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Trace Metal Dynamic Extraction from Five Pumps in Hydrochloric Acid

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Summary

The objective of this test was to determine the type and rate of trace metals extraction from five pumps: Levitronix BPS-1.5 (S/N: 060406-0615), Levitronix BPS-3.7 (S/N: 060406-0710), Levitronix BPS-4.2 (S/N: 060406-0322), Trebor Mega 960DF16000A0 (S/N: L01114), and a Yamada DP-25F UHP EXT F-T (S/N: 311495). A dynamic extraction test method was used in 35% hydrochloric (HCl) acid during the 14-day extraction test.   Both surface and bulk contamination can be determined with this method.   Surface contamination is defined as the amount of contamination extracted in the first 40 minutes of exposure of the component to chemical.   Bulk contamination is defined as the amount of contamination extracted after 40 minutes of exposure to chemical.

The pumps were plumbed into the dynamic extraction test apparatus shown in Figure 1. High purity 35% HCl was used as the extractant during each test. Continuous flow of the chemical was maintained through the pumps during each test. The test pumps were operated continuously during the test to ensure that the acid was well mixed within the pump. A background sample was taken from each test system prior to each test and samples were taken at approximately evenly spaced time intervals on a logarithmic scale from a sample port located in the circulation loop. The chemical samples were submitted for analysis of 37 metallic elements. The results of the analyses were converted to cumulative mass extracted.

The surface contamination extracted from all elements was 0.4, 0.8, 2.6, 4.1, and 9.3 µg for the BPS-1, BPS-3, BPS-4, Mega 960D, and DP-25F pumps, respectively. Iron and copper were among the three highest surface contaminants in all five tests. The mass extraction rates were calculated to be 0.06, 0.05, 0.12, 0.10, and 0.12 µg/day at 7 days for the BPS-1, BPS-3, BPS-4, Mega 960D, and DP-25F pumps, respectively. The total bulk contamination from all elements extracted during the tests was 1.1, 0.9, 1.6, 4.3, and 3.3 µg for the BPS-1, BPS-3, BPS-4, Mega 960D, and DP-25F pumps, respectively.

Test System

The dynamic extraction test system is shown in Figure 1. Except for the chemical reservoir, all of the wetted system components are made of fluoropolymers. The reservoir is constructed of high-density polyethylene.   All of the components in the extraction test system were preconditioned for a minimum of two months in 35% HCl.

System Cleaning

Prior to testing, the system shown was cleaned with a 10% hydrochloric acid solution, with fluoropolymer spool pieces in place of each pump. The spool pieces allow the system to be cleaned with the plumbing pieces required for the test, without having the test pump in the system. The purpose of cleaning the system was to remove any contamination remaining in the system from the previous test, and to clean the components that were installed to connect to the test pump. After cleaning, the system was flushed with ultra pure water and drained completely three times.

All five pumps were tested in ultra pure water for particle shedding prior to the start of this test (see CTA report #: LTX 977A 1981).

Figure 1. Schematic of Dynamic Extraction Test System
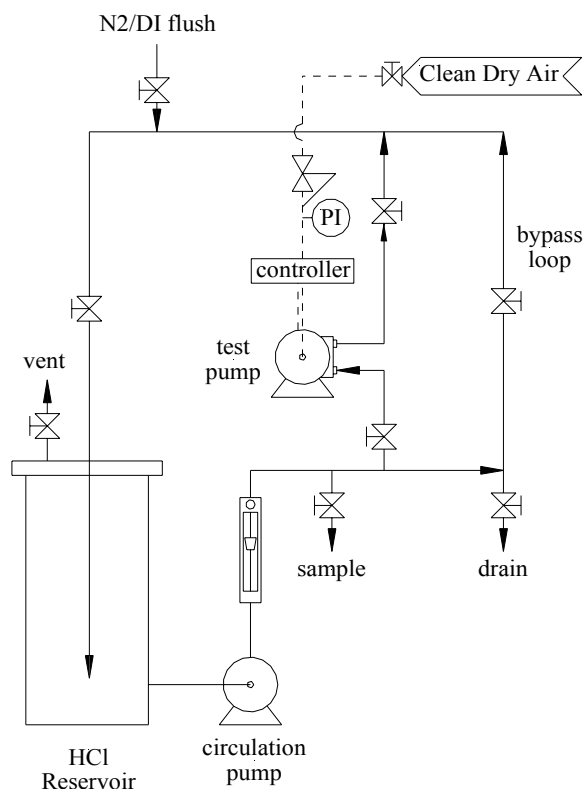
Extraction Test Procedure

After the system was cleaned, one of the test pumps was installed into the system, but was isolated by closing isolation valves located on both sides of the pump. A known volume of 35% Fisher Scientific Trace Metal Grade Seastar hydrochloric acid was added to the reservoir. To maximize the sensitivity of the test, the volume of hydrochloric acid was minimized. The initial volume included enough chemical to fill the system plumbing and test pump plus an additional 750 mL for chemical samples. The acid was added to the system five days prior to the start of the test and was circulated using a pre-extracted circulation pump shown in Figure 1. A background sample of this chemical was taken just prior to initiating circulation of the chemical through each test pump. Five additional samples of chemical were removed from the system during 14 days of circulation through each pump. Continuous flow of the chemical was maintained through each pump during the test at a low flow rate. Each test pump was continuously operated during the test at a low speed. The sample times were approximately evenly spaced on a logarithmic scale (see Table I) to improve the accuracy of the data analysis. After the 14-day sample was taken, the samples were submitted as a group to Seastar Chemicals, Inc. (Sidney, BC, Canada) for the trace metals analysis of 37 elements using ICP-MS (inductively coupled plasma-mass spectroscopy). The detection limits for all elements are presented in Appendix A. Finally, the system was flushed with water and the pump was removed.

Miscellaneous Test Specifics

Specifics to these tests are shown in Table I.

Table I. Test specifics

Test Conditions	
Component(s) Tested	Levitronix BPS-1.5 (S/N: 060406-0615), Levitronix BPS-3.7 (S/N: 060406-0710), Levitronix BPS-4.2 (S/N: 060406-0322), Trebor Mega 960DF16000A0 (S/N: L01114), and Yamada DP-25F UHP EXT F-T (S/N: 311495)
Chemical Manufacturer and Grade	Fisher Scientific – Trace Metal Grade (lot #: 4107040)
Chemical Volume	1066 mL (BPS-1), 2035 mL (BPS-3), 1955 mL (BPS-4), 3369 mL (Mega), and 3487 mL (DP-25F)
Temperature	22-25 °C
Sample Times	Background, 40 minutes, 2 hours, 8 hours, 2 days, 14 days

Results

Surface contamination
Table II shows the major contributors to surface contamination in each test. The raw data are found in Appendix A. Iron and copper were among the three highest surface contaminants in all five tests.   These two elements contributed more than 70% of the surface contamination measured in four of the five tests. Other significant contributors were lead and calcium. A variety of other elements contributed the remainder of the surface contamination. The surface contamination extracted from all elements was 0.4, 0.8, 2.6, 4.1, and 9.3 μg for the BPS-1, BPS-3, BPS-4, Mega 960D, and DP-25F pumps, respectively.

Bulk contamination
Figures 2-6 show the mass of selected elements extracted from the bulk material of the pumps over time. The data are plotted on a log-log scale as a function of time. Figure 2-6 shows the total mass extracted from all measured elements over time.   All figures exclude surface contamination.

Like the surface contamination, copper and iron were the two top bulk contaminants in four of the five tests. These two elements contributed at least one-third of the bulk contamination (as defined as the amount of mass extracted after the first 40 minutes of the test) extracted during each test. Other significant contributors were aluminum and calcium. A variety of elements contributed the remainder of the bulk contamination. The total bulk contamination from all elements extracted during the tests was 1.1, 0.9, 1.6, 4.3, and 3.3 μg for the BPS-1, BPS-3, BPS-4, Mega 960D, and DP-25F pumps, respectively.

Figures 7-11 present the mass extracted from the bulk material of each pump over time for all measured elements on a log-log scale. Since theory predicts that the extraction data can be fit by a power law equation, the data should follow a straight line when plotted in this format [1]. A simple regression analysis of the data in this format is also presented in Figures 7-11.

Table II. Surface contamination (μg) measured during test

BPS-1			BPS-3			BPS-4		
Element	Mass Extracted (μg)	% of Total (%)	Element	Mass Extracted (μg)	% of Total (%)	Element	Mass Extracted (μg)	% of Total (%)
Fe	0.18	47.4	Cu	0.47	56.6	Cu	1.25	47.9
Cu	0.13	34.2	Fe	0.23	27.7	Fe	0.48	18.4
Ni	0.04	10.5	Pb	0.07	8.4	Pb	0.47	18.0
Na	0.01	2.6	Al	0.06	7.2	Ca	0.17	6.5
Pb	0.01	2.6				Al	0.07	2.7
Misc.	0.01	2.6	Misc.	0.00	0.0	Misc.	0.17	6.5
Total	**0.38**	**100.0**	**Total**	**0.83**	**100.0**	**Total**	**2.61**	**100.0**

Mega 960D			DP-25F		
Element	Mass Extracted (μg)	% of Total (%)	Element	Mass Extracted (μg)	% of Total (%)
Cu	1.89	46.0	Ca	3.37	36.4
Fe	1.05	25.5	Fe	2.67	28.8
Pb	0.38	9.2	Cu	0.98	10.6
Zn	0.22	5.4	Mg	0.83	9.0
Al	0.17	4.1	Na	0.33	3.6
Misc.	0.40	9.7	Misc.	1.08	11.7
Total	**4.11**	**100.0**	**Total**	**9.26**	**100.0**

The mathematical model used to predict the cumulative mass extracted as a function of time is an equation of the type:

$$m = k * t^n \tag{1}$$

where:

t = time (days)
m = cumulative mass extracted (μg) at time t
k = proportionality constant
n = exponent

Taking the log of both sides of the equation gives:

$$\log(m) = \log(k) + n * \log(t) \tag{2}$$

The parameters in equation (1) for total metals are given in Table III. These values were obtained from the linear regression analysis illustrated in Figures 7-11, where n is the slope and log k is the intercept as shown in equation (2).

