MAXIM
TECHNOLOGIES INC®
A TETRA TECH COMPANY

303 Irene (59801)
P.O. Box 4669
Helena, MT 59604

(406) 443-5210
Fax (406) 449-3729

TECHNICAL MEMORANDUM

To: Mary Beth Marks – On Scene Coordinator
Frank Ehernberger – Project Engineer

From: Michael Cormier

Date: June 23, 2003

Re: Summary of Repository Sump Monitoring – Fall 2002 through June 2003
New World Mining District Response and Restoration Project

This memorandum presents a summary of the monitoring data collected since repairs were completed at the Selective Source repository in September 2002. Monitoring conducted over this period include measurements of water level in the sump and sump water chemistry. Water chemistry data collected in the winter and spring of 2002 are also presented for comparison purposes. This technical memorandum supplements the memorandum on estimates of drainage from waste into the repository sump prepared by Cam Stringer, dated June 20, 2003.

Maxim and the USDA Forest Service collected data on sump water levels and chemistry in the fall of 2002 and more recently on January 8, April 23, May 13, May 29, June 4, June 12, and June 19, 2003. Water levels were collected for all monitoring events. The depth of water measured in the sump was calibrated to a corresponding volume of water using data collected in the summer of 2002 when the repository sump was pumped for disposal. Samples were collected for chemical analysis from the sump on January 8 and May 29, 2003; electrical conductivity was measured on samples collected from the sump on June 12 and June 19, 2003.

Sump Water Levels

Figure 1 shows the depth of water in the repository sump over the period of August 2002 to the present. It also shows the dates and volumes when water was pumped from the sump. Figure 2 presents the same information in terms of volume and shows cumulative volume as well as actual volume. To date, a total of about 70,000 gallons has drained from the repository into the sump since summer 2002; about 42,300 gallons was pumped from the repository between August and October 2002, and disposed at the Cody, Wyoming sewage lagoon.

Sump Chemistry

Water samples were collected from the repository sump on January 8 and May 29, 2003. Previously, during monitoring of the sump in the winter and spring of 2002, numerous samples were collected for water quality analysis. The 2003 water quality analyses are presented first, followed by a comparison of the 2003 data with water chemistry measured in 2002. Complete sump chemistry results are presented in the attached Table 1. For electrical conductivity, both laboratory and field measurements are shown in Table 1, but the text and discussion below references only the laboratory data when both are available.

