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Technical Memorandum

To:	Jamie Sturgess	**From:**	Mark A. Williamson
Company:	Rosemont Copper Company	**Date:**	March 18, 2009
Re:	Tailings Geochemistry	**Project #:**	114-3207777
CC:	Kathy Arnold (Rosemont Copper) Jamie Joggerst (Tetra Tech)	**Document #**	038/09-320777-5.3

Summary

To date, four (4) samples of tailings material (predominantly Horquilla) have been generated for the proposed Rosemont Copper Project. All of the samples were tested for acid-generating capacity and metals release using standard static and short-term leaching procedures, including: Acid-base accounting (ABA), net acid generation (NAG) pH testing, kinetic (humidity cell testing), synthetic precipitation leaching procedure (SPLP), meteoric water mobility procedure (MWMP), and whole rock analysis. Results from the testing indicate that the tailings material generally contains less than 0.01% sulfide-sulfur, can be classified as inert with respect to acid generation, and possess a high capacity for acid neutralization. Humidity cell testing was used to accelerate the weathering and release of various constituents from the tailings and the results provided no indication for the onset of acid generation or leaching of significant metals concentrations for tests lasting 20 weeks. The tailings were also subjected to short-term leaching tests (SPLP and MWMP) which produced only very low metal concentrations in the resulting leachates.

Sampling and Analysis

The approximate dates in which each tailings sample was generated are May 2006, February 2007, June 2007, and July 2008, and their rock compositions are provided in Table 1. Table 2 provides a summary of the completed test work for each sample and the analytical results for all tailings geochemical characterization conducted to date are presented in this memorandum.

Table 1. Rock composition for Tailings Samples

Sample Date	Rock Units
May 2006	Horquilla[1]
February 2007	Horquilla[1]
June 2007	Horquilla
July 2008	21.3% Earp 72.9% Horquilla 5.8% Escabrosa (Year 0 to 3 composite)

[1] Assumed rock samples processed for flotation was composed of Horquilla

Table 2. Tailings Test Protocols

Sample Date	ABA	NAG	Whole Rock	SPLP	MWMP	Kinetic
May 2006	X	X	X	X		
February 2007	X	X	X			X
June 2007	X	X	X	X	X	
July 2008	X		X	X	X	X

Acid-Base Accounting

The ABA properties of the tailings (Table 3) meets Arizona Department of Environmental Quality (ADEQ) criteria as inert, with total-Sulfur concentrations less than 0.3%, and a net neutralization potential (NNP) greater than 0 or a neutralization potential ratio (NPR) greater than 3 (ADEQ, 1999). The ABA characterization of the tailings indicates not simply a lack of acid potential (AP) but a pronounced neutralizing potential (NP). Thus, with respect to the potential for acidic drainage, the tailings are not only inert but furthermore acid consuming.

The NAG pH is a measure of the net acid generating capacity of a sample. The value of the NAG test is typically associated with waste rock, where the NAG result can often be tied to NNP. Thus, NAG testing offers an on-the-ground technique for segregating waste rock during operations. With respect to tailings, NAG testing has limited value, as this material is seldom segregated for specific handling and storage. However, the results obtained from two (2) tailings samples support the overall non-acid generating nature of the tailings due to the NAG pH values greater than 7 (Table 3).