Table III. Mass extraction parameters

Pump	k	n
BPS-1	0.330	0.502
BPS-3	0.422	0.392
BPS-4	0.619	0.502
Mega	2.307	0.206
DP-25F	1.687	0.292

The values for constants k and n can be used to calculate the total mass extracted from each pump at different times using equation (1). In addition, the rate of extraction can be determined by taking the derivative of equation (1) with respect to time:

$$\text{Rate of extraction} = dm/dt = n*k*t^{n-1} \qquad (3)$$

Based on equation (3) and the calculated curve fit parameters listed in Table III, the rates of extraction for total metals at 1, 7, and 14 days are shown in Table IV.

Figure 2. Mass extracted for the primary contributing elements from the BPS-1 pump
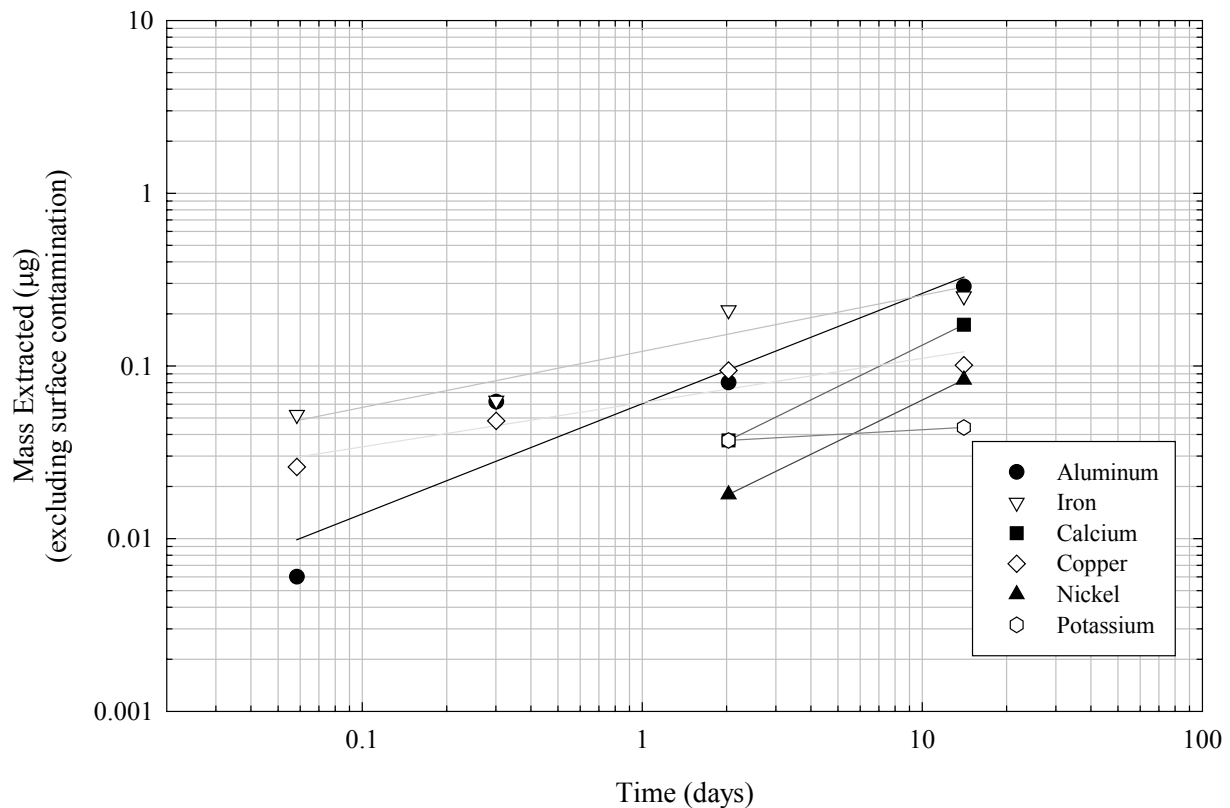
Figure 3. Mass extracted for the primary contributing elements from the BPS-3 pump

Time (days)
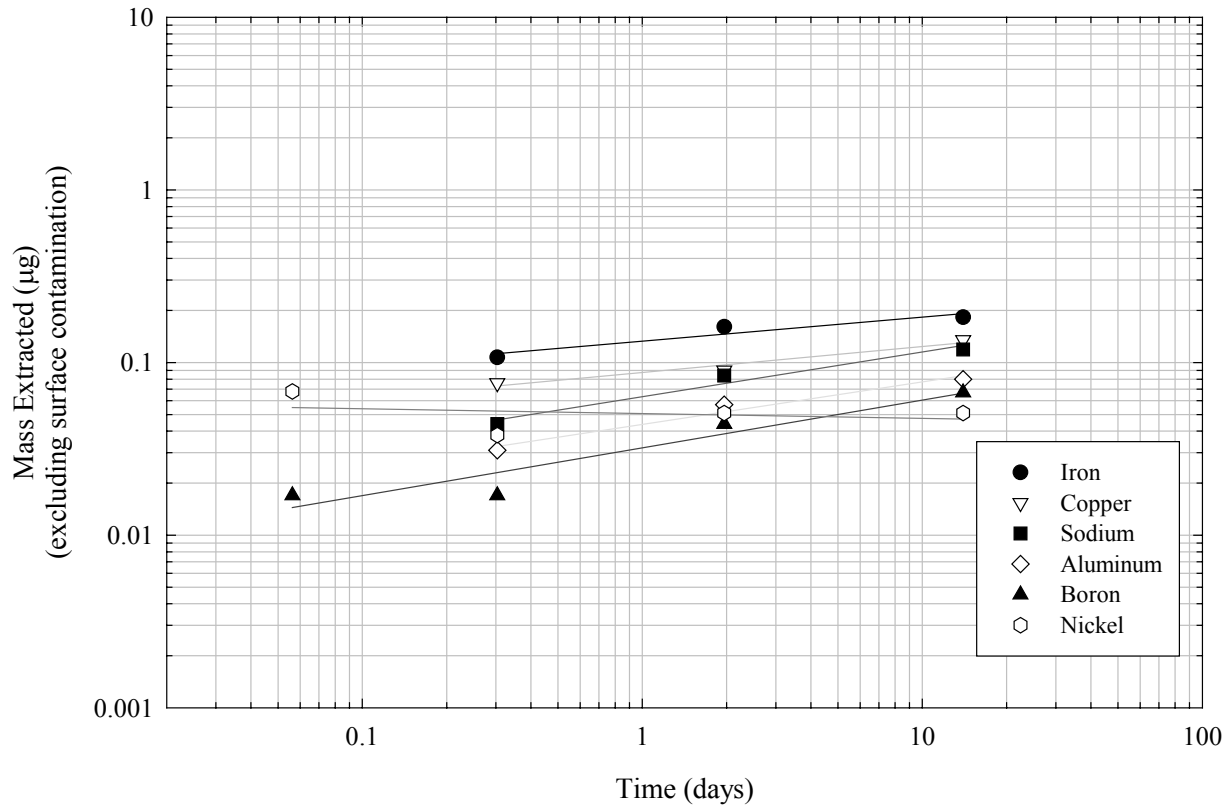
Figure 4. Mass extracted for the primary contributing elements from the BPS-4 pump