Figure 1: Depth of Water in Sump

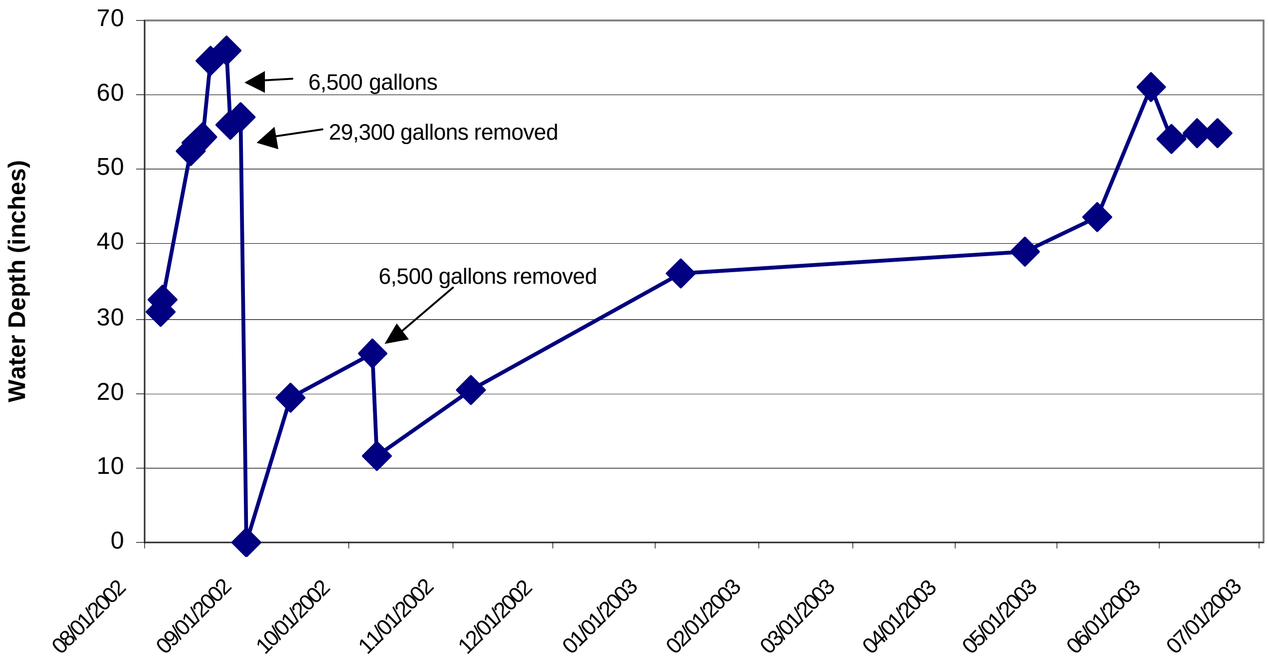
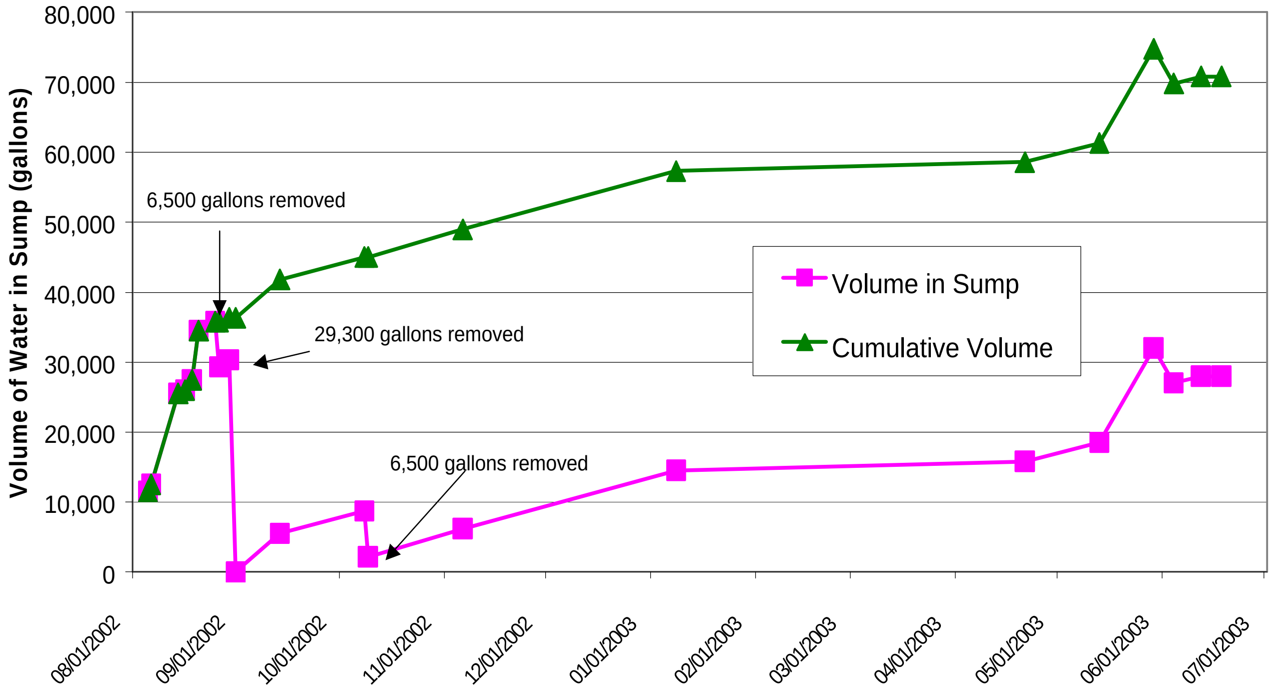


Figure 2: Volume of Water in Sump and Cumulative Drainage



In January 2003, pH of water in the sump was 6.5 standard units (s.u.), electrical conductivity (or specific conductance) was 2,920 micromhos per centimeter (µmhos/cm), and total dissolved solids (TDS) were 2,870 mg/L. Iron and manganese were the major metals detected at 7.9 and 4.6 milligrams per liter (mg/L), respectively. Trace amounts of arsenic (0.005 mg/L), barium (0.04 mg/L), copper (0.006 mg/L), selenium (0.002 mg/L), and zinc (0.12 mg/L) were also detected. Of the anions, sulfate concentrations were by far the highest at 1,220 mg/L. This chemistry is a result of the sulfides present in the waste.

