7/14/2004	PCC7 8/18/2004	PCC7 9/15/2004	PCC3 (EC) 9/15/2004	P2 (EC) 9/15/2004	Water Quality Guidelines CCME[a]
pH		6.89				7.05	6.31			
sp. Conductance	us/cm	270				554	417			
Temperature	C	0.45				4.55	1.36			
Dissolved Oxygen	mg/L	15.5				12	16			
Orthophosphate-P Dissolved	mg/L	0.09	0.12	0.10	0.12	0.13	0.08			
Bicarbonate	mg/L	61	48	37	198	209	130			
Carbonate	mg/L	<6	<6	<6	<6	<6	<6			
Electrical Conductivity	µS/cm at 25 C	294	186	208	549	564	413			
Hydroxide	mg/L	<5	<5	<5	<5	<5	<5			
Nitrate - N	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.052	0.077	13
P-Alkalinity as CaCO3	mg/L	<5	<5	<5	<5	<5	<5			
pH		7.86	7.46	7.55	7.75	7.94	7.80	6.94	7.35	6.5-9
Sulphate (SO4) Dissolved	mg/L	80.8	47.4	60.9	138	131	111		82	
T-Alkalinity as CaCO3	mg/L	50	39	31	162	171	106		54.2*	
Total Metals										
Aluminum Total	mg/L	0.026	0.044	0.044	0.009	0.007	0.019	*0.10*	< 0.06	0.005-0.1[b]
Antimony Total	mg/L	0.0004	0.0004	0.0005	0.0060	0.0056	0.0042	< 0.06	< 0.06	
Arsenic Total	mg/L	0.0030	*0.0082*	*0.0050*	*0.0086*	*0.0080*	*0.0074*	*< 0.05*	*< 0.05*	0.005
Barium Total	mg/L	0.046	0.058	0.050	0.032	0.036	0.028	0.045	0.038	
Beryllium Total	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	< 0.001	< 0.001	
Bismuth Total	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005			
Boron Total	mg/L	<0.002	<0.002	0.007	0.002	0.002	0.004	< 0.01	< 0.01	
Cadmium Total	mg/L	*0.00004*	*0.00003*	*0.00003*	*0.00170*	*0.00204*	*0.00168*	*< 0.006*	*< 0.006*	0.000017
Calcium Total	mg/L	37.0	24.6	24.8	75.4	87.4	61.7	33.0	29.4	
Chromium Total	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	<0.0005	< 0.006	< 0.006	0.001
Cobalt Total	mg/L	0.0023	0.0005	0.0004	0.0003	<0.0001	0.0009	< 0.006	< 0.006	
Copper Total	mg/L	<0.001	0.001	<0.001	*0.008*	*0.010*	*0.014*	< 0.006	< 0.006	0.002-0.004[c]
Iron Total	mg/L	0.3	1.0	0.7	0.1	<0.1	0.1	0.464	0.248	
Lead Total	mg/L	<0.0001	0.0001	<0.0001	0.0003	0.0002	0.0005	*< 0.06*	*< 0.06*	0.001-0.007[d]
Lithium Total	mg/L	0.001	<0.001	<0.001	0.003	0.003	0.003			
Magnesium Total	mg/L	8.2	5.6	5.7	19.3	21.8	15.0	7.7	7.1	
Manganese Total	mg/L	0.063	0.141	0.113	0.227	0.317	0.223	0.097	0.021	
Molybdenum Total	mg/L	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	< 0.01	< 0.01	0.073
Nickel Total	mg/L	0.0007	0.0005	<0.0005	<0.0005	<0.0005	0.0012	< 0.02	< 0.02	0.025-0.15[e]
Potassium Total	mg/L	*<0.4*	*<0.4*	*<0.4*	*0.8*	*1.0*	*0.8*	*0.3*	*< 0.1*	0.001
Selenium Total	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	< 0.06	< 0.06	
Silicon Total	mg/L	6.60	6.22	7.23	6.39	7.05	6.14	7.21	6.44	
Silver Total	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	*< 0.01*	*< 0.01*	0.0001
Sodium Total	mg/L	3.6	3.4	3.2	4.8	5.1	4.3	3.8	3.5	
Strontium Total	mg/L	0.275	0.161	0.158	0.584	0.662	0.473	0.271	0.247	
Sulphur Total	mg/L	24.3	14.8	18.6	44.3	43.4	34.0	27	24.2	
Thallium Total	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005			0.0008
Tin Total	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.06	< 0.06	
Titanium Total	mg/L	0.0053	0.0014	0.0028	0.0025	0.0028	0.0048	0.007	< 0.002	
Uranium Total	mg/L	<0.0005	<0.0005	<0.0005	0.0012	0.0016	0.0007			
Vanadium Total	mg/L	0.0003	0.0004	0.0003	<0.0001	0.0001	0.0003	< 0.01	< 0.01	
Zinc Total	mg/L	0.007	0.004	0.004	*0.197*	*0.216*	*0.199*	0.012	0.019	0.03
Zirconium Total	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001			
Dissolved Metals										
Aluminum Dissolved	mg/L	0.018	0.034	0.031	0.008	0.006	0.014	< 0.05	< 0.05	0.005-0.1[b]
Antimony Dissolved	mg/L	0.0005	0.0004	0.0005	0.0060	0.0054	0.0042	< 0.05	< 0.05	
Arsenic Dissolved	mg/L	0.0024	0.0080	0.0040	0.0083	0.0078	0.0067	< 0.05	< 0.05	0.005
Barium Dissolved	mg/L	0.044	0.053	0.046	0.033	0.030	0.027	0.043	0.039	
Beryllium Dissolved	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	< 0.001	< 0.001	
Bismuth Dissolved	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005			
Boron Dissolved	mg/L	<0.002	<0.002	0.007	<0.002	0.002	0.004	< 0.01	< 0.01	
Cadmium Dissolved	mg/L	0.00003	0.00002	0.00003	0.00160	0.00177	0.00143	< 0.005	< 0.005	0.000017
Calcium Dissolved	mg/L	36.5	25.1	24.6	82.8	87.1	59.8	34.2	34.3	
Chromium Dissolved	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	< 0.005	< 0.005	0.001
Cobalt Dissolved	mg/L	0.0001	0.0004	0.0003	<0.0001	<0.0001	0.0001	< 0.005	< 0.005	
Copper Dissolved	mg/L	<0.001	<0.001	<0.001	0.009	0.010	0.010	< 0.005	< 0.005	0.002-0.004[c]
Iron Dissolved	mg/L	0.14	1.02	0.35	0.09	0.06	0.08	0.216	0.122	0.3
Lead Dissolved	mg/L	<0.0001	<0.0001	<0.0001	0.0002	0.0001	0.0003	< 0.05	< 0.05	0.001-0.007[d]
Lithium Dissolved	mg/L	<0.001	<0.001	<0.001	0.002	0.003	0.002			
Magnesium Dissolved	mg/L	8.3	5.7	5.8	21.4	21.8	14.8	8.1	8.1	
Manganese Dissolved	mg/L	0.060	0.155	0.106	0.240	0.312	0.214	0.092	0.021	
Molybdenum Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.01	< 0.01	0.073
Nickel Dissolved	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0009	< 0.02	< 0.02	0.025-0.15[e]
Potassium Dissolved	mg/L	0.4	<0.4	<0.4	0.8	1.0	0.8	0.4	0.4	
Selenium Dissolved	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	< 0.05	< 0.05	
Silicon Dissolved	mg/L	6.95	6.86	6.43	6.76	7.06	6.74	6.57	6.51	
Silver Dissolved	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	< 0.01	< 0.01	0.0001
~~Sodium Dissolved~~	~~mg/L~~	~~3.7~~	~~3.6~~	~~3.3~~	~~4.9~~	~~5.1~~	~~4.3~~	~~3.8~~	~~3.8~~	
Strontium Dissolved	mg/L	0.244	0.157	0.148	0.563	0.589	0.440	0.232	0.229	
Sulphur Dissolved	mg/L	26.9	15.8	20.3	45.8	43.8	37.1	26.3	26.3	
Thallium Dissolved	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005			0.0008
Tin Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.05	< 0.05	
Titanium Dissolved	mg/L	0.0022	0.0014	0.0018	0.0024	<0.0005	0.0027	< 0.002	< 0.002	
Uranium Dissolved	mg/L	<0.0005	<0.0005	<0.0005	0.0013	0.0013	0.0006			
Vanadium Dissolved	mg/L	0.0003	0.0003	0.0002	<0.0001	<0.0001	0.0003	< 0.01	< 0.01	
Zinc Dissolved	mg/L	0.004	0.003	0.002	0.197	0.206	0.199	0.020	0.024	0.03