Time (days)
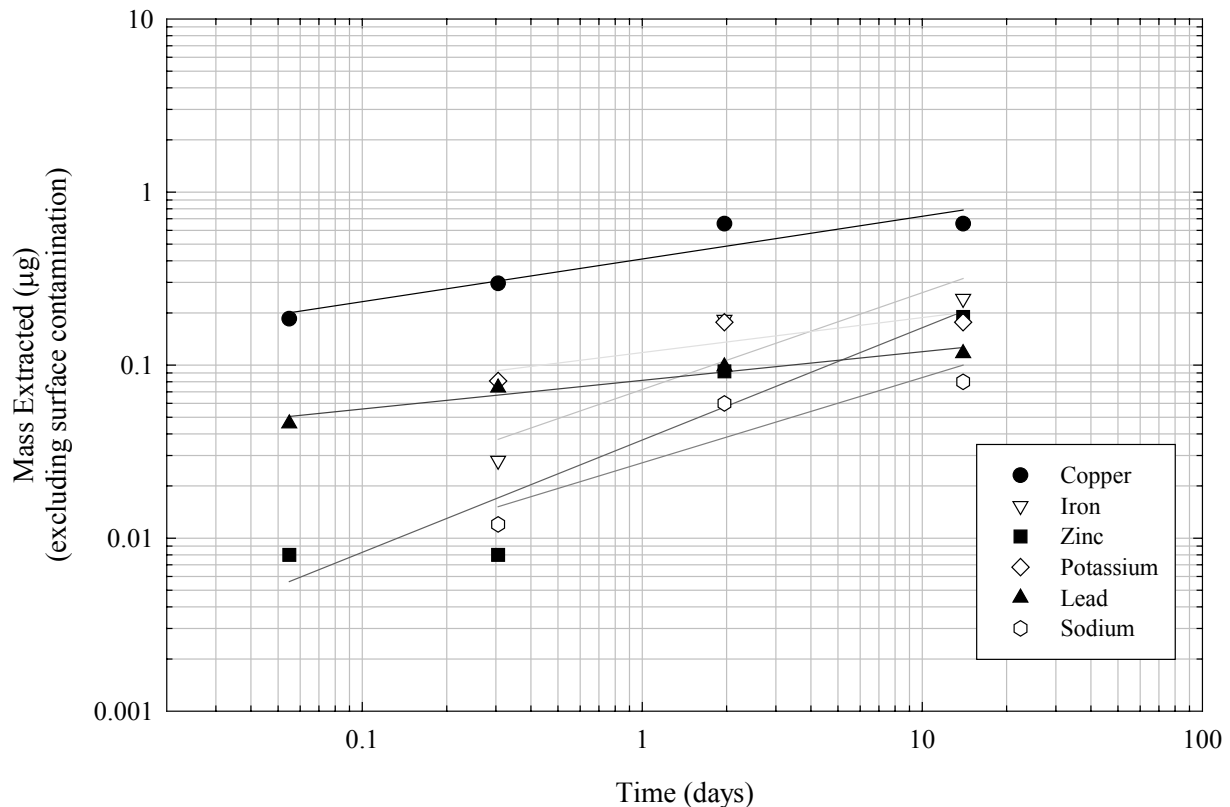
Figure 5. Mass extracted for the primary contributing elements from the Mega 960D pump

Time (days)
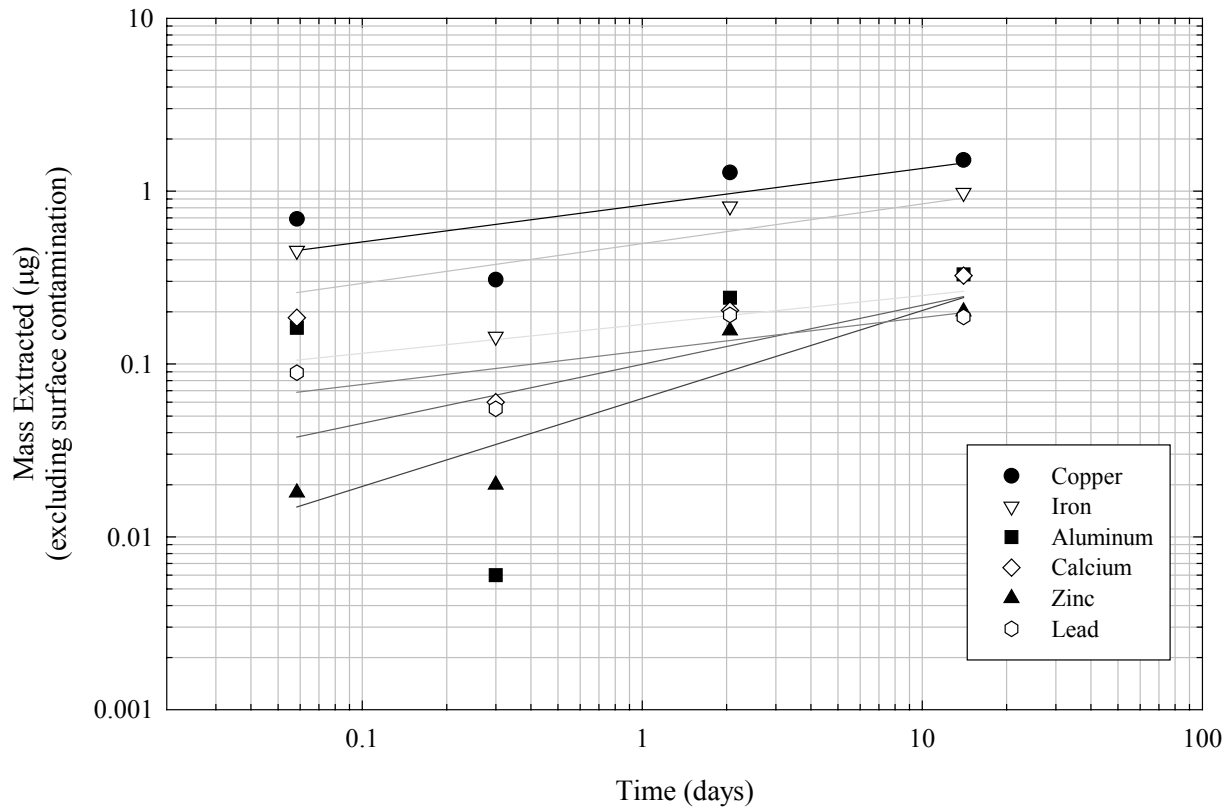
Figure 6. Mass extracted for the primary contributing elements from the DP-25F pump