Sump water chemistry on May 29, 2003, was similar to that measured in January. The pH, TDS, iron and sulfate concentrations were the same (6.5 s.u., 2,840 mg/L, 7.9 mg/L, and 1,230 mg/L, respectively). Electrical conductivity was about 17% higher at 3,400 µmhos/cm. Manganese concentrations were considerably higher (6.1 mg/L), although trace concentrations of arsenic (0.003 mg/L), barium (0.02 mg/L), copper (0.004 mg/L), and zinc (0.02 mg/L) were lower than those measured in January.

Constituent concentrations measured in the water draining through the waste placed in the repository reflect the nature of the waste disposed, a sulfide waste rock and alkaline tailings with elevated metals concentrations. The relatively high TDS concentrations (i.e., several thousand) measured by the laboratory in samples collected from the sump in January and May is a good indicator of water that has percolated through waste. Since the field measurement of electrical conductivity is a good approximation of TDS, electrical conductivity was monitored in the field during subsequent sump monitoring visits made on June 12 and June 18. Electrical conductivity on these two dates was measured at 2,480 and 2,230 µmhos/cm, respectively, indicating that TDS concentrations had fallen from previous measurements made on May 29. Where available, Table 1 displays both lab and field measurements of conductivity.

Water samples collected in 2002 (prior to repairing the liner in the sump area of the repository, which was completed in September 2002) are indicative of both the chemistry of water that had drained through the waste between October 2001 and May 2002, and the chemistry of water diluted by snowmelt that entered the sump in mid-May 2002 through the temporary cover (samples collected between May 21 and June 30, 2002; Table 1).

Sump water chemistry measured in January and May 2003 is similar in some respects to sump chemistry measured on May 2, 2002, before spring snowmelt entered the sump and diluted the water that had collected over the winter. As shown in Table 1, pH (6.5 s.u.), conductivity (3,020 mmhos/cm), TDS (2,570 mg/L), sulfate (1,030 mg/L), and manganese (3.55 mg/L) measured on May 2, 2002, were nearly the same as measured in 2003, while iron concentrations were more than 10 time lower in May 2002. With the influx of snowmelt into the sump after May 2, 2002, conductivity, TDS, and sulfate concentrations dropped by more than half, reflecting the dilution of constituents in the sump water by snowmelt.

Discussion

According to field data, water drained into the sump at a fairly steady rate between October 2002 and January 2003, dropped off considerably between January and April 2003, and then increased again between April and May 2003. The rate of accumulation of water in the sump increased further between May 13 and May 29, 2003. By June 4, the water level measured in the sump was seven inches lower than that measured on May 29.

Several factors could account for the observed changes in drainage rates. Since the repository was built at high altitude, average temperatures during winter months are well below freezing. Frost may penetrate several feet into the repository during these months. As a result, vertical flow of water, especially in upper layers of waste material, may be greatly impeded by freezing of pore water. During spring months average air temperatures rise, and material within the repository likely thawed.

Variable drainage rates may be expected over time due to the heterogeneous nature of the material in the repository. Because material in the repository is not saturated, the principals of unsaturated flow control drainage. In areas where a layer of fine-grained material is underlain by a much coarser-grained material, a capillary barrier may form. Water may accumulate above this barrier until sufficient hydraulic head builds up for the water to break through the capillary barrier. This could cause a sudden increase in the drainage rate. These processes could be responsible for some or all of the increase in drainage rates observed between April 22 and May 29, 2003.

The observed increase in drainage rates measured between May 13 and May 29, and the drop in water level between May 29 and June 4 could also be an indication of a leak or leaks in the liner in the vicinity of the sump. The shape of the curve based on data from April through June 2003 (Figures 1 and 2) resembles the 2003 hydrograph for Soda Butte Creek at the Yellowstone National Park Boundary. This was the period during which most of the snow overlying the repository was actively melting. The drop in water level is also coincident with a change in sump water chemistry, with the lower electrical conductivity measured on June 11 and June 18. This lower electrical conductivity may indicate a clean source of water is mixing with water in the sump.