All units mg/l unless otherwise noted

* to pH 4.5

a) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2003,

b) 0.005mg/L at pH < 6.5, [Ca2+] < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH > 6.5, [Ca2+] > 4 mg/L, DOC > 2 mg/L

c) 0.002 mg/L at [CaCO3] = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

d) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

e) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

*Average of sample and replicate

Italic results exceed CCME Aquatic Life Guidelines

Table 7. Pit Lake Water Quality

		Water Quality Guidelines	SP1 - 3m	SP1 - 5.5	SP2 - 0	SP2 -5.5	SP3-0	SP3 - 3.5	SP3-0	SP1-0	SP1-2m	SP1 -4.5	SP2 - 0	SP2-3.5	SP3-0	SP3-4	S-PIT (EC)
	depth (m)	CCME [a]	3	5.5	0	5.5	0	3.5	0	0	2	4.5	0	3.5	0	4	
	units		14-Jul-04	14-Jul-04	14-Jul-04	14-Jul-04	14-Jul-04	14-Jul-04	18-Aug-04	15-Sep-04	15-Sep-04	15-Sep-04	15-Sep-04	15-Sep-04	15-Sep-04	15-Sep-04	15-Sep-04
Temp. of observed pH and EC	°C		20.6	20.5	20.8	20.5	20.5	20.7	18.5	19.8	19.9	20.0	20.0	20.4	20.0	20.1	
Bicarbonate	mg/L		179	259	140	280	143	172	155	163	214	271	161	229	167	331	
Carbonate	mg/L		<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	
Electrical Conductivity	µS/cm at 25 C		1770	2740	1130	2950	1120	1590	1230	1300	2330	2970	1290	2560	1360	3740	
Hydroxide	mg/L		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	
Nitrate - N	mg/L		3.6	2.5	2.7	1.9	2.7	3.0	2.8	3.0	2.7	1.5	3.1	2.7	3.0	1.5	
P-Alkalinity as CaCO3	mg/L		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	
pH			7.59	7.30	8.08	7.22	8.12	7.68	8.16	8.08	7.52	7.36	8.07	7.48	8.05	7.45	
Sulphate (SO4) Dissolved	mg/L		1020	1840	504	1930	508	861	582	606	1350	1920	618	1550	623	2450	
T-Alkalinity as CaCO3	mg/L		147	212	115	230	118	141	127	134	176	222	132	188	137	272	
Total Metals																	
Aluminum Total	mg/L	0.005-0.1[b]	0.036	0.058	0.050	0.049	0.097	0.041	0.015	0.013	0.011	0.016	0.017	<0.01	0.020	0.429	< 0.06
Antimony Total	mg/L		0.0067	0.0016	0.0125	0.0012	0.0127	0.0096	0.0145	0.0155	0.0057	0.0026	0.0146	0.0030	0.0141	0.0038	< 0.06
Arsenic Total	mg/L	0.005	0.0083	0.0143	0.0138	0.0078	0.0137	0.0112	0.0148	0.0160	0.0156	0.0253	0.0172	0.0145	0.0174	0.0152	< 0.05
Barium Total	mg/L		0.034	0.014	0.029	0.011	0.029	0.031	0.025	0.019	0.027	0.023	0.027	0.030	0.029	0.031	0.006
Beryllium Total	mg/L		<0.0002	<0.0002	<0.0001	<0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	< 0.001
Bismuth Total	mg/L		<0.001	<0.001	<0.0005	<0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	<0.001	<0.0005	<0.001	<0.0005	<0.001	
Boron Total	mg/L		0.005	0.008	0.004	0.008	0.004	0.006	0.004	0.006	0.009	0.011	0.006	0.010	0.005	0.012	< 0.01
Cadmium Total	mg/L	0.000017	0.0153	0.0172	0.00644	0.0120	0.00647	0.0115	0.00609	0.00637	0.0198	0.0148	0.00669	0.0175	0.00669	0.0180	0.028
Calcium Total	mg/L		274	467	180	453	183	245	203	212	379	489	218	451	217	421	290
Chromium Total	mg/L	0.001	<0.001	<0.001	<0.0005	<0.001	<0.0005	<0.0005	0.0005	<0.0005	<0.001	<0.001	<0.0005	<0.001	<0.0005	0.0011	< 0.006
Cobalt Total	mg/L		0.0004	0.0009	0.0002	0.0003	0.0003	0.0004	<0.0001	0.0007	0.0008	0.0009	0.0002	0.0014	0.0001	0.0014	< 0.006
Copper Total	mg/L	0.002-0.004[c]	0.017	0.024	0.009	0.015	0.008	0.011	0.015	0.013	0.021	0.017	0.015	0.018	0.015	0.014	0.168
Iron Total	mg/L	0.3	<0.2	<0.2	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2	<0.1	<0.2	<0.1	0.5	0.083
Lead Total	mg/L	0.001-0.007[d]	0.0016	0.0030	0.0017	0.0016	0.0021	0.0017	0.0014	0.0010	0.0018	0.0019	0.0011	0.0014	0.0010	0.0083	< 0.06
Lithium Total	mg/L		0.011	0.021	0.008	0.021	0.008	0.009	0.007	0.010	0.019	0.028	0.011	0.022	0.010	0.027	
Magnesium Total	mg/L		99.0	245	53.0	264	53.7	82.0	58.9	62.7	142	243	64.4	174	64.4	450	78.8
Manganese Total	mg/L		0.517	1.08	0.154	0.448	0.154	0.249	0.109	0.140	0.519	0.697	0.146	0.481	0.154	2.94	0.587
Molybdenum Total	mg/L	0.073	<0.002	<0.002	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	<0.002	<0.001	<0.002	0.01
Nickel Total	mg/L	0.025-0.15[e]	0.0015	0.0017	0.0012	<0.001	0.0017	0.0021	<0.0005	0.0023	0.0030	0.0032	0.0027	0.0036	0.0028	0.0135	< 0.02
Potassium Total	mg/L		2.9	5.0	1.7	4.9	1.8	2.3	2.0	2.0	3.7	5.2	2.1	4.4	2.0	5.1	2.8
Selenium Total	mg/L		<0.0004	0.0008	0.0003	0.0006	0.0002	0.0004	<0.0002	0.0003	0.0005	0.0005	0.0005	0.0004	0.0003	0.0006	< 0.06
Silicon Total	mg/L		3.66	3.79	3.40	3.59	3.50	3.43	3.87	3.75	3.70	3.95	3.76	3.66	3.76	4.70	3.44
Silver Total	mg/L	0.0001	<0.0002	<0.0002	<0.0001	<0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	< 0.01
Sodium Total	mg/L		8.7	13.8	5.6	13.4	5.7	7.2	6.6	6.8	9.8	14.3	6.9	11.7	6.9	10.6	6.9
Strontium Total	mg/L		0.869	1.50	0.626	1.52	0.638	0.836	0.653	0.730	1.20	1.64	0.798	1.46	0.814	2.20	0.899
Sulphur Total	mg/L		324	564	155	605	157	274	176	194	400	606	198	486	196	775	306