Time (days)
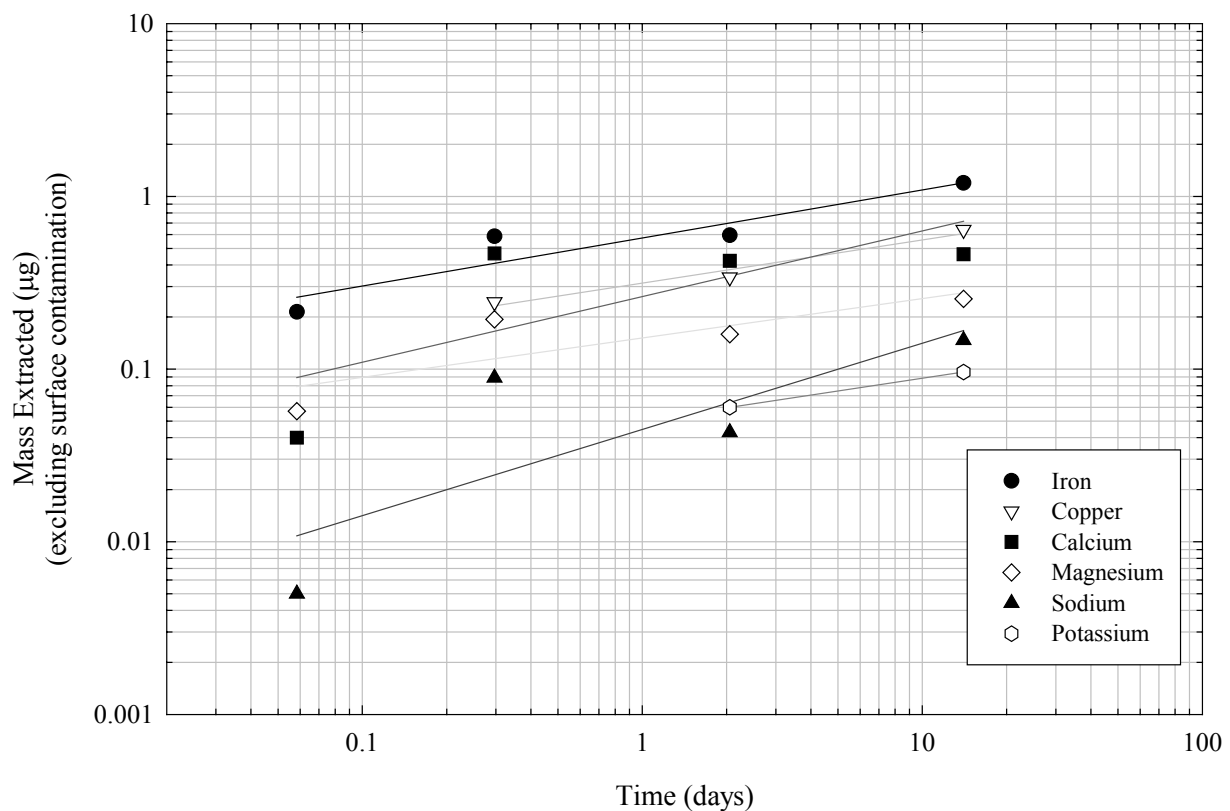
Figure 7. Total mass extracted from the BPS-1 pump
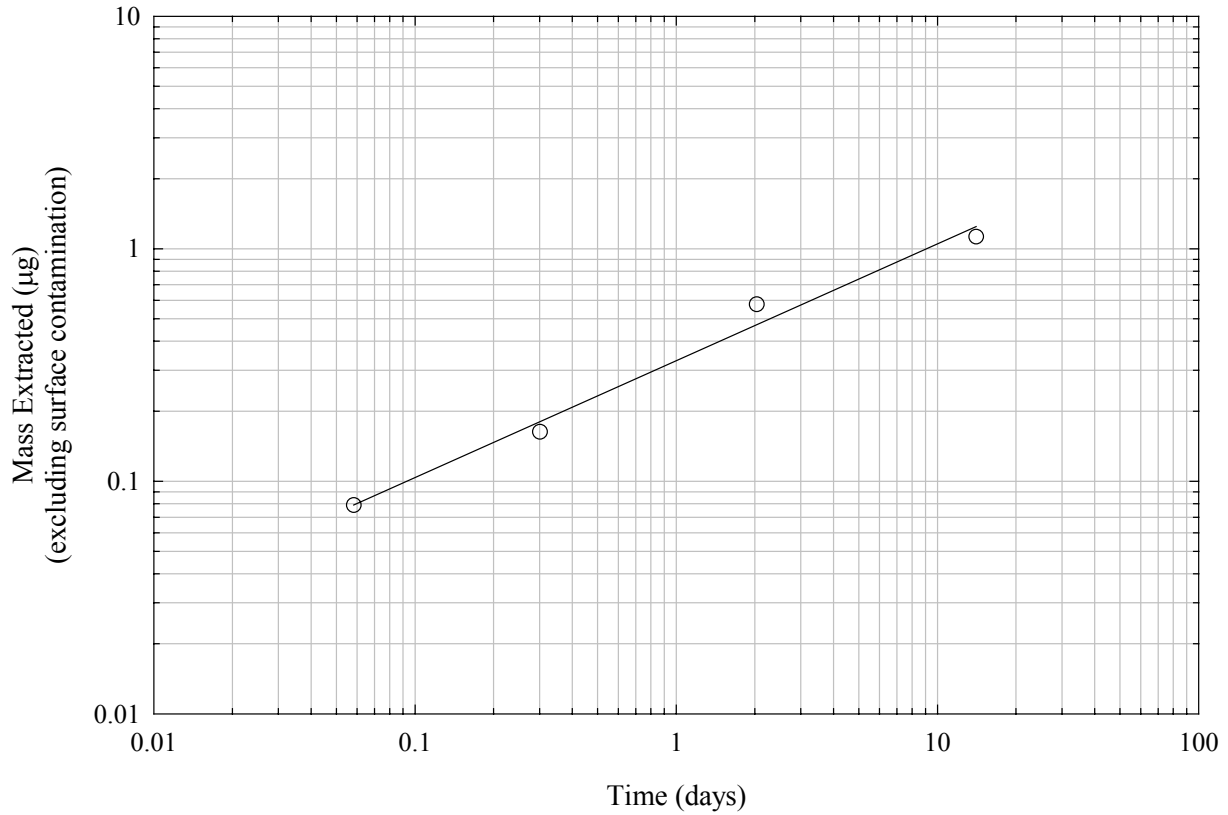
Figure 8. Total mass extracted from the BPS-3 pump
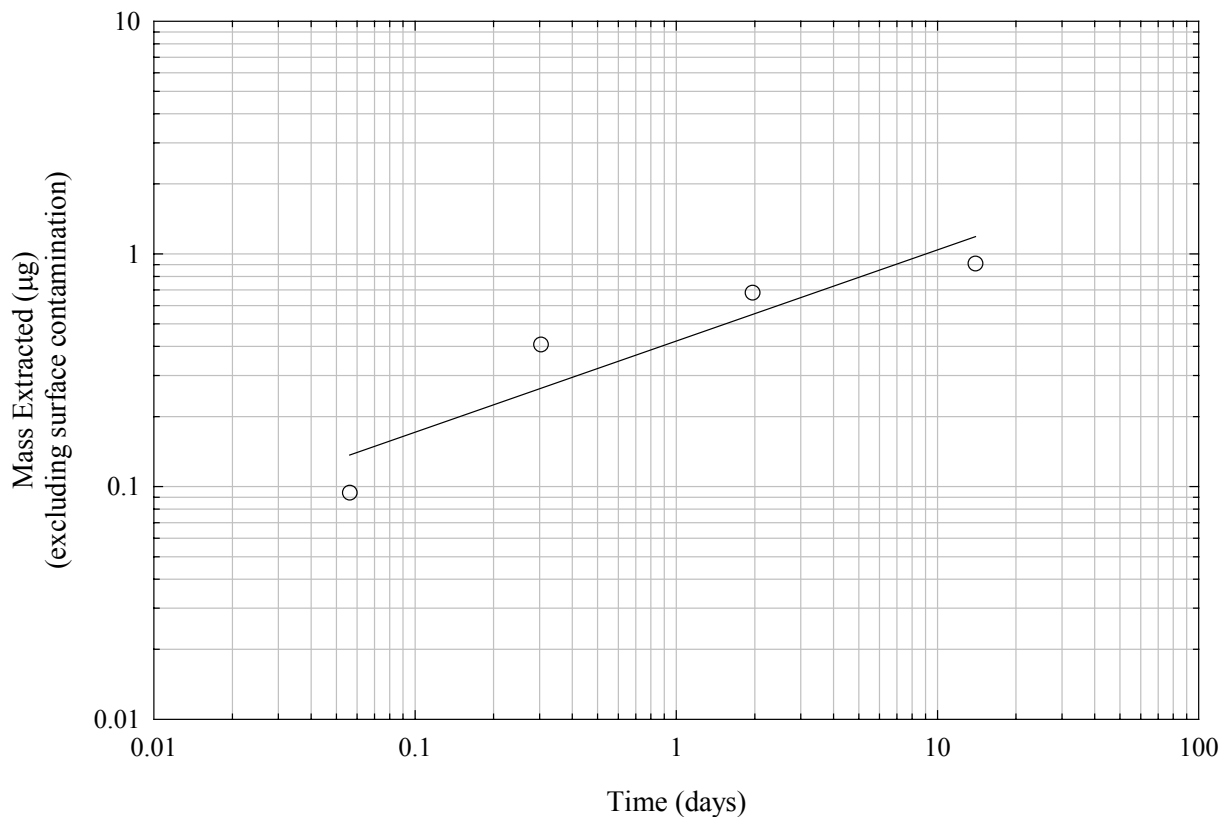
Figure 9. Total mass extracted from the BPS-4 pump
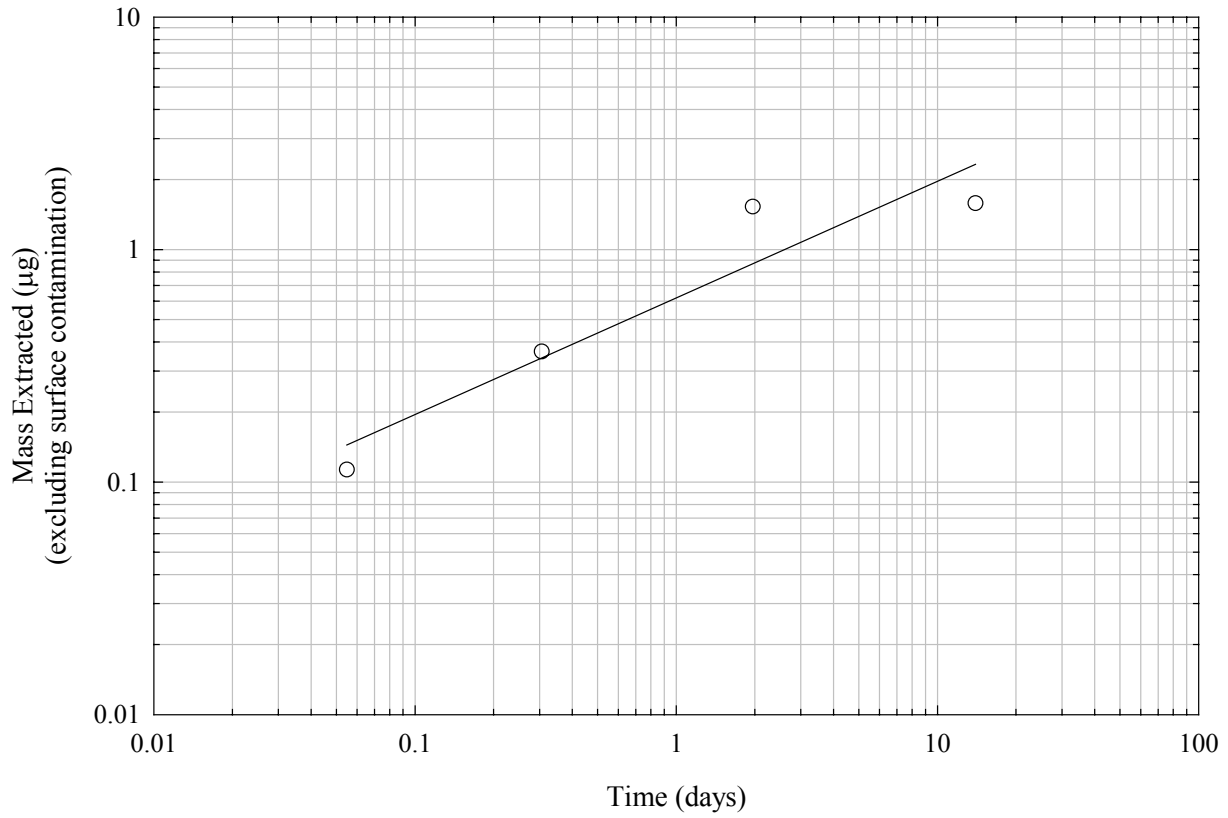
Figure 10. Total mass extracted from the Mega 960D pump
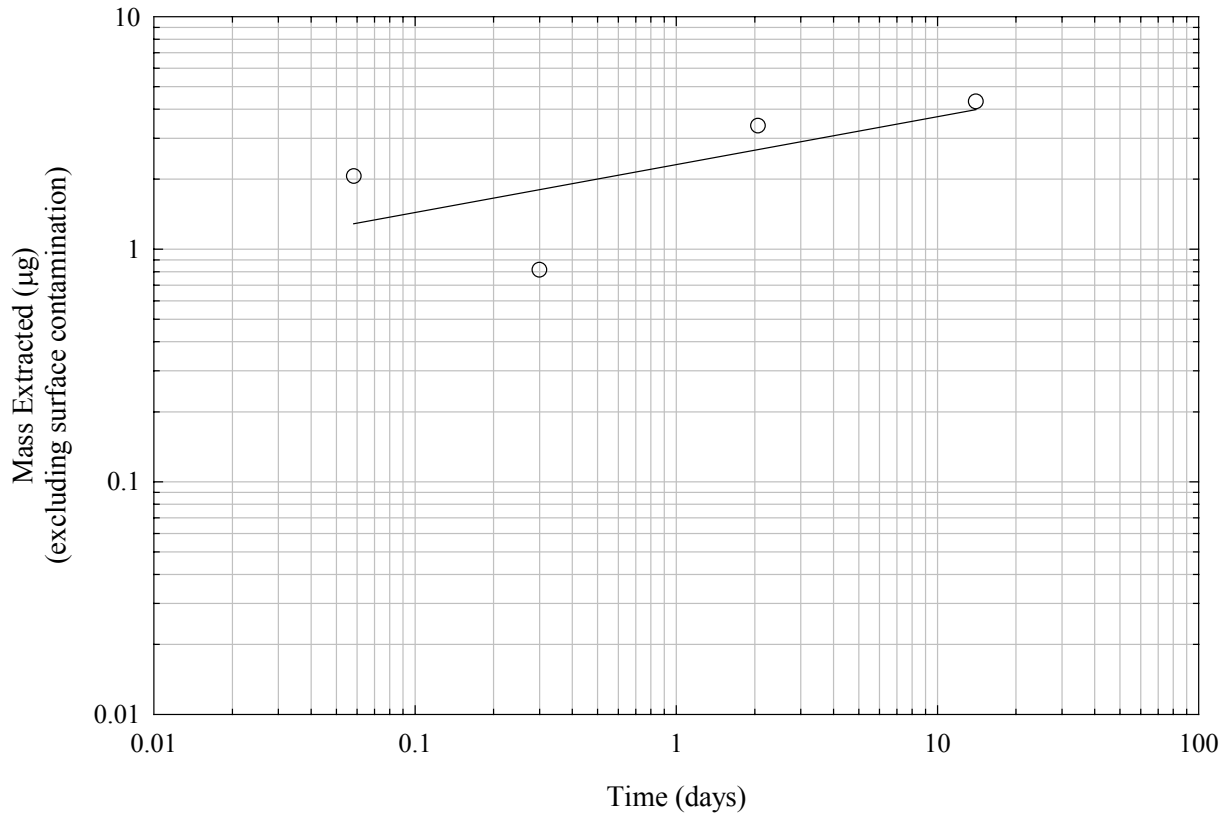
Figure 11. Total mass extracted from the DP-25F pump
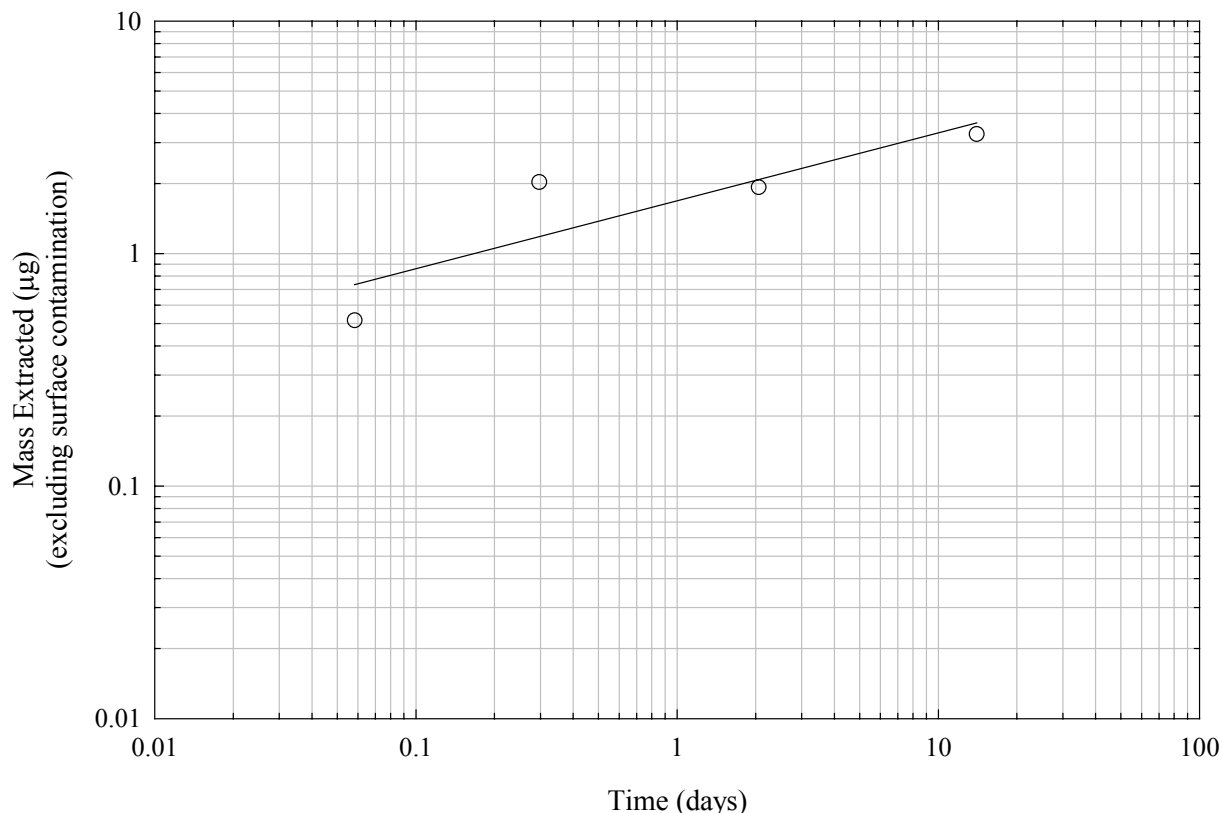
Table IV. Calculated rates of extraction for 37 metallic elements