Table 3. Summary of ABA Results for Rosemont Tailings Samples

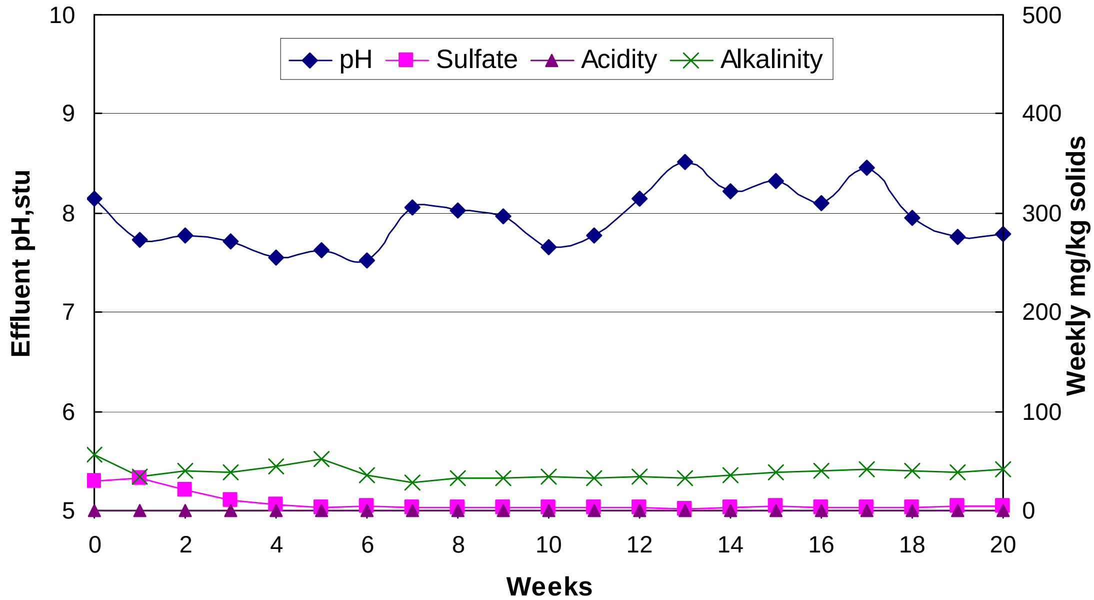
Sample ID	AP	NP	NNP	NP/AP	NAG pH	Non-Extractable Sulfur (%)	Sulfide Sulfur (%)	Sulfate Sulfur (%)	Total Sulfur (%)
	T $CaCO_3$/kT								
May 2006	1	426	425	426	NA	<0.01	0.01	0.04	0.05
February 2007	<0.3	332	332	2210	7.87	<0.01	<0.01	<0.01	<0.01
June 2007	<0.3	248	248	1650	8.25	<0.01	<0.01	0.04	0.04
July 2008	<0.3	304	304	2030	NA	<0.01	<0.01	<0.01	<0.01

Kinetic Testing

Kinetic, humidity cell testing, is an accelerated weathering laboratory-based test. During the procedure, the tested material is exposed to moist, oxygenated air which accelerates the weathering of any sulfide minerals present. The purpose is to gauge the extent to which mine materials with uncertain acid generation potential (per ABA) can produce acidic drainage. On a weekly basis, the weathering solids are rinsed with water and the leachate is analyzed for its chemical constituents.

The humidity cell results from the tailings samples are consistent with the results from ABA testing. The tailings samples meet the ADEQ criteria as inert and did not produce acidic drainage. Results from the February 2007 sample show that in addition to maintaining a neutral pH, the effluent from the humidity cell also maintained a constant alkalinity value (Figure 1). A decreasing alkalinity value (despite a neutral pH) is a precursor to the onset of lower pH values, and therefore the February 2007 tailings sample showed no signs of acid onset. The concentrations of aluminum, beryllium, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, and thallium were below detection in all of the humidity cell leachate samples (Table 4). All of the remaining metal concentrations were low, although antimony was present in at least one sample at concentrations near or slightly above its Aquifer Water Quality Standard (AWQS) value (0.006 mg/L). A general depletion in soluble constituents (rinse-out), rather than accumulation of weathering products, was observed as the test progressed by the decreasing concentrations of TDS and major ion concentrations (Table 4).

Figure 1. Humidity Cell Results for February 2007 Tailings Sample



The tailings sample from July 2008 produced a very similar humidity cell response (Figure 2). The effluent from the July 2008 sample maintained a pH greater than 8, with stable alkalinity values and low sulfate concentrations due to the high carbonate content and resulting NNP characteristics of the sample. Trends in the humidity cell leachate concentrations were also similar, with aluminum, beryllium, cadmium, chromium, iron, lead, mercury, silver, thallium, uranium, and zinc below detection in all leachates (Table 5). The remaining detectable metals were present at low concentrations, although one of the antimony values exceeded its respective AWQS. The July 2008 tailings sample also produced the characteristic initial "rinse-out" of more soluble constituents, as indicated by the decreasing concentrations of TDS and major constituents over time (Table 5).