Thallium Total	mg/L	0.0008	0.00012	0.00021	0.00010	0.00019	0.00011	0.00011	0.00013	0.00013	0.00015	0.00027	0.00012	0.00016	0.00014	0.00062	
Tin Total	mg/L		<0.002	<0.002	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001	0.005	<0.001	0.006	0.07
Titanium Total	mg/L		0.0183	0.0307	0.0091	0.0306	0.0109	0.0179	0.0112	0.0276	0.0597	0.0926	0.0315	0.0789	0.0327	0.140	< 0.002
Uranium Total	mg/L		0.0040	0.0049	0.0022	0.0051	0.0024	0.0038	0.0028	0.0031	0.0046	0.0053	0.0032	0.0054	0.0032	0.0194	
Vanadium Total	mg/L		0.0002	<0.0002	0.0002	<0.0002	0.0003	0.0002	0.0001	0.0009	0.0007	0.0007	0.0004	0.0018	0.0004	0.0018	< 0.01
Zinc Total	mg/L	0.03	1.43	1.94	0.583	1.57	0.585	0.989	0.485	0.750	1.88	2.05	0.812	2.23	0.850	4.23	2.02
Zirconium Total	mg/L		<0.002	<0.002	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	0.003	<0.001	<0.002	<0.001	<0.002	
Dissolved Metals																	
Orthophosphate-P Dissolved	mg/L		0.07	0.07	0.06	0.08	0.06	0.06	0.08	0.06	0.05	0.06	0.06	0.05	0.05	0.06	
Aluminum Dissolved	mg/L	0.005-0.1[b]	<0.02	0.058	<0.005	<0.05	0.043	<0.02	<0.005	<0.005	0.006	<0.02	<0.005	<0.02	<0.005	<0.02	< 0.05
Antimony Dissolved	mg/L		0.0068	<0.002	0.0132	<0.002	0.0127	0.0083	0.0146	0.0155	0.0055	0.0024	0.0153	0.0032	0.0155	0.0033	< 0.05
Arsenic Dissolved	mg/L	0.005	0.0083	0.014	0.0123	0.0071	0.0131	0.0090	0.0153	0.0148	0.0133	0.0173	0.0143	0.0120	0.0150	0.0082	< 0.05
Barium Dissolved	mg/L		0.031	0.014	0.028	0.011	0.029	0.031	0.022	0.021	0.020	0.016	0.024	0.017	0.022	0.024	0.006
Beryllium Dissolved	mg/L		<0.0005	<0.001	<0.0001	<0.001	<0.0001	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0001	<0.0005	<0.0001	<0.0005	< 0.001
Bismuth Dissolved	mg/L		<0.002	<0.005	<0.0005	<0.005	<0.0005	<0.002	<0.0005	<0.0005	<0.002	<0.002	<0.0005	<0.002	<0.0005	<0.002	
Boron Dissolved	mg/L		<0.01	<0.02	0.003	<0.02	0.003	<0.01	0.003	0.005	<0.01	0.007	0.006	0.007	0.005	0.008	< 0.01
Cadmium Dissolved	mg/L	0.000017	0.0153	0.0170	0.00584	0.0118	0.00606	0.0116	0.00560	0.00686	0.0174	0.0134	0.00569	0.0166	0.00612	0.0173	0.026
Calcium Dissolved	mg/L		298	492	182	482	188	252	199	218	396	471	214	441	216	415	274
Chromium Dissolved	mg/L	0.001	<0.002	<0.005	<0.0005	<0.005	<0.0005	<0.002	<0.0005	<0.0005	<0.002	<0.002	<0.0005	<0.002	<0.0005	<0.002	< 0.005
Cobalt Dissolved	mg/L		<0.0005	<0.001	<0.0001	<0.001	0.0001	<0.0005	<0.0001	0.0002	<0.0005	<0.0005	0.0002	<0.0005	0.0001	0.0012	< 0.005
Copper Dissolved	mg/L	0.002-0.004[c]	0.016	0.020	0.006	0.012	0.007	0.010	0.013	0.005	0.007	0.005	0.015	0.015	0.004	0.005	0.162
Iron Dissolved	mg/L	0.3	<0.05	0.21	<0.01	<0.1	0.04	<0.05	0.01	0.04	0.05	0.07	0.01	0.06	0.01	0.09	< 0.005
Lead Dissolved	mg/L	0.001-0.007[d]	0.0006	0.0019	0.0002	0.0014	0.0017	0.0007	0.0003	0.0003	0.0007	0.0006	0.0003	0.0005	0.0003	<0.0005	< 0.05
Lithium Dissolved	mg/L		0.009	0.016	0.006	0.017	0.006	0.009	0.007	0.009	0.016	0.022	0.009	0.018	0.009	0.026	
Magnesium Dissolved	mg/L		105	234	53.6	282	54.6	81.4	59.1	65.1	156	249	64.2	180	64.3	456	75.9
Manganese Dissolved	mg/L		0.543	1.02	0.150	0.48	0.157	0.26	0.104	0.140	0.561	0.688	0.144	0.481	0.150	3.18	0.558
Molybdenum Dissolved	mg/L	0.073	<0.005	<0.01	<0.001	<0.01	<0.001	<0.005	<0.001	<0.001	<0.005	<0.005	<0.001	<0.005	<0.001	<0.005	0.02
Nickel Dissolved	mg/L	0.025-0.15[e]	<0.002	<0.005	<0.0005	<0.005	0.0006	<0.002	<0.0005	0.0021	0.0026	0.0031	0.0022	0.0035	0.0021	0.012	< 0.02
Potassium Dissolved	mg/L		2.8	4.2	1.8	4.1	1.8	<4	2.0	2.2	4.0	4.9	2.1	4.2	2.1	4.8	2.8
Selenium Dissolved	mg/L		<0.001	<0.002	0.0003	<0.002	<0.0002	<0.001	<0.0002	<0.0002	<0.001	<0.001	<0.0002	<0.001	<0.0002	<0.001	< 0.05
Silicon Dissolved	mg/L		3.73	4.2	3.60	4.0	3.71	3.70	3.99	4.04	4.04	4.20	4.06	3.97	4.09	4.56	3.01
Silver Dissolved	mg/L	0.0001	<0.0005	<0.001	<0.0001	<0.001	<0.0001	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0001	<0.0005	<0.0001	<0.0005	< 0.01
Sodium Dissolved	mg/L		8.7	14	5.8	14	6.0	7.7	6.5	7.2	10	14	7.1	11	6.8	10	6.9
Strontium Dissolved	mg/L		0.876	1.44	0.591	1.42	0.601	0.833	0.609	0.658	1.12	1.35	0.656	1.24	0.675	2.00	0.748
Sulphur Dissolved	mg/L		339	612	168	644	170	287	194	202	449	639	206	517	208	818	273
Thallium Dissolved	mg/L	0.0008	<0.0002	<0.0005	0.00010	<0.0005	0.00010	<0.0002	0.00010	0.00012	<0.0002	0.00026	0.00012	<0.0002	0.00014	0.00030	
Tin Dissolved	mg/L		<0.005	<0.01	<0.001	<0.01	<0.001	<0.005	<0.001	<0.001	<0.005	<0.005	<0.001	<0.005	<0.001	<0.005	0.11
Titanium Dissolved	mg/L		0.017	0.0328	0.0087	0.0326	0.0097	0.018	0.0124	0.0157	0.0337	0.0482	0.0158	0.0397	0.0157	0.0655	< 0.002
Uranium Dissolved	mg/L		0.0039	<0.005	0.0022	0.0051	0.0023	0.0037	0.0025	0.0026	0.0044	0.0046	0.0032	0.0048	0.0032	0.019	
Vanadium Dissolved	mg/L		<0.0005	<0.001	0.0001	<0.001	0.0002	<0.0005	<0.0001	0.0001	<0.0005	<0.0005	0.0002	<0.0005	0.0002	0.0015	< 0.01
Zinc Dissolved	mg/L	0.03	1.30	1.51	0.525	1.26	0.564	1.45	0.455	0.646	1.38	1.88	0.662	2.19	0.712	4.01	2.04