Pump	Extraction Rate (µg/day)		
	1 day	7 days	14 days
BPS-1	0.17	0.06	0.04
BPS-3	0.17	0.05	0.03
BPS-4	0.31	0.12	0.08
Mega 960D	0.48	0.10	0.06
DP-25F	0.49	0.12	0.08

The mass extraction rates were calculated to be 0.06, 0.05, 0.12, 0.10, and 0.12 µg/day at 7 days for the BPS-1, BPS-3, BPS-4, Mega 960D, and DP-25F pumps, respectively. The total contamination from all elements extracted during the tests was 1.5, 1.7, 4.2, 8.4, and 12.5 µg for the BPS-1, BPS-3, BPS-4, Mega 960D, and DP-25F pumps, respectively.

Conclusions

Five pumps (Levitronix BPS-1.5, Levitronix BPS-3.7, Levitronix BPS-4.2, Trebor Mega 960DF16000A0, and a Yamada DP-25F UHP EXT F-T) were tested for trace metal extraction using a dynamic extraction test method in 35% HCl. The surface contamination extracted from all elements was 0.4, 0.8, 2.6, 4.1, and 9.3 µg for the BPS-1, BPS-3, BPS-4, Mega 960D, and DP-25F pumps, respectively.   Iron and copper were among the three highest surface contaminants in all five tests. The mass extraction rates were calculated to be 0.06, 0.05, 0.12,

0.10, and 0.12 μg/day at 7 days for the BPS-1, BPS-3, BPS-4, Mega 960D, and DP-25F pumps, respectively. The total bulk contamination from all elements extracted during the tests was 1.1, 0.9, 1.6, 4.3, and 3.3 μg for the BPS-1, BPS-3, BPS-4, Mega 960D, and DP-25F pumps, respectively.

References

Grant D.C., T. Lemke, G. Duepner, D. Wilkes, and N. Powell (1996). "Measurement of Inorganic Contaminant Extraction from Fluid Handling Components by Dynamic Extraction," *Journal of the Institute of Environmental Sciences* 39(2):29-37.