Figure 2. Humidity Cell Results for July 2008 Tailings Sample

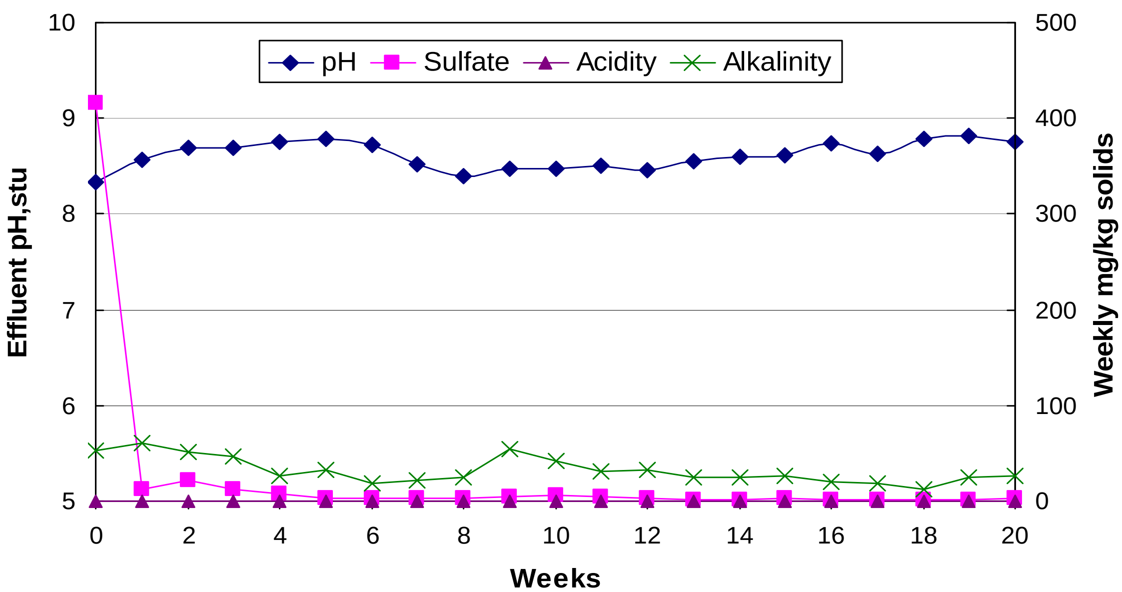


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Table 4. Summary of Humidity Cell Metal Concentrations for the February 2007 Tailings Sample.

Parameter	Humidity Cell Effluent Metal Concentration (mg/L)				
Sample Date	February 2007				
Week	**0**	**1-5**	**6-10**	**11-15**	**16-20**
Aluminum	<0.08	<0.08	<0.08	<0.08	<0.08
Antimony	<0.006	0.0035	0.0057	0.0058	0.0056
Arsenic	<0.01	0.0071	0.0095	0.0087	0.0153
Barium	0.0409	0.0176	0.0113	0.0067	0.0094
Beryllium	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium	<0.002	<0.002	<0.002	<0.002	<0.002
Calcium	26.9	22.8	14.4	10.7	11.8
Chloride	4.07	1.5	1.43	0.2	<0.2
Chromium	<0.006	<0.006	<0.006	<0.006	<0.006
Copper	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoride	0.81	1.09	1.17	1.34	1.65
Iron	<0.06	<0.06	<0.06	<0.06	<0.06
Lead	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075
Magnesium	1.45	1.49	0.75	0.6	0.75
Manganese	0.005	0.017	0.005	<0.004	<0.004
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	NM	NM	NM	NM	NM
Nickel	<0.01	<0.01	<0.01	<0.01	<0.01
Potassium	3.99	3.24	1.57	1.08	1.03
Selenium	<0.04	<0.04	<0.04	<0.04	<0.04
Silver	<0.005	<0.005	<0.005	<0.005	<0.005
Sodium	15.6	10.3	2.7	6.32	7.58
Sulfate	74.3	50.5	14.4	13.7	15.3
Thallium	<0.002	<0.002	<0.002	<0.001	<0.001
TDS	162	137	83	99	112
Uranium	NM	NM	NM	NM	NM
Zinc	0.0162	<0.01	<0.01	<0.01	<0.01

NM = Not measured.

Table 5. Summary of Humidity Cell Metal Concentrations for the July 2008 Tailings Sample.