All units mg/l unless otherwise noted

a) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2003,

b) 0.005mg/L at pH < 6.5, [Ca2+] < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH > 6.5, [Ca2+] > 4 mg/L, DOC > 2 mg/L

c) 0.002 mg/L at [CaCO3] = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

d) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

e) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

*Average of sample and replicate

Gartner
Lee

Table 8. Pit Seepage Water Quality

sample ID		SEE-1	SEE1-D	SEE-PO	SEE-PO	SEE-PO-D	SEE-PO	E2
sample location	units	rock face drip	duplicate	ponded water	ponded water	duplicate	ponded water	
field parameters	sample date	14-Jul-04	14-Jul-04	14-Jul-04	8-Aug-04	15-Sep-04	15-Sep-04	15-Sep-04
pH				7.76		7.41		
sp. Conductance	us/cm			437		712		
Temperature	C			3.77		1.0		
Dissolved Oxygen	mg/L			95%		13		
Temp. of observed pH and EC	°C	20.8	20.7	21.0	18.6	20.1	20.2	
Bicarbonate	mg/L	209	214	196	218	241	241	
Carbonate	mg/L	<6	<6	<6	<6	<6	<6	
Electrical Conductivity	µS/cm at 25 C	669	672	700	698	671	695	
Hydroxide	mg/L	<5	<5	<5	<5	<5	<5	
Nitrate - N	mg/L	6.3	6.1	5.9	4.2	3.6	3.7	
P-Alkalinity as CaCO3	mg/L	<5	<5	<5	<5	<5	<5	
pH		8.30	8.27	8.01	8.06	7.92	7.92	
Sulphate (SO4) Dissolved	mg/L	169	170	189	188	171	170	
T-Alkalinity as CaCO3	mg/L	172	175	160	179	198	198	
Total Metals								
Aluminum Total	mg/L	<0.005	<0.005	0.114	<0.005	0.034	0.045	0.14
Antimony Total	mg/L	0.0138	0.0157	0.0426	0.0338	0.0151	0.0152	< 0.06
Arsenic Total	mg/L	0.0592	0.0868	0.0588	0.0339	0.0148	0.0164	< 0.05
Barium Total	mg/L	0.026	0.024	0.022	0.021	0.021	0.021	0.069
Beryllium Total	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	< 0.001
Bismuth Total	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	
Boron Total	mg/L	0.005	0.005	0.005	0.004	0.004	0.004	0.02
Cadmium Total	mg/L	0.00381	0.00411	0.00874	0.00816	0.00395	0.00410	< 0.006
Calcium Total	mg/L	108	114	115	115	114	115	225
Chromium Total	mg/L	<0.0005	<0.0005	<0.0005	0.0006	<0.0005	<0.0005	< 0.006
Cobalt Total	mg/L	0.0002	0.0004	0.0009	0.0002	0.0006	0.0003	0.036
Copper Total	mg/L	0.023	0.021	0.033	0.027	0.014	0.014	< 0.006
Iron Total	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10.6
Lead Total	mg/L	0.0005	0.0005	0.0018	0.0009	0.0009	0.0010	< 0.06
Lithium Total	mg/L	0.005	0.005	0.005	0.005	0.006	0.005	
Magnesium Total	mg/L	18.8	19.8	21.0	20.6	20.2	20.4	11.6
Manganese Total	mg/L	0.048	0.062	0.510	0.328	0.138	0.137	6.58
Molybdenum Total	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.01
Nickel Total	mg/L	0.0013	0.0013	0.0047	0.0030	0.0040	0.0039	< 0.02
Potassium Total	mg/L	0.9	0.9	1.1	1.1	1.1	1.1	5.9
Selenium Total	mg/L	0.0002	<0.0002	0.0003	0.0004	0.0003	0.0002	< 0.06
Silicon Total	mg/L	8.28	8.65	8.02	7.80	7.90	7.54	4.61
Silver Total	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	< 0.01
Sodium Total	mg/L	7.4	7.8	7.5	7.5	6.8	6.9	156
Strontium Total	mg/L	0.600	0.641	0.612	0.562	0.647	0.639	0.839
Sulphur Total	mg/L	50.7	53.2	58.4	60.0	55.0	53.2	268
Thallium Total	mg/L	0.00019	0.00021	0.00019	0.00016	0.00009	0.00007	
Tin Total	mg/L	<0.001	0.002	0.001	<0.001	<0.001	<0.001	0.06
Titanium Total	mg/L	0.0029	0.0032	0.0035	0.0039	0.0094	0.0094	0.004
Uranium Total	mg/L	0.0012	0.0013	0.0015	0.0019	0.0021	0.0021	
Vanadium Total	mg/L	0.0002	0.0002	0.0003	0.0002	0.0006	0.0007	< 0.01
Zinc Total	mg/L	0.534	0.615	1.18	0.872	0.624	0.623	0.052
Zirconium Total	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Dissolved Metals								
Orthophosphate-P Dissolved	mg/L	0.14	0.15	0.13	0.16	0.10	0.10	
Aluminum Dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.09
Antimony Dissolved	mg/L	0.0136	0.0136	0.0453	0.0343	0.0163	0.0158	< 0.05
Arsenic Dissolved	mg/L	0.0333	0.0340	0.0622	0.0362	0.0141	0.0140	< 0.05
Barium Dissolved	mg/L	0.025	0.024	0.019	0.020	0.021	0.023	0.055
Beryllium Dissolved	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	< 0.001
Bismuth Dissolved	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	
Boron Dissolved	mg/L	0.004	0.004	0.003	0.003	0.004	0.003	0.02
Cadmium Dissolved	mg/L	0.00344	0.00335	0.00813	0.00776	0.00421	0.00384	< 0.005
Calcium Dissolved	mg/L	111	112	116	116	112	109	186
Chromium Dissolved	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	< 0.005
Cobalt Dissolved	mg/L	<0.0001	<0.0001	0.0006	0.0002	0.0002	0.0001	0.031
Copper Dissolved	mg/L	0.023	0.020	0.030	0.026	0.004	0.004	< 0.005
Iron Dissolved	mg/L	<0.01	<0.01	<0.01	0.03	0.05	<0.01	8.94
Lead Dissolved	mg/L	0.0004	0.0004	0.0011	0.0008	<0.0001	0.0001	< 0.05
Lithium Dissolved	mg/L	0.004	0.004	0.004	0.004	0.006	0.005	
Magnesium Dissolved	mg/L	19.5	19.7	21.2	21.1	20.2	19.7	9.7
Manganese Dissolved	mg/L	0.034	0.034	0.506	0.334	0.095	0.092	5.21
Molybdenum Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
Nickel Dissolved	mg/L	0.0007	0.0006	0.0043	<0.0005	0.0037	0.0035	< 0.02
Potassium Dissolved	mg/L	0.9	0.9	0.9	1.1	1.2	1.1	5.0
Selenium Dissolved	mg/L	<0.0002	<0.0002	0.0003	0.0002	<0.0002	<0.0002	< 0.05
Silicon Dissolved	mg/L	9.24	9.31	8.51	7.72	8.37	8.25	3.54
Silver Dissolved	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	< 0.01
Sodium Dissolved	mg/L	7.8	7.8	7.5	7.8	6.8	6.5	134
Strontium Dissolved	mg/L	0.571	0.577	0.554	0.546	0.581	0.576	0.650
Sulphur Dissolved	mg/L	56.2	56.6	63.0	62.7	57.0	56.8	209
Thallium Dissolved	mg/L	0.00018	0.00019	0.00017	0.00014	0.00009	0.00008	
Tin Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.10
Titanium Dissolved	mg/L	0.0030	0.0031	0.0034	0.0035	0.0042	0.0041	0.002
Uranium Dissolved	mg/L	0.0011	0.0011	0.0015	0.0017	0.0016	0.0020	
Vanadium Dissolved	mg/L	0.0002	0.0002	0.0002	0.0001	0.0002	0.0002	< 0.01
Zinc Dissolved	mg/L	0.486	0.502	1.16	0.861	0.567	0.572	0.079

3.2.4 Biological Activity in Pit Lake

Some algal growth was observed in August and September (see Appendix A for photos) near the shore of the pit lake and in shallow areas. Some organic matter was also observed at the bottom of the lake with small bubbles forming on the surface. The nature of this material was not determined.

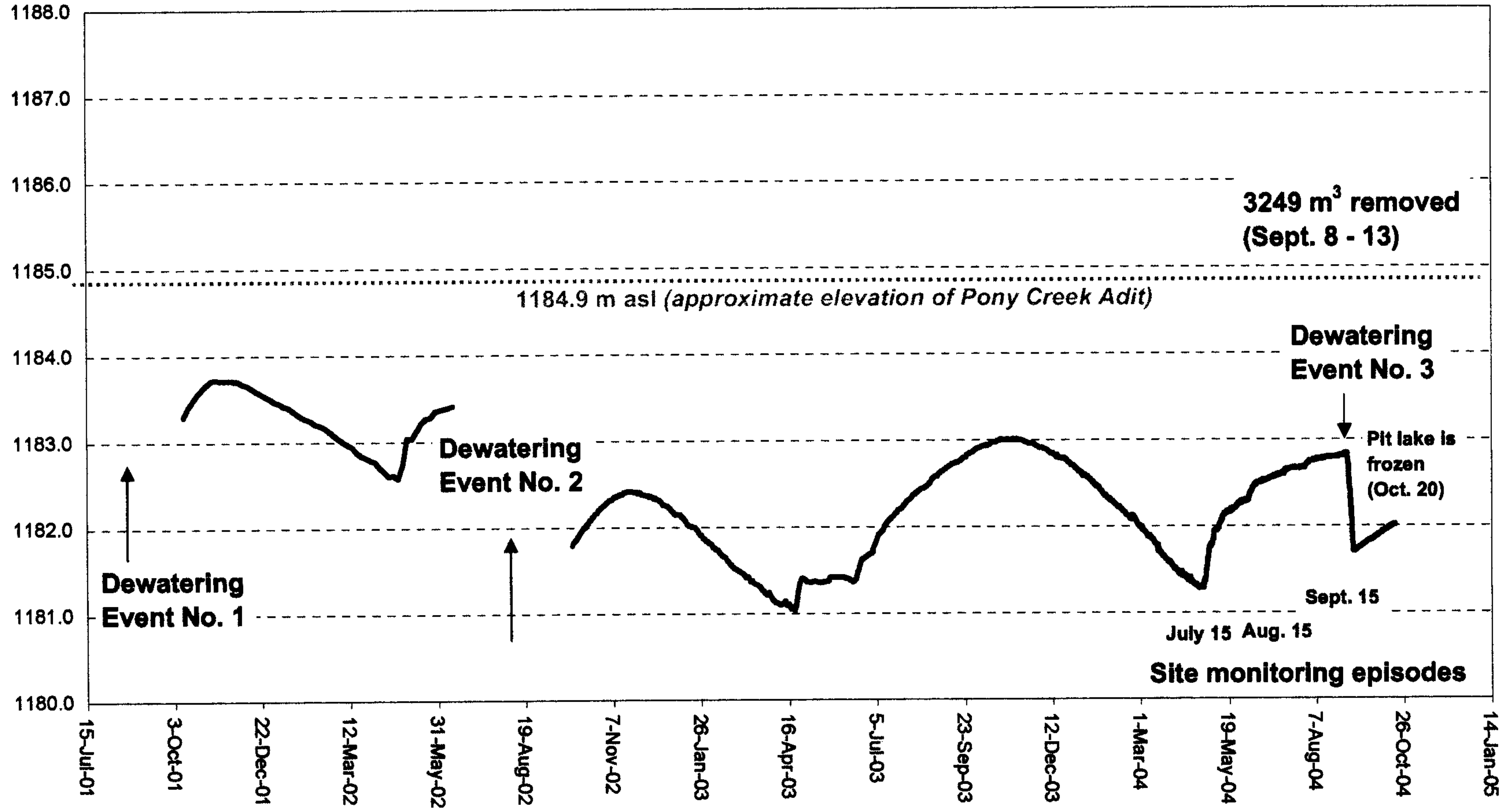
3.2.5 Meteorological Data

A meteorological station was installed by YG Department of Environment, Water Resources Section at the Mt. Nansen site following closure in 1999. Available data from the site is summarized in a report by Gartner Lee (2004). Data acquired since February 2004 is included in Appendix C.