Appendix A

Dynamic Extraction Study - Test Results and Data Analysis
Test Material: Levitronix BPS-1   Serial Numbers:
Model No:

Leachate Type: 34-37% HCl
Initial Fill Volume: 1.666 liters
Sample+Rinse Volume 0:   0.205 liters
Sample+Rinse Volume 1:   0.171 liters
Sample+Rinse Volume 2:   0.182 liters
Sample+Rinse Volume 3:   0.187 liters
Sample+Rinse Volume 4:   0.203 liters

Date		10/30/07	10/30/07	10/30/07	11/01/07	11/13/07										
Time		7:55	8:35	9:59	15:48	9:23	10:25			Cumulative Metal Extraction (ug)					
Time	Detection														% of
(hours)	Limit	Control	0.00	1.40	7.22	48.80	337.83		Day>>>	0.058	0.301	2.033	14.076		Total	Total
										% of					
			Concentration (ppb)						Surface	Surface		Extracted			
Ag	0.1	0.1	0.1	0.1	0.1	0.1	0.1	Ag	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Al	0.05	0.34	0.35	0.35	0.4	0.42	0.71	Al	0.01	1.9%	0.01	0.06	0.08	0.29	25.6%	0.30	19.6%
As	0.1	0.1	0.1	0.1	0.1	0.1	0.1	As	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Au	0.1	0.1	0.1	0.1	0.1	0.1	0.1	Au	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
B	0.05	0.35	0.35	0.35	0.34	0.37	0.39	B	0.00	0.0%	0.00	-0.01	0.02	0.03	2.7%	0.03	2.1%
Ba	0.001	0.006	0.006	0.005	0.006	0.007	0.009	Ba	0.00	0.0%	0.00	0.00	0.00	0.00	0.2%	0.00	0.1%
Be	0.01	0.01	0.01	0.01	0.01	0.01	0.01	Be	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Bi	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Bi	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Ca	0.05	0.23	0.22	0.22	0.22	0.26	0.45	Ca*	-0.01	-3.9%	0.00	0.00	0.04	0.17	15.4%	0.16	10.5%
Cd	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Cd	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Co	0.001	0.001	0.002	0.002	0.002	0.003	0.003	Co	0.00	0.4%	0.00	0.00	0.00	0.00	0.1%	0.00	0.2%
Cr	0.02	0.02	0.02	0.02	0.02	0.06	0.05	Cr	0.00	0.0%	0.00	0.00	0.04	0.03	2.6%	0.03	2.0%
Cs	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Cs	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Cu	0.01	0.08	0.17	0.19	0.21	0.26	0.27	Cu	0.13	34.7%	0.03	0.05	0.09	0.10	9.0%	0.23	15.5%
Fe	0.05	0.27	0.39	0.43	0.44	0.6	0.66	Fe	0.18	46.3%	0.05	0.06	0.21	0.25	22.5%	0.43	28.5%
Ga	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Ga	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
In	0.001	0.001	0.001	0.001	0.001	0.001	0.001	In	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
K	0.05	0.05	0.05	0.05	0.05	0.09	0.1	K*	0.00	0.0%	0.00	0.00	0.04	0.04	3.9%	0.04	2.9%
Li	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Li	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Mg	0.005	0.02	0.025	0.025	0.03	0.035	0.05	Mg	0.01	1.9%	0.00	0.01	0.01	0.02	1.9%	0.03	1.9%
Mn	0.001	0.021	0.019	0.022	0.021	0.018	0.024	Mn	0.00	-0.8%	0.00	0.00	0.00	0.00	0.4%	0.00	0.1%
Mo	0.005	0.005	0.005	0.005	0.005	0.005	0.005	Mo	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Na	0.01	0.06	0.07	0.06	0.06	0.09	0.13	Na	0.01	3.9%	-0.01	-0.01	0.01	0.04	3.9%	0.06	3.9%
Nb	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Nb	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Ni	0.01	0.01	0.04	0.04	0.04	0.06	0.15	Ni	0.04	11.6%	0.00	0.00	0.02	0.08	7.4%	0.13	8.4%
Pb	0.001	0.005	0.015	0.019	0.02	0.024	0.029	Pb	0.01	3.9%	0.01	0.01	0.01	0.01	1.2%	0.03	1.9%
Rb	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Rb	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Re	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Re	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Sn	0.01	0.01	0.01	0.01	0.01	0.01	0.01	Sn	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Sr	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Sr	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Ti	0.01	0.01	0.01	0.01	0.01	0.02	0.03	Ti	0.00	0.0%	0.00	0.00	0.01	0.02	1.5%	0.02	1.1%
Tl	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Tl	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
U	0.001	0.001	0.001	0.001	0.001	0.001	0.001	U	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
V	0.01	0.01	0.01	0.01	0.01	0.01	0.01	V	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
W	0.01	0.01	0.01	0.01	0.01	0.01	0.01	W	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Zn	0.03	0.03	0.03	0.03	0.03	0.03	0.06	Zn	0.00	0.0%	0.00	0.00	0.00	0.02	1.9%	0.02	1.4%
Zr	0.001	0.001	0.001	0.001	0.001	0.002	0.001	Zr	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
								Total	**0.38**		**0.08**	**0.16**	**0.58**	**1.13**		**1.50**	

					Extraction Rates (ug/day)	
					Day	
B0(=log K	-0.482		K =	0.32961	1	0.165
B1(=n)	0.502		N=	0.502	7	0.063
			N-1 =	-0.498	14	0.044

Dynamic Extraction Study - Test Results and Data Analysis

Test Material: Levitronix BPS-3   Serial Numbers:

Model No:

Leachate Type: 34-37% HCl

Initial Fill Volume:	2.035	liters
Sample+Rinse Volume 0:	0.159	liters
Sample+Rinse Volume 1:	0.170	liters
Sample+Rinse Volume 2:	0.178	liters
Sample+Rinse Volume 3:	0.188	liters
Sample+Rinse Volume 4:	0.197	liters

Date		10/09/07	10/09/07	10/09/07	10/09/07	10/11/07	10/23/07					Cumulative Metal Extraction (ug)					
Time		8:13	8:52	10:13	16:09	7:55	8:30										% of
Time (hours)	Detection Limit	Control	0.00	1.35	7.28	47.05	335.63	Day>>>		0.056	0.303	1.960	13.985		Total	Total
				Concentration (ppb)					% of			Extracted				
									Surface							
									Surface							
Ag	0.1	0.1	0.1	0.1	0.1	0.1	0.1	Ag	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Al	0.05	0.37	0.4	0.4	0.42	0.44	0.46	Al	0.06	6.8%	0.00	0.03	0.06	0.08	8.8%	0.14	7.9%
As	0.1	0.1	0.1	0.1	0.1	0.1	0.1	As	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Au	0.1	0.1	0.1	0.1	0.1	0.1	0.1	Au	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
B	0.05	0.12	0.12	0.13	0.13	0.15	0.17	B	0.00	0.0%	0.02	0.02	0.04	0.07	7.4%	0.07	3.9%
Ba	0.001	0.002	0.002	0.003	0.003	0.004	0.004	Ba	0.00	0.0%	0.00	0.00	0.00	0.00	0.3%	0.00	0.2%
Be	0.01	0.01	0.01	0.01	0.01	0.01	0.01	Be	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Bi	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Bi	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Ca	0.05	0.28	0.28	0.27	0.27	0.26	0.31	Ca*	-0.01	-1.1%	-0.01	-0.02	-0.02	0.03	3.8%	0.02	1.4%
Cd	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Cd	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Co	0.001	0.001	0.002	0.002	0.001	0.002	0.004	Co	0.00	0.2%	0.00	0.00	0.00	0.00	0.2%	0.00	0.2%
Cr	0.02	0.03	0.04	0.04	0.04	0.05	0.07	Cr	0.02	2.3%	0.00	0.00	0.01	0.04	4.0%	0.06	3.2%
Cs	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Cs	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Cu	0.01	0.09	0.34	0.34	0.39	0.4	0.44	Cu	0.47	56.8%	0.00	0.08	0.09	0.14	14.9%	0.60	34.9%
Fe	0.05	0.45	0.57	0.57	0.64	0.68	0.7	Fe	0.23	27.3%	0.00	0.11	0.16	0.18	20.2%	0.41	23.6%
Ga	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Ga	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
In	0.001	0.001	0.001	0.001	0.001	0.001	0.001	In	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
K	0.05	0.05	0.05	0.05	0.05	0.1	0.1	K*	0.00	0.0%	0.00	0.00	0.07	0.07	7.4%	0.07	3.9%
Li	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Li	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Mg	0.005	0.02	0.02	0.02	0.03	0.04	0.03	Mg	0.00	0.0%	0.00	0.02	0.03	0.02	1.9%	0.02	1.0%
Mn	0.001	0.023	0.021	0.024	0.019	0.021	0.022	Mn	0.00	-0.5%	0.01	0.00	0.00	0.00	0.1%	0.00	-0.1%
Mo	0.005	0.005	0.005	0.005	0.005	0.005	0.005	Mo	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Na	0.01	0.09	0.08	0.07	0.11	0.14	0.17	Na	-0.02	-2.3%	-0.02	0.04	0.08	0.12	13.1%	0.10	5.8%
Nb	0.001	0.001	0.001	0.001	0.001	0.003	0.003	Nb	0.00	0.0%	0.00	0.00	0.00	0.00	0.3%	0.00	0.2%
Ni	0.01	0.03	0.04	0.08	0.06	0.07	0.07	Ni	0.02	2.3%	0.07	0.04	0.05	0.05	5.6%	0.07	4.0%
Pb	0.001	0.008	0.044	0.05	0.046	0.059	0.053	Pb	0.07	8.2%	0.01	0.00	0.02	0.01	1.6%	0.08	4.7%
Rb	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Rb	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Re	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Re	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Sn	0.01	0.01	0.01	0.01	0.01	0.01	0.01	Sn	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Sr	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Sr	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Ti	0.01	0.01	0.01	0.01	0.01	0.01	0.02	Ti	0.00	0.0%	0.00	0.00	0.00	0.01	1.3%	0.01	0.7%
Tl	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Tl	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
U	0.001	0.001	0.001	0.001	0.001	0.001	0.001	U	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
V	0.01	0.01	0.01	0.01	0.01	0.01	0.01	V	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
W	0.01	0.01	0.01	0.01	0.01	0.01	0.01	W	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Zn	0.03	0.03	0.03	0.04	0.09	0.08	0.08	Zn	0.00	0.0%	0.02	0.09	0.08	0.08	8.8%	0.08	4.6%
Zr	0.001	0.001	0.001	0.001	0.001	0.001	0.002	Zr	0.00	0.0%	0.00	0.00	0.00	0.00	0.1%	0.00	0.1%
								Total	0.83		0.09	0.41	0.68	0.91		1.73	