Parameter	Humidity Cell Effluent Metal Concentration (mg/L)					
Sample Date	July 2008					
Weeks	0	1-4	4-8	9-12	13-16	17-20
Aluminum	<0.08	<0.080	<0.080	<0.080	<0.080	<0.080
Antimony	0.009	0.00573	0.00654	0.00469	0.00328	0.00354
Arsenic	0.017	0.00619	0.00871	0.0102	0.0110	0.00937
Barium	0.017	0.0182	0.0447	0.0758	0.0509	0.0510
Beryllium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Calcium	335	46.1	13.5	16.8	13.5	13.5
Chloride	15.2	0.255	0.275	0.250	<0.2	<0.2
Chromium	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Copper	0.012	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoride	1.68	2.44	2.22	1.81	2.19	2.05
Iron	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Lead	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075
Magnesium	6.92	1.09	0.475	0.744	0.558	0.546
Manganese	0.045	0.0089	<0.0040	0.0074	0.0057	0.0069
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	0.832	0.369	0.241	0.111	0.0965	0.0867
Potassium	25.4	6.60	3.08	2.26	1.34	1.18
Selenium	0.151	<0.04	<0.04	<0.04	<0.04	<0.04
Silver	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sodium	106	5.20	0.58	<0.50	<0.50	<0.50
Sulfate	1060	114	12.3	6.88	7.32	6.99
Thallium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
TDS	1,700	230	56	110	96	121
Uranium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Whole Rock Analysis

Whole rock analysis determines the total concentration of selected chemical constituents in a sample and has been performed on every tailings sample to date (Table 6). There are variations in the composition of each sample tested. However, such total analyses do not bear directly on potential impacts to water resources, but serve to identify potential constituents of concern in the tailings. Metals such as arsenic, cadmium, copper, lead, manganese, and zinc were detected in the tailings during whole rock analysis (Table 6) and therefore the leaching characteristics of these metals were further evaluated using the SPLP and MWMP.

Synthetic Precipitation Leaching Procedure (SPLP)

The SPLP is designed to determine the potential for release of chemical constituents from a solid that is exposed to meteoric precipitation (rain or snow melt). There are no specific regulatory criteria that dictate interpretation of SPLP results, but the results may be used as input to models that predict potential impacts to either ground or surface water resources. The tailings samples tested for SPLP to date show very limited release of any chemical parameter, including metals (Table 6). This is expected due to the non-acidic nature of the tailings and the near-neutral pH conditions that are associated with its leaching. Most metals have limited solubility at neutral pH, although some chemical constituents, such as arsenic and selenium, can be mobile under such pH conditions. However, the majority of the metal concentrations in the tailings SPLP extractions (Table 6) were either below detection or low compared to AWQS values.

Meteoric Water Mobility Procedure (MWMP)

The MWMP is a short-term leaching test with similar objectives to the SPLP. The MWMP is tailored more for “run of mine” materials without crushing, whereas the SPLP was developed more for soil materials with smaller grain size. This grain size issue is more germane to waste rock than to the tailings results reported here. However, the MWMP is a suitable and largely accepted test of mine materials.

Consistent with the SPLP results, MWMP results indicate a very limited release of metals. There are a few differences in the extractable concentrations which are largely related to the water:rock ratio employed by the test. For example, the sulfate concentration for the June 2007 MWMP was 285 mg/L compared to only 20 mg/L in the SPLP test of the same sample (Table 6). The MWMP is performed using a water to rock ratio of 1:1 while the SPLP ratio is 20:1, and therefore constituent concentrations are generally higher in the MWMP compared to the SPLP. On a mass basis, however, the MWMP yields a value of 285 mg sulfate/kg of rock, while the SPLP yields a value of 400 mg/kg. Thus, both the MWMP and SPLP provide information which can be used to better understand the potential for release of various constituents from geologic materials. It should be noted that the SPLP leaching solution uses sulfuric acid, which adds a very small amount of sulfate, perhaps on the order of 1 to 3 mg/L in the leachate. Thus, the 400 mg sulfate/kg solid value calculated above is biased a bit high. The result is that the leachable sulfate values for SPLP and MWMP are actually a bit closer. The value of 400 mg/kg may be more on the order of 340 mg/kg compared to the value of 285 mg/kg from MWMP. The recasting of extraction solutions concentration in the MWMP and SPLP to a mass of solid basis is shown here only to illustrate the effect of the different water:rock ratios in each test. Although they provide a gauge of a similar property, the SPLP and MWMP tests are inherently different and should not be expected to produce identical results.