3.2.6 September 2004 Pit Dewatering Event

YTG personnel dewatered the pit in September 2004. It was reported by Bruce Wheeler (personal communication) that 3249 m3 of water were removed during a 120 hour period (5 full 24 hour days) from September 10th to 15th. During this time, the pump intake was located at an elevation roughly 6 inches below the water level as measured on September 15th (after pumping). Pumping resulted in a decrease of approximately 1.5 m in water level. A summary of water levels including fluctuations due to dewatering is included in Figure 8.

Figure 8. Brown-McDade Pit Post-operational Water Level Fluctuations (2001 – 2004)



3.2.7 Quality Assurance and Quality Control

All water samples submitted for analyses were collected in pre-cleaned bottles supplied by the analytical laboratory. The following sampling and preservation methods were used:

- Samples submitted for dissolved metal analyses were collected in 250 mL high density polyethylene (HDPE) bottles and were preserved in the field (pH < 2) using laboratory-supplied and measured aliquots of nitric acid. Samples were filtered in the field using 0.45 micron filters.
- Samples submitted for total metal analyses were collected in 250 mL high density polyethylene (HDPE) bottles and were preserved in the field (pH < 2) using laboratory-supplied and measured aliquots of nitric acid.
- Samples submitted for general parameters (i.e. pH, alkalinity) and nutrient analyses (nitrate) were collected unfiltered into 1-L HDPE laboratory-supplied bottles.

Following sample collection, all samples were kept cool and transported by courier to the laboratory within the allotted transport periods. (Norwest Labs of Vancouver, BC), a member of the Canadian Association for Environmental Analytical Laboratories (CAEAL), conducted all water analyses.

4. Conclusions and Recommendations

Essential data needed for a quantitative prediction of final water quality for the Brown McDade Pit were collected from July to September 2004. The water quality of seepage into the pit was determined as well as the flow process through which this seepage enters the pit. Pit chemistry was monitored both qualitatively using field measurements and quantitatively by collecting water samples. Water quality and flow in Pony Creek were also monitored. Unfortunately, direct management intervention from pit de-watering in October 2004 may cause difficulties in accurately predicting final pit water quality because of discontinuity with future monitoring of seasonal pit lake fluctuations, pit water balance component interactions, and pit lake chemistry evolution.

A comprehensive analysis of the data collected was not within the scope of this phase of work. However, based on initial review, the following conclusions and recommendations have been made.

4.1 Conclusions (Water Balance)

Initial review of data collected during the 2004 season allows the following conclusions to be drawn:

- Seepage does not flow directly into the pit but accumulates and ponds in the bottom of the east adit prior to infiltration.
- Seepage water into the pit along the north pit face (likely from Pony Creek) is contributing the largest positive component of water balance. No other evidence of seepage into the pit was observed during summer.
- Seepage ranging from 5 to 20 L/s in the north end of the pit occurred during all months of monitoring (July, Aug., Sept.).
- Seepage rates were observed to be variable with the largest occurring in July and decreasing in August and again in September. This is consistent with predictions made by GLL (2004) using the preliminary water balance model.
- Some surface runoff features were observed along the road which curves around the rock dumps near the north end of the pit. This likely is a pathway for runoff into the pit associated with snowmelt and rainfall originating from the rock dumps in this area. Piles of fill at the end of this pathway might provide retention of surface runoff and subsequent infiltration into the underlying fractured bedrock/seepage system in the north end.

- Flow in Pony Creek decreased from July to August and again in September. Maximum measured flow in the main channel of Pony Creek was approximately 0.8 L/s.

- No evidence of seepage into the north end of the pit was observed on the surface of the top bench overlying the adits. All seepage was observed to emanate from below the bench within the fractured rock matrix.

- More than 95% of the seepage into the north end of the pit occurs within the east adit and ponds at the bottom. The west adit located 5m away from the east adit did not show evidence of seepage during all three monitoring periods (July, Aug., Sept.).

4.2 Conclusions (Pit Water Quality)

The following conclusions are based on the water quality sampling that was conducted over the course of 2004. Any trends or observations cannot be confirmed without further data collection and analysis:

- Pony Creek water quality seems to degrade as it flows downstream from above the pit to below the pit.

- Water quality in Pony Creek does not appear to vary dramatically according to season

- The water flowing through the seep in the East adit has higher concentrations of As, Cd, Ca, Cu, Mg, Na, Sr, S, Ti and Zn than Pony Creek upstream or downstream of the adit.

- The water column of McDade pit lake is stratified but relatively homogeneous throughout the length of the pit. It is possible that the pit undergoes inversion in the Fall. The data collected in September does not reflect an inversion however, given the temperature distribution it appears an inversion was imminent.

- The water flowing from the seep into the pit lake has higher concentrations of Mn, Pb, S, SO4, Ti, and Mg and to a lesser extent Ca and Cd.

- The seep water has similar alkalinity values to those in the lake. The seep water has slightly higher concentrations of bicarbonate.

4.3 Recommendations (Pit Water Balance)

The data collected in 2004 represent important information for estimating seepage into the pit through the fractured rock matrix at the north end of the pit and a significant improvement in determining seasonal fluctuations in major water balance components. Some of these recommendations were made by Gartner Lee (2004) and are repeated here. The following recommendations are offered:

- Continuous monitoring of pit lake water levels using the existing level logger system should be continued as well as the collection of site specific meteorological data.
- The preliminary water balance model should be updated and further calibrated with site specific measurements (variable seepage rates) and meteorological data collected since March 2004 as part of this study.
- Key observations of exact timing of snowmelt, ice collapse, pit-wall runoff, qualitative observations of seepage rates and seep locations within the pit, surface runoff patterns (during and following rainfall events) should be noted, recorded and photographed whenever possible by mine site personnel and YG personnel to provide qualitative validation and refinement to the water balance model.
- Flow in Pony Creek and seepage into the pit should be measured and monitored seasonally to supplement the existing data and determine seasonal trends.
- The evolution of water levels in a secondary pond within the pit (by the parking platform) which at least seasonally contained water, should be noted whenever possible as it could provide information related to pit wall runoff rates.

4.4 Recommendations (Pit Water Quality)

Water quality data now includes pit lake, pit seepage and Pony Creek measurements. These data are required to predict the chemical evolution of the pit lake water. Additional work is recommended to better constrain the understanding of the controls on the pit lake. Also, thorough review of the data acquired in 2004 might lead to additional recommendations. Accordingly, the following recommendations are offered:

- Collect detailed information on the conductivity, temperature and Dissolved Oxygen with depth profiles (CTD) of the pit lake water column at 2 locations of the pit lake during the winter season (March) to determine if lake inversion occurs. This has implications in predicting the chemical and physical behaviour of the pit.
- Collect detailed depth-discrete water quality measurements (metals specifically) at one profile location (3 depths) in the pit during the winter season (March) to determine water quality beneath the ice cover.
- To better quantify the loads to the pit, it is recommended that spring and fall seep surveys be carried out to delineate other discrete loadings to the pit during spring melt and fall rain events.
- Continue CTD profiling of pit once every 2 months (at a minimum) to examine behaviour of the pit over a full year cycle and examine evolution of water chemistry now that de-watering occurred in September, 2004.
- Perform analysis of 2004 water quality and water balance component data to determine data requirements for the development of a mass balance approach to chemical modeling of pit behavior and evolution.
- Continue water quality monitoring of pit lake, Pony creek and pit seepage throughout the 2005 season.
- Review 2004 data in order to identify data gaps and refine the water quality and water balance monitoring program for the upcoming 2005 season.
- Acquire and/or collect precipitation water quality data

- The secondary pond within the pit (near the parking platform) should be sampled at least twice during the upcoming 2005 season as it might yield information of pit wall runoff quality.
- Measure pit lake quality again using depth-discrete sampling at surface and at depth (3 or 4 locations) once every two months during the upcoming 2005 season. It is important that any pit lake management activities be well-documented to facilitate interpretation of results.
- Any management intervention such as de-watering should be performed in such a way that is consistent with the goals of this study. It is strongly recommended that no further de-watering activities be conducted during implementation of the proposed sampling plan.
- As the next phase of work, the water quality data collected thus far by Gartner Lee, Environment Canada and YG Water Resources should be analyzed and a detailed interpretation of results should be done to optimize future monitoring at the site. This is a most important step in developing a scientifically sound management plan for the Brown-McDade pit.