				Extraction Rates (ug/day)
				Day
B0(=log K	-0.374	K =	0.42228	1 0.165
B1(=n)	0.392	N=	0.3917	7 0.051
		N-1 =	-0.6083	14 0.033

Dynamic Extraction Study - Test Results and Data Analysis
Test Material: Levitronix BPS-4   Serial Numbers:
Model No:

Leachate Type: 34-37% HCl
Initial Fill Volume: 1.955 liters
Sample+Rinse Volume 0: 0.238 liters
Sample+Rinse Volume 1: 0.175 liters
Sample+Rinse Volume 2: 0.159 liters
Sample+Rinse Volume 3: 0.185 liters
Sample+Rinse Volume 4: 0.217 liters

Date		10/09/07	10/09/07	10/09/07	10/09/07	10/11/07	10/23/07				Cumulative Metal Extraction (ug)						
Time		8:03	8:43	10:02	16:03	7:50	8:22										% of
Time (hours)	Detection Limit	Control	0.00	1.32	7.33	47.12	335.65	Day>>>			0.055	0.306	1.963	13.985		Total	Total
										% of Surface			Extracted				
				Concentration (ppb)					Surface	Surface							
Ag	0.1	0.1	0.1	0.1	0.1	0.1	0.1	Ag	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Al	0.05	0.39	0.43	0.4	0.37	0.42	0.43	Al	0.07	2.6%	-0.05	-0.09	-0.03	-0.02	-1.1%	0.05	1.2%
As	0.1	0.1	0.1	0.1	0.1	0.1	0.1	As	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Au	0.1	0.1	0.1	0.1	0.1	0.1	0.1	Au	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
B	0.05	0.24	0.23	0.24	0.21	0.23	0.24	B	-0.02	-0.7%	0.02	-0.03	0.00	0.01	0.5%	-0.01	-0.2%
Ba	0.001	0.004	0.005	0.004	0.004	0.006	0.007	Ba	0.00	0.1%	0.00	0.00	0.00	0.00	0.1%	0.00	0.1%
Be	0.01	0.01	0.01	0.01	0.01	0.01	0.01	Be	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Bi	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Bi	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Ca	0.05	0.22	0.32	0.3	0.3	0.36	0.33	Ca*	0.17	6.6%	-0.03	-0.03	0.04	0.01	0.7%	0.18	4.4%
Cd	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Cd	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Co	0.001	0.001	0.001	0.001	0.002	0.18	0.002	Co	0.00	0.0%	0.00	0.00	0.21	0.04	2.5%	0.04	1.0%
Cr	0.02	0.02	0.04	0.03	0.05	0.05	0.06	Cr	0.03	1.3%	-0.02	0.01	0.01	0.02	1.4%	0.06	1.3%
Cs	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Cs	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Cu	0.01	0.07	0.8	0.92	1	1.3	1.3	Cu	1.25	48.1%	0.19	0.30	0.66	0.66	41.4%	1.91	45.6%
Fe	0.05	0.25	0.53	0.53	0.55	0.68	0.74	Fe	0.48	18.4%	0.00	0.03	0.18	0.24	15.3%	0.72	17.3%
Ga	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Ga	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
In	0.001	0.001	0.001	0.001	0.001	0.001	0.001	In	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
K	0.05	0.05	0.07	0.06	0.13	0.21	0.21	K*	0.03	1.3%	-0.02	0.08	0.18	0.18	11.2%	0.21	5.0%
Li	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Li	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Mg	0.005	0.02	0.03	0.03	0.03	0.04	0.05	Mg	0.02	0.7%	0.00	0.00	0.01	0.02	1.4%	0.04	0.9%
Mn	0.001	0.016	0.014	0.013	0.014	0.016	0.017	Mn	0.00	-0.1%	0.00	0.00	0.00	0.00	0.2%	0.00	0.1%
Mo	0.005	0.005	0.005	0.005	0.005	0.005	0.005	Mo	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Na	0.01	0.06	0.08	0.07	0.09	0.13	0.15	Na	0.03	1.3%	-0.02	0.01	0.06	0.08	5.0%	0.11	2.7%
Nb	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Nb	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Ni	0.01	0.01	0.04	0.03	0.04	0.05	0.07	Ni	0.05	2.0%	-0.02	0.00	0.01	0.03	1.9%	0.08	1.9%
Pb	0.001	0.005	0.28	0.31	0.33	0.35	0.37	Pb	0.47	18.1%	0.05	0.07	0.10	0.12	7.4%	0.59	14.1%
Rb	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Rb	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Re	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Re	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Sn	0.01	0.01	0.01	0.01	0.01	0.01	0.01	Sn	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Sr	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Sr	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Ti	0.01	0.01	0.01	0.01	0.01	0.01	0.01	Ti	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Tl	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Tl	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
U	0.001	0.001	0.001	0.001	0.001	0.001	0.001	U	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
V	0.01	0.01	0.01	0.01	0.01	0.01	0.01	V	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
W	0.01	0.01	0.01	0.01	0.01	0.01	0.01	W	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Zn	0.03	0.03	0.035	0.04	0.04	0.11	0.21	Zn	0.01	0.3%	0.01	0.01	0.09	0.19	12.0%	0.20	4.7%
Zr	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Zr	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
								Total	**2.61**		**0.11**	**0.36**	**1.53**	**1.58**		**4.19**	

			Extraction Rates (ug/day)	
			Day	
B0(=log K)	-0.208	K =	0.619013	1	0.311
B1(=n)	0.502	N=	0.5017	7	0.118
		N-1 =	-0.4983	14	0.083

Dynamic Extraction Study - Test Results and Data Analysis

Test Material: Trebor Mega 960D   Serial Numbers:
Model No:

Leachate Type: 34-37% HCl
Initial Fill Volume: 3.369 liters
Sample+Rinse Volume 0: 0.167 liters
Sample+Rinse Volume 1: 0.177 liters
Sample+Rinse Volume 2: 0.199 liters
Sample+Rinse Volume 3: 0.441 liters
Sample+Rinse Volume 4: 0.214 liters