Summary of Tailings Geochemical Testing

Geochemical characterization of four (4) Rosemont tailings samples (predominantly Horquilla) indicates that the tailings generally contain less than 0.01% sulfide-sulfur, can be classified as inert with respect to acid generation, and possess a high capacity for acid neutralization. Humidity cells were used to accelerate the weathering and release of various constituents from the tailings, but the results provided no indication for the onset of acid generation or leaching of significant metals concentrations for tests lasting 20 weeks. The tailings were also subjected to short-term leaching tests (SPLP and MWMP) which produced only very low metal concentrations in the resulting leachates.

References

Arizona Department of Environmental Quality (ADEQ). 1999. Draft Policy for the Evaluation of Mining Rock Materials for the Determination of Inertness.

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Table 6. Summary of Geochemical Data for Rosemont Tailings Testing

Parameter	May 2006		February 2007		June 2007			July 2008		
	Whole Rock (mg/kg)	SPLP (mg/L)	Whole Rock (mg/kg)	SPLP (mg/L)	Whole Rock (mg/kg)	SPLP (mg/L)	MWMP (mg/L)	Whole Rock (mg/kg)	SPLP (mg/L)	MWMP (mg/L)
pH	NA	NM	NA	NM	NA	NM	7.43	NA	9.5	8.5
Alkalinity	NA	NM	NA	NM	NA	NM	NM	NA	8.3	11.5
Aluminum	12,000	NM	3,910	0.08	6,210	0.08	<0.08	5,870	<0.08	<0.08
Antimony	<10	NM	2	NM	2.2	<0.02	<0.02	<2	<0.02	<0.02
Arsenic	5.5	<1	8.6	<0.003	8.2	<0.003	<0.003	22	<0.02	<0.003
Barium	20	<10	7.7	<0.002	12.2	0.0032	0.0172	25.6	0.02	0.0229
Beryllium	NM	NM	0.36	NM	0.58	<0.002	<0.002	0.537	<0.002	<0.002
Cadmium	0.9	<0.5	1.51	<0.002	0.97	<0.002	<0.002	1.1	<0.002	<0.002
Calcium	150,000	NM	125,000	8.8	146,000	13	103	126,000	15.6	150
Chloride	40	NM	11.3	0.36	46	0.43	5.69	10.3	0.55	5.18
Chromium	14	<1	10.4	<0.006	21	<0.006	<0.006	17.7	<0.006	<0.006
Copper	NM	NM	2,070	<0.010	1,100	<0.010	<0.01	1,120	<0.01	<0.01
Fluoride	NM	NM	8.72	1.25	NM	1.29	1.02	2.35	0.85	1.11
Iron	18,000	NM	15,300	<0.06	23,600	<0.06	<0.06	21,700	<0.06	<0.06
Lead	7	<1	10.4		13.6	<0.0075	<0.0075	20	<0.0075	<0.008
Magnesium	8,400	NM	4,960	0.23	5,410	0.17	0.65	8,300	0.2	1.91
Manganese	2,100	NM	1,520	<0.004	2,000	<0.0040	0.019	1,670	<0.004	0.0172
Mercury	<0.100	<0.01	0.038	<0.0002	0.042	<0.0002	0.00033	1.77	0.0007	<0.0002
Molybdenum	NM	NM	90	NM	46	0.075	0.46	13.8	0.06	0.463
Nickel	NM	NM	8.8	<1	5.5	<0.01	<0.01	11.2	<0.01	<0.01
NO_2+NO_3-N	NM	NM	NM	0.04	NM	NM	0.021	NM	NM	NM
Potassium	1,000	NM	786	0.62	977	0.86	8.33	1,040	1.24	11.3
Selenium	<5	<0.5	<4	<0.5	<4	<0.04	<0.04	<4	<0.04	<0.04
Silver	0.8	NM	2.41	<0.005	0.87	<0.0050	<0.005	1.15	<0.005	<0.005
Sodium	<250	NM	117	2.57	154	2.22	27.6	225	4.1	37.1
Sulfate	320	NM	123	6.95	311	20	285	632	35	441
TDS	NA	NM	NA	13	NA	66	505	NA	NM	NM
Thallium	NM	NM	1.5	NM	2	<0.015	<0.015	<1.5	<0.02	<0.015
Uranium	NM	NM	NM	NM	NM	NM	NM	2.89	<0.002	<0.001
Zinc	85	NM	271	NM	118	<0.01	<0.01	108	<0.01	<0.01

NA = Not applicable. NM = Not measured.