Report Prepared By:

Martin Guilbeault, M.Sc., P.Eng.
Hydrogeologist

Report Reviewed By:

Emma McClenning for

Leslie Gomm, P.Eng, Ph.D.
Senior Environmental Engineer

5. Acknowledgements

Gartner Lee Limited would like to thank the following individuals for assisting with the project, providing useful discussions, facilitating site access and/or providing guidance for the overall project:

- Hugh Copland, Project manager for Energy, Mines and Resources, Yukon Government
- Bruce Wheeler, Mt. Nansen Mine site caretaker
- Glenn Ford and Ric Janowicz, Department of the Environment, Yukon Government,
- Wayne Kettley, Water Resources, Yukon Government
- Frank Patch, Energy, Mines and Resources, Yukon Government
- John Miller, Pollution Abatement, Environment Canada, Yukon

6. References

Gartner Lee Limited, 2004. Mt. Nansen Brown-McDade Open Pit Hydrological and Hydgrogeological Study. Draft report, project#23-669

Bruce Wheeler (personal communication, September 15, 2004)

Gartner Lee Limited, June 15, 2004.. "23669 – Mt Nansen, Brown McDade Pit Summer / Fall 2004 Revised Monitoring Plan."

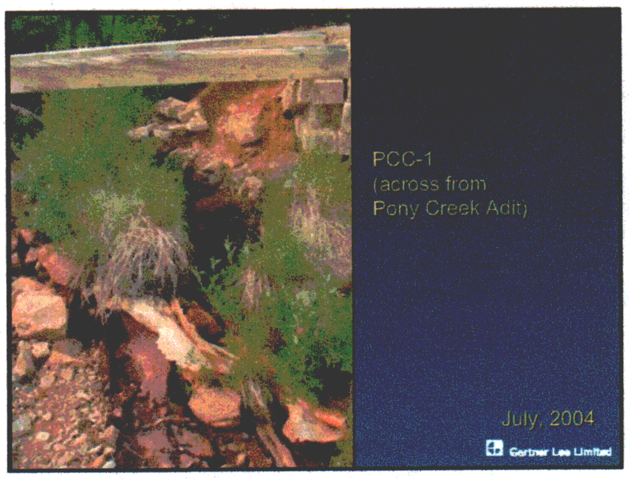
Appendices

Appendix A

Photographs of Site and Field Activities

Pony Creek Adit

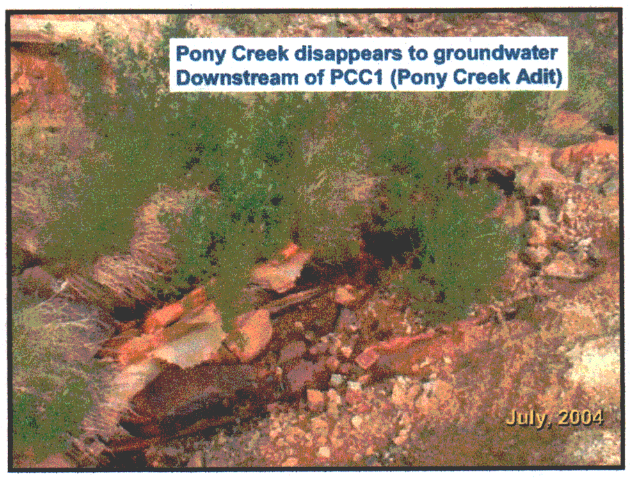
July, 2004



PCC-1
(across from
Pony Creek Adit)

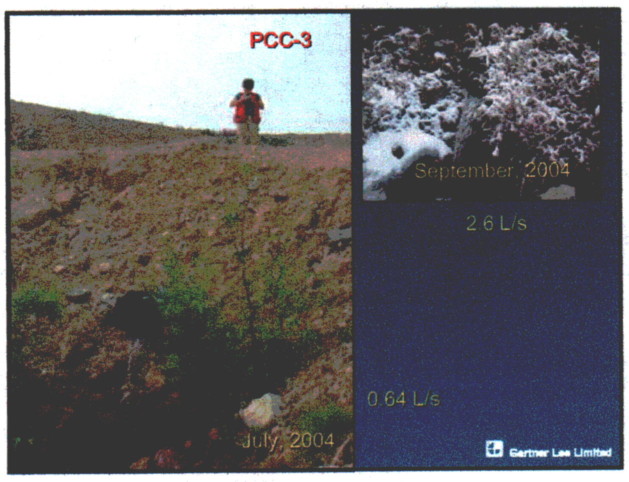
July, 2004

Gartner Lee Limited



**Pony Creek disappears to groundwater
Downstream of PCC1 (Pony Creek Adit)**

July, 2004



PCC-3

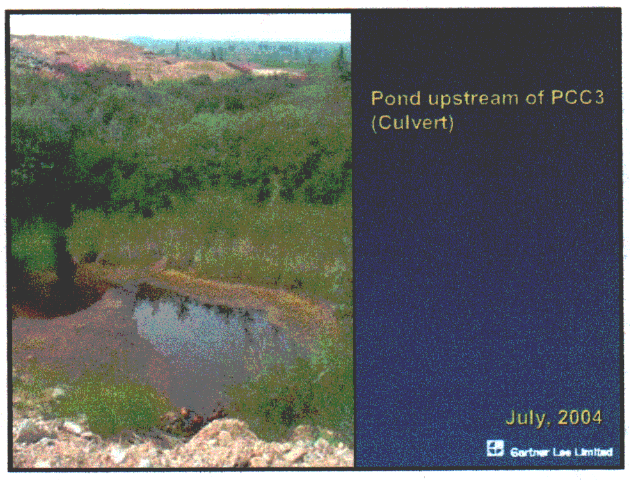
September, 2004

2.6 L/s

0.64 L/s

July, 2004

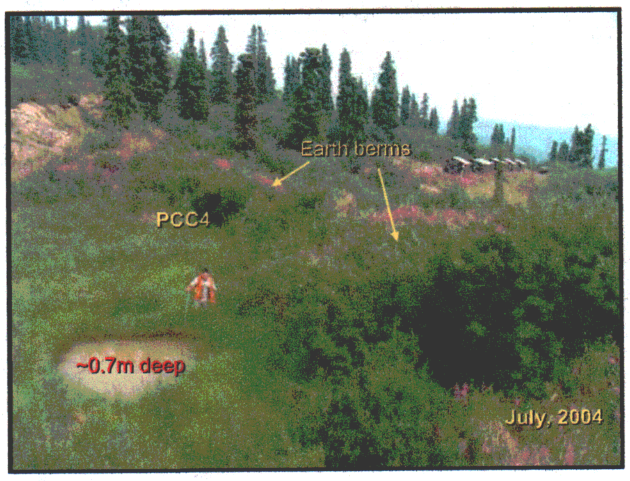
Gartner Lee Limited



Pond upstream of PCC3
(Culvert)