Date		09/18/07	09/18/07	09/18/07	09/18/07	09/20/07	10/02/07									
Time		8:22	9:03	10:27	16:14	10:25	9:40		Cumulative Metal Extraction (ug)							
Time (hours)	Detection Limit	Control	0.00	1.40	7.18	49.37	336.62	Day>>>	Surface	% of Surface	0.058	0.299	2.057	14.026	Total	% of Total
			Concentration (ppb)									Extracted				
Ag	0.1	0.1	0.1	0.1	0.1	0.1	0.1	Ag	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
Al	0.05	0.28	0.33	0.38	0.33	0.43	0.47	Al	0.17	4.1%	0.16	0.01	0.24	0.33 7.6%	0.50	5.9%
As	0.05	0.05	0.05	0.05	0.05	0.05	0.05	As	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
Au	0.1	0.1	0.1	0.1	0.1	0.1	0.1	Au	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
B	0.05	0.24	0.28	0.35	0.30	0.34	0.34	B	0.12	3.0%	0.22	0.08	0.18	0.17 4.0%	0.29	3.5%
Ba	0.001	0.003	0.003	0.004	0.004	0.006	0.009	Ba	0.00	0.0%	0.00	0.00	0.01	0.01 0.3%	0.01	0.2%
Be	0.01	0.01	0.01	0.01	0.01	0.01	0.01	Be	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
Bi	0.001	0.001	0.001	0.002	0.001	0.002	0.002	Bi	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
Ca	0.05	0.17	0.21	0.27	0.22	0.28	0.34	Ca*	0.10	2.6%	0.18	0.06	0.20	0.32 7.5%	0.43	5.1%
Cd	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Cd	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
Co	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Co	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
Cr	0.02	0.03	0.03	0.04	0.04	0.05	0.07	Cr	0.01	0.2%	0.04	0.02	0.05	0.09 2.1%	0.10	1.2%
Cs	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Cs	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
Cu	0.01	0.08	0.67	0.90	0.77	1.17	1.28	Cu	1.89	46.1%	0.69	0.31	1.28	1.51 35.0%	3.41	40.4%
Fe	0.05	0.37	0.70	0.85	0.74	1.02	1.10	Fe	1.05	25.6%	0.45	0.14	0.82	0.98 22.7%	2.03	24.1%
Ga	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Ga	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
In	0.001	0.001	0.001	0.001	0.001	0.001	0.001	In	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
K	0.05	0.05	0.05	0.06	0.05	0.05	0.08	K*	0.00	0.0%	0.03	0.00	0.00	0.06 1.5%	0.06	0.7%
Li	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Li	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
Mg	0.005	0.02	0.03	0.03	0.03	0.03	0.04	Mg	0.02	0.6%	0.01	0.00	0.02	0.03 0.8%	0.06	0.7%
Mn	0.001	0.02	0.03	0.03	0.02	0.03	0.03	Mn	0.03	0.7%	0.00	-0.01	0.00	0.00 0.0%	0.03	0.4%
Mo	0.005	0.005	0.005	0.005	0.005	0.005	0.005	Mo	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
Na	0.01	0.04	0.05	0.08	0.07	0.07	0.12	Na	0.03	0.7%	0.10	0.08	0.08	0.17 4.0%	0.20	2.4%
Nb	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Nb	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
Ni	0.01	0.01	0.02	0.03	0.03	0.05	0.08	Ni	0.03	0.6%	0.03	0.02	0.07	0.13 3.0%	0.16	1.9%
Pb	0.001	0.01	0.13	0.16	0.15	0.20	0.20	Pb	0.38	9.3%	0.09	0.06	0.19	0.19 4.3%	0.57	6.8%
Rb	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Rb	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
Re	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Re	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
Sn	0.01	0.01	0.01	0.01	0.01	0.01	0.01	Sn	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
Sr	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Sr	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
Ti	0.01	0.01	0.02	0.03	0.03	0.04	0.06	Ti	0.04	1.0%	0.03	0.02	0.05	0.08 1.8%	0.12	1.4%
Tl	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Tl	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
U	0.001	0.001	0.001	0.001	0.001	0.001	0.001	U	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
V	0.01	0.01	0.01	0.01	0.01	0.01	0.01	V	0.00	0.0%	0.00	0.00	0.00	0.00 0.0%	0.00	0.0%
W	0.01	0.01	0.01	0.02	0.01	0.02	0.02	W	0.00	0.0%	0.02	0.00	0.02	0.02 0.5%	0.02	0.3%
Zn	0.03	0.03	0.10	0.11	0.11	0.16	0.18	Zn	0.22	5.4%	0.02	0.02	0.16	0.20 4.7%	0.42	5.0%
Zr	0.001	0.001	0.001	0.002	0.001	0.003	0.003	Zr	0.00	0.0%	0.00	0.00	0.00	0.00 0.1%	0.01	0.1%
								Total	4.11		2.06	0.82	3.39	4.32	8.43	

B0(=log K)	0.363	K = 2.306747
B1(=n)	0.206	N= 0.206
		N-1 = -0.794

Extraction Rates (ug/day)

Day	
1	0.475
7	0.101
14	0.058

Dynamic Extraction Study - Test Results and Data Analysis
Test Material: Yamada DP-25F   Serial Numbers:
Model No:

Leachate Type: 34-37% HCl
Initial Fill Volume: 3.487 liters
Sample+Rinse Volume 0: 0.156 liters
Sample+Rinse Volume 1: 0.185 liters
Sample+Rinse Volume 2: 0.192 liters
Sample+Rinse Volume 3: 0.162 liters
Sample+Rinse Volume 4: 0.181 liters

Date		09/18/07	09/18/07	09/18/07	09/18/07	09/20/07	10/02/07									
Time		8:34	9:14	10:38	16:21	10:30	9:45		Cumulative Metal Extraction (ug)							
Time (hours)	Detection Limit	Control	0.00	1.40	7.12	49.27	336.52	Day>>>		0.058	0.297	2.053	14.022		Total	% of Total
									% of Surface							
			Concentration (ppb)						Surface			Extracted				
Ag	0.1	0.1	0.1	0.1	0.1	0.1	0.1	Ag	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Al	0.05	0.30	0.37	0.38	0.43	0.41	0.39	Al	0.25	2.6%	0.03	0.19	0.12	0.08	2.4%	0.32	2.6%
As	0.05	0.05	0.05	0.05	0.05	0.05	0.05	As	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Au	0.1	0.1	0.1	0.1	0.1	0.1	0.1	Au	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
B	0.05	0.18	0.24	0.26	0.28	0.24	0.24	B	0.18	1.9%	0.07	0.13	0.02	0.02	0.6%	0.20	1.6%
Ba	0.001	0.001	0.010	0.010	0.011	0.011	0.015	Ba	0.03	0.3%	0.00	0.00	0.01	0.01	0.4%	0.04	0.3%
Be	0.01	0.01	0.01	0.01	0.01	0.01	0.01	Be	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Bi	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Bi	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Ca	0.05	0.14	1.15	1.16	1.31	1.29	1.31	Ca*	3.37	36.4%	0.04	0.47	0.42	0.46	14.2%	3.83	30.6%
Cd	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Cd	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Co	0.001	0.001	0.002	0.002	0.002	0.002	0.01	Co	0.00	0.0%	0.00	0.00	0.00	0.01	0.3%	0.01	0.1%
Cr	0.02	0.02	0.03	0.04	0.04	0.04	0.06	Cr	0.03	0.3%	0.03	0.02	0.02	0.08	2.4%	0.11	0.9%
Cs	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Cs	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Cu	0.01	0.11	0.40	0.39	0.48	0.52	0.63	Cu	0.98	10.6%	-0.01	0.24	0.34	0.64	19.6%	1.62	12.9%
Fe	0.05	0.45	1.25	1.32	1.45	1.45	1.68	Fe	2.67	28.8%	0.21	0.59	0.60	1.19	36.6%	3.86	30.9%
Ga	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Ga	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
In	0.001	0.001	0.001	0.001	0.001	0.001	0.001	In	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
K	0.05	0.05	0.05	0.05	0.05	0.07	0.09	K*	0.00	0.0%	0.00	0.00	0.06	0.10	3.0%	0.10	0.8%
Li	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Li	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Mg	0.005	0.02	0.27	0.28	0.33	0.32	0.36	Mg	0.83	9.0%	0.06	0.19	0.16	0.26	7.8%	1.09	8.7%
Mn	0.001	0.02	0.02	0.03	0.03	0.03	0.03	Mn	0.02	0.2%	0.00	0.01	0.01	0.02	0.6%	0.04	0.3%
Mo	0.005	0.005	0.005	0.005	0.005	0.005	0.005	Mo	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Na	0.01	0.05	0.14	0.15	0.17	0.16	0.20	Na	0.33	3.6%	0.00	0.09	0.04	0.15	4.5%	0.48	3.8%
Nb	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Nb	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Ni	0.01	0.01	0.02	0.01	0.02	0.02	0.02	Ni	0.02	0.2%	-0.01	0.01	0.01	0.02	0.6%	0.04	0.3%
Pb	0.001	0.01	0.08	0.08	0.09	0.10	0.11	Pb	0.23	2.5%	0.01	0.04	0.05	0.08	2.4%	0.31	2.5%
Rb	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Rb	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Re	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Re	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
Sn	0.01	0.01	0.01	0.01	0.01	0.01	0.02	Sn	0.00	0.0%	0.00	0.00	0.00	0.02	0.6%	0.02	0.2%
Sr	0.001	0.001	0.01	0.01	0.01	0.01	0.01	Sr	0.02	0.2%	0.00	0.00	0.00	0.00	0.1%	0.02	0.2%
Ti	0.01	0.01	0.03	0.03	0.04	0.03	0.04	Ti	0.06	0.6%	0.02	0.02	0.02	0.04	1.1%	0.10	0.8%
Tl	0.001	0.001	0.001	0.001	0.001	0.001	0.001	Tl	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
U	0.001	0.001	0.001	0.001	0.001	0.001	0.001	U	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
V	0.01	0.01	0.01	0.01	0.01	0.01	0.01	V	0.00	0.0%	0.00	0.00	0.00	0.00	0.0%	0.00	0.0%
W	0.01	0.01	0.03	0.04	0.04	0.03	0.05	W	0.08	0.8%	0.02	0.02	-0.01	0.04	1.4%	0.12	1.0%
Zn	0.03	0.03	0.08	0.10	0.08	0.10	0.10	Zn	0.18	1.9%	0.04	0.00	0.04	0.04	1.3%	0.22	1.7%
Zr	0.001	0.001	0.001	0.001	0.002	0.002	0.002	Zr	0.00	0.0%	0.00	0.00	0.00	0.00	0.1%	0.00	0.0%
								Total	**9.26**		**0.52**	**2.03**	**1.93**	**3.26**		**12.52**	

Extraction Rates (ug/day)

				Day	
B0(=log K)	0.227	K =	1.686553	1	0.492
B1(=n)	0.292	N=	0.292	7	0.124
		N-1 =	-0.708	14	0.076