It should be emphasized that sump monitoring data presented above do not present conclusive evidence on drainage quantity or chemical interactions that may be occurring in the sump. Furthermore, the rather simple hypothesis presented in this memorandum on drainage rates and the potential for incursions through the liner in the sump area are based on a limited number of measurements, and actual conditions of drainage from the waste may be much more complex. It is evident that monitoring of the sump should be performed on a frequent basis, and that plans should be formulated for a more comprehensive monitoring program through the winter and spring of 2004.

ATTACHMENT

TABLES

Table 1

REPOSITORY SUMP MONITORING

2002/2003 WATER QUALITY DATA

New World Mining District Response and Restoration Project

PARAMETER (metals are total recoverable)	**2002**									**2003**			
	15-Jan	**5-Mar**	**2-May**	**21-May**	**30-May**	**6-Jun**	**12-Jun**	**25-Jun**	**30-Jun**	**8-Jan**	**29-May**	**11-Jun**	**18-Jun**
Inches water	48	45	38	69	68	42	40	36	36	36	61	55	55
pH - lab (field) (s.u.)	6.8	7.1	6.5	7.1	(6.75)	6.9	(6.9)	(7.15)	(7.1)	6.5	6.5	--	--
Conductivity - lab (field) (mmhos/cml)	4050	3110	3020 (3170)	1360 (1377)	(1229)	1330 (1354)	(1371)	(1044)	(1346)	2920 (3160)	3400 (3280)	(2480)	(2230)
Chloride (mg/)	12	13	8	<4	--	1	--	--	--	8	14	--	--
Sulfate (mg/l)	1720	1620	1030	425	--	377	--	--	--	1220	1230	--	--
Alkalinity (mg/l)	839	778	1060	428	--	428	--	--	--	1010	1020	--	--
TDS (mg/l)	3350	3250	2570	1010	--	1020	--	--	--	2870	2840	--	--
TSS (mg/l)	16	<10	12	10	--	47	--	--	--	25	22	--	--
Hardness (mg/l)	1840	1735	1700	867	--	833	--	--	--	2020	2110	--	--
Aluminum (mg/l)	0.2	<0.1	<0.1	0.14	--	0.3	--	--	--	<0.1	<0.1	--	--
Arsenic (mg/l)	<0.003	0.003	<0.003	0.003	--	<0.003	--	--	--	0.005	0.003	--	--
Barium (mg/l)	0.03	0.03	0.03	0.02	--	0.04	--	--	--	0.04	0.02	--	--
Cadmium (mg/l)	<0.0001	<0.0001	0.0008	<0.0001	--	<0.0001	--	--	--	<0.0001	<0.0001	--	--
Chromium (mg/l)	<0.001	<0.001	<0.001	<0.001	--	<0.001	--	--	--	<0.001	0.001	--	--
Copper (mg/l)	<0.001	0.002	0.002	0.002	--	0.004	--	--	--	0.006	0.004	--	--
Iron (mg/l)	0.89	0.78	0.94	0.64	--	0.7	--	--	--	7.9	7.95	--	--
Lead (mg/l)	<0.001	<0.001	<0.001	<0.001	--	0.003	--	--	--	<0.001	<0.002	--	--
Manganese (mg/l)	1.99	1.71	3.55	1.79	--	1.66	--	--	--	4.61	6.09	--	--
Mercury (mg/l)	<0.0002	<0.0002	<0.0002	<0.0002	--	<0.0002	--	--	--	<0.0002	<0.0002	--	--
Selenium (mg/l)	0.003	0.002	0.001	<0.001	--	<0.001	--	--	--	0.002	0.002	--	--
Silver (mg/l)	0.0055	<0.0005	<0.0005	<0.0005	--	<0.0005	--	--	--	<0.0005	<0.0005	--	--
Zinc (mg/l)	<0.01	<0.01	<0.01	0.02	--	0.03	--	--	--	0.12	0.02	--	--