July, 2004

Gartner Lee Limited



Earth berms

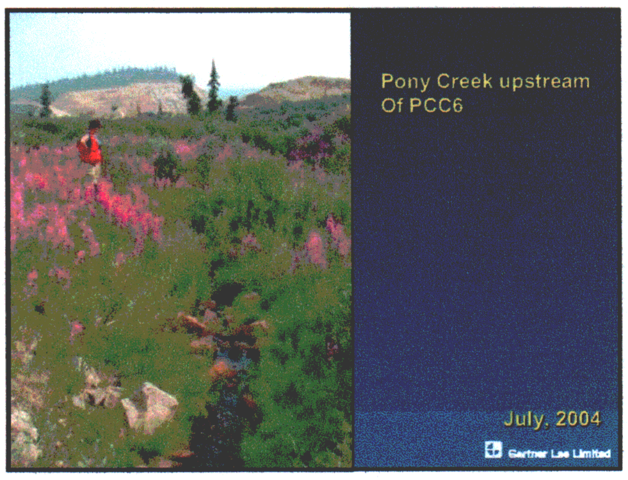
PCC4

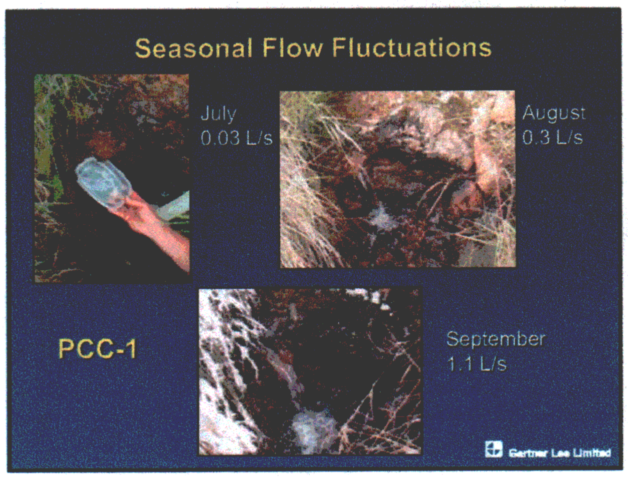
~0.7m deep

July, 2004


Flow Measurments
PCC-6
July, 2004


PCC-6
August, 2004


Pony Creek upstream
Of PCC6
July, 2004
Gartner Lee Limited


Seasonal Flow Fluctuations

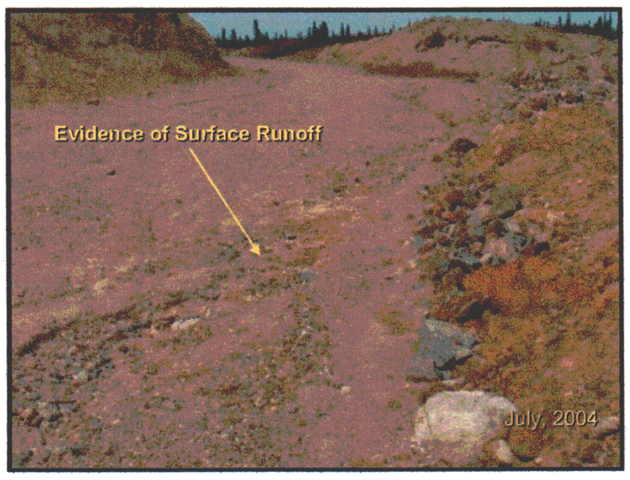
July
0.03 L/s

August
0.3 L/s

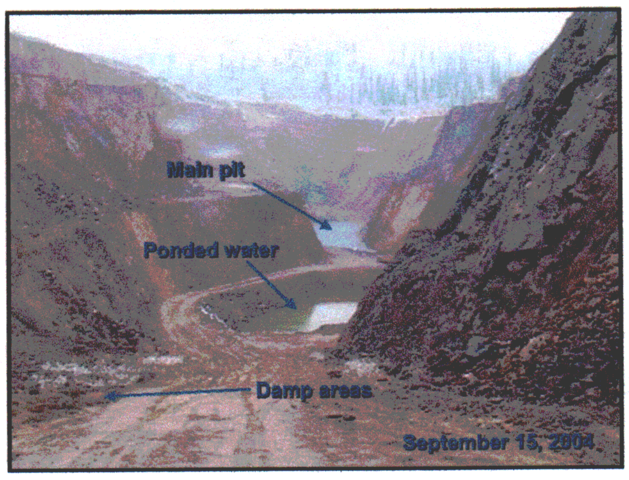
PCC-1

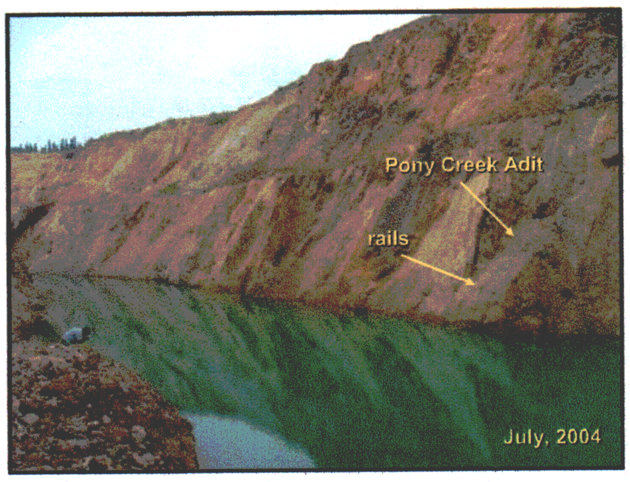
September
1.1 L/s

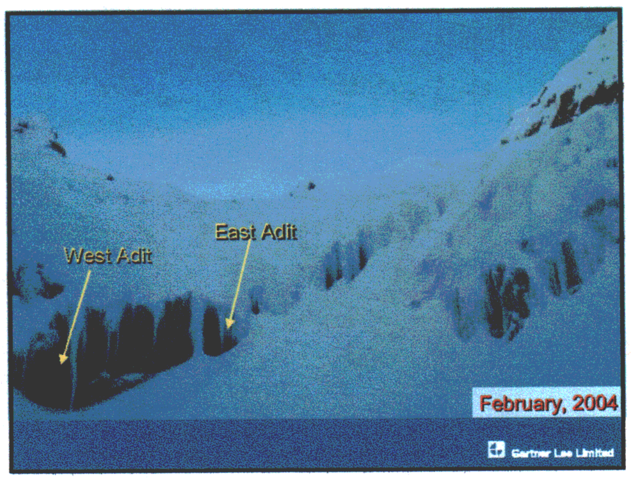
Gartner Lee Limited

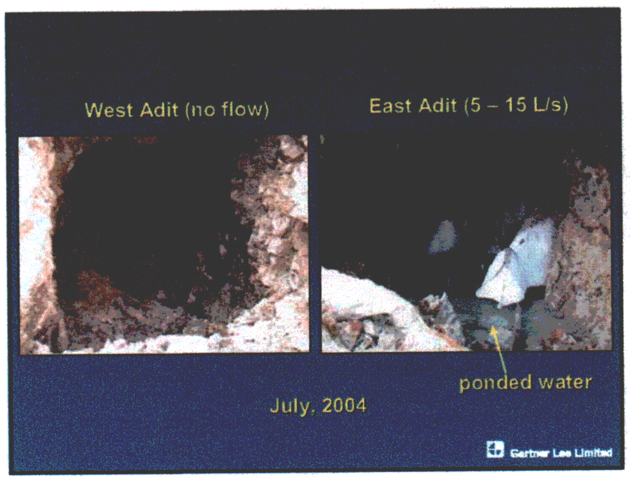

Evidence of Surface Runoff
July, 2004

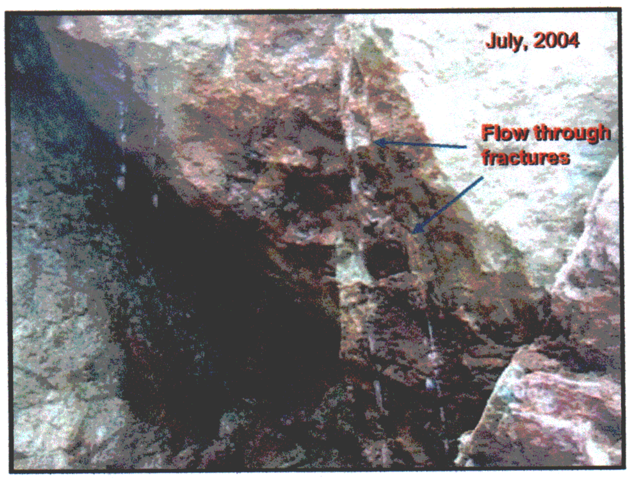

Rock is fractured
July, 2004

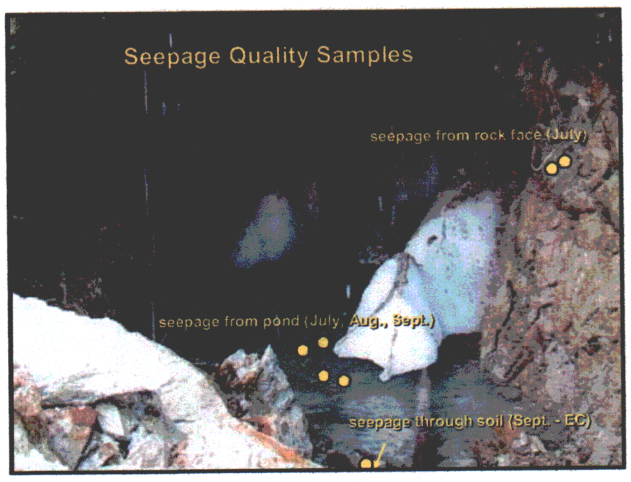

Main pit
Ponded water
Damp areas
September 15, 2004


Pony Creek Adit
rails
July, 2004

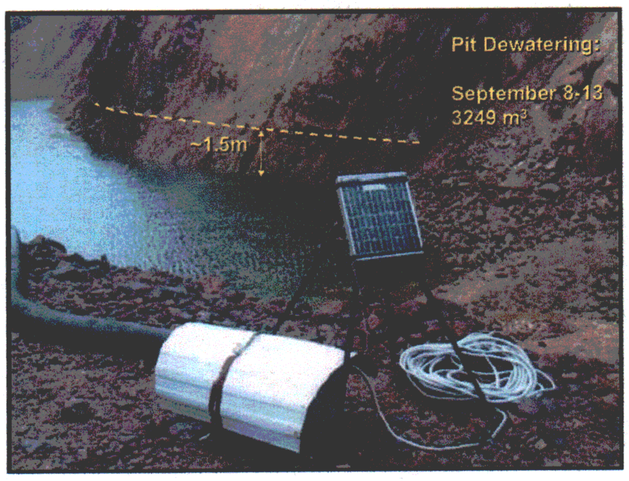

West Adit
East Adit
February, 2004
Gartner Lee Limited


West Adit (no flow)
East Adit (5 – 15 L/s)
ponded water
July, 2004
Gartner Lee Limited


July, 2004
Flow through fractures


Seepage Quality Samples
seepage from rock face (July)
seepage from pond (July, Aug., Sept.)
seepage through soil (Sept. - EC)


Evidence of Biological Activity
August, 2004


Pit Dewatering:
September 8-13
3249 m³
~1.5m

Appendix B

2004 Field Work Summary Memos

Gartner Lee Limited **memorandum**

to: Hugh Copland (YTG)
from: Martin Guilbeault
date: July 15, 2004
ref: 40-568
re: **Mt. Nansen Mine – Brown McDade Pit Monitoring – July 2004**

This brief memo outlines activities that were completed by Gartner Lee Limited during a field visit to the Mt. Nansen Mine on July 13th and 14th, 2004. Major observations were noted and recorded using a digital video recorder and camera. These observations have not been included in this memo but will be summarized upon completion of summer and fall monitoring activities. The purpose of the study was to document hydrogeological conditions of the pit during non-frozen conditions and to collect information and data relevant to the pit water quantity and water quality balance. Emma Kennirey and Martin Guilbeault of GLL were at the site on July 13th and 14th and completed the following activities:

- Stream flow measurements of Pony Creek adjacent to the pit at seven locations (coordinates for each location were recorded and sites were flagged)
- Inspection of the Pony Creek adit on the Pony Creek side
- Inspection of the Pony Creek adit on the Pit side
- Observations of pit wall staining and surficial flow patterns
- Surface water quality sampling of Pony Creek at 2 locations (2 samples) (upstream and downstream of the Pony Creek adit)
- Photo and video documentation of hydrological and hydrogeological conditions at the site
- Pit Water Quality sampling at three locations and 2 or 3 different depths at each (7 samples). The sampling locations were chosen to be as close as possible to locations monitored in February, 2004.
- Water Quality sampling of seepage into north-end of the pit (3 samples including one duplicate)
- Flow estimates of seepage into north-end of the pit
- Visual observation and documentation of conditions of the 2 adits in the north-end of the pit
- Water physical parameter (pH, ORP, Conductivity, Dissolved Oxygen and TSS) profiling using a multi-probe at the three sampling locations (over 35 depth-discrete measurements at 50cm spacing from pit lake surface to pit bottom)
- Surveying of the base of Pony Creek Adit (estimated due to gravel blocking adit) relative to a known benchmark

2251 2nd Avenue, Whitehorse, Yukon, Y1A 5W1 tel 867.633.6474 fax 867.633.6321
www.gartnerlee.com

Wayne Kettley of YTG Water Resources was also present at the site on July 14th and collected one surface water sample from the Pit lake surface (adjacent to data-logger). As discussed, the water samples will be sent to Norwest Labs in Burnaby, BC for analysis. I trust that this memo provides a satisfactory update of our summer/fall 2004 monitoring program. Do not hesitate to contact me at 867-633-6474 ext. 24 if you have any questions or concerns.

Regards,

Martin Guilbeault, M.Sc., P.Eng. (ON)
Hydrogeologist
(via e-mail)

MG:mg

Gartner Lee Limited

memorandum

to: Hugh Copland (YTG)
from: Martin Guilbeault
date: August 19, 2004
ref: 40-568
re: **Mt. Nansen Mine – Brown McDade Pit Monitoring – August 2004**

This brief memo outlines activities that were completed by Gartner Lee Limited during a field visit to the Mt. Nansen Mine on August 18th, 2004. Major observations were noted and recorded using a digital video recorder and camera. The main observations were that seepage was still occurring in the northern end of the pit in one of the adit ends, however, flowrates seemed lower than observed in July. The purpose of the study was to document hydrogeological conditions of the pit and of Pony Creek. Martin Guilbeault of GLL was at the site on August 18th and completed the following activities:

- Stream flow measurements of Pony Creek adjacent to the pit at four locations
- Inspection of the Pony Creek adit on the Pony Creek side for evidence of flow
- Inspection of the Pony Creek adit on the Pit side for evidence of seepage
- Surface water quality sampling of Pony Creek at 1 locations (1 sample) (downstream of the Pony Creek adit)
- Photo and video documentation of hydrological and hydrogeological conditions at the site
- Pit Water Quality sampling at one location from surface (one sample). The sampling was conducted to provide water quality data from the pit during August.
- Water Quality sampling of seepage into north-end of the pit from ponded water on bottom of drift end (1 sample)
- Flow of seepage into north-end of the pit was visually estimated to be less than observed in July. For safety and logistical reasons, flow rates could not be measured directly.
- Visual observation and documentation of conditions of the 2 adits in the north-end of the pit (ice observed in July had melted)
- Water physical parameter (pH, ORP, Conductivity, Dissolved Oxygen and TSS) profiling using a multi-probe at the three sampling locations (over 35 depth-discrete measurements at 50cm spacing from pit lake surface to pit bottom to replicate locations from July, 2004)

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The three water quality samples were sent to Norwest Labs in Burnaby, BC for analysis. ***It was also noted that a hose had been installed down the ramp into the pit. There was no evidence that this hose had been used to pump water from the pit, however, if such activities are planned, it would be beneficial to note (if possible) flow rates, water quality, the location/depth of the hose intake during de-watering and the exact time and date of dewatering events in order to facilitate interpretation of hydrological and geochemical data from the pit lake.*** I trust that this memo provides a satisfactory update of our summer/fall 2004 monitoring program. Do not hesitate to contact me at 867-633-6474 ext. 24 if you have any questions or concerns.

Regards,

Martin Guilbeault, M.Sc., P.Eng. (ON)
Hydrogeologist
(via e-mail)

MG:mg

Gartner Lee Limited

memorandum

to: Hugh Copland (YTG)
from: Martin Guilbeault
date: Sept 16, 2004
ref: 40-568
re: **Mt. Nansen Mine – Brown McDade Pit Monitoring – September 2004**

This brief memo outlines activities that were completed by Gartner Lee Limited during a field visit to the Mt. Nansen Mine on September 15th, 2004. Major observations were noted and recorded using a digital video recorder and camera. These observations have not been included in this memo but will be summarized upon completion of summer and fall monitoring activities. The purpose of the study was to document hydrogeological conditions of the pit during non-frozen conditions and to collect information and data relevant to the pit water quantity and water quality balance. It was noted that the pit had been de-watered. Bruce Wheeler, caretaker at the site informed GLL that 3249 m^3 had been removed within 120 hours, 5 full 24 hour days (pumping 24 hours / day). The intake for the pump was located approximately 6 inches below the water level on September 15th for the entire duration of the pumping event. The pumping event resulted in an approximate decrease of 1.5 m in water levels in the pit. John Miller of Environment Canada was also on site performing sampling and field measurements. Martin Guilbeault of GLL coordinated site activities with Environment Canada and completed the following activities:

- Stream flow measurements of Pony Creek adjacent to the pit at five locations (PCC7, PCC1, P2 (Env. Canada), PCC6 and PCC3)
- Inspection of lower Dome Creek valley downgradient of the pit for site conditions
- Observations of pit wall staining and surficial flow patterns
- Surface water quality sampling of Pony Creek at 3 locations (2 samples) (PCC7, PCC6 and PCC1)
- Environment Canada also sampled Pony Creek at 2 locations (PCC3 and P2 (EC))
- Photo and video documentation of hydrological and hydrogeological conditions at the site
- Pit Water Quality sampling at three locations and 2 or 3 different depths at each (7 samples). SP1, SP2 and SP3.
- Water Quality sampling of seepage into north-end of the pit (2 samples including one duplicate)
- Environment Canada collected a sample from the ponded water near the parking platform at the south end of the pit.
- Flow estimates of seepage into north-end of the pit, this could only be done visually and relative to previous months.

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- Water physical parameter (pH, ORP, Conductivity, Dissolved Oxygen, Temperature and TSS) profiling using a multi-probe at the three sampling locations SP1, SP2 and SP3 (over 25 depth-discrete measurements at 50cm spacing from pit lake surface to pit bottom)

As discussed, the water samples will be sent to Norwest Labs in Burnaby, BC for analysis. I trust that this memo provides a satisfactory update of our summer/fall 2004 monitoring program. Do not hesitate to contact me at 867-633-6474 ext. 24 if you have any questions or concerns.

Regards,

Martin Guilbeault, M.Sc., P.Eng. (ON)
Hydrogeologist
(via e-mail)

MG:mg

Appendix C

Mt. Nansen Meteorological Data (electronic)

Appendix D

Water Resources Sampling Data (electronic)