



STEVEN A. THOMPSON
Executive Director

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

BRAD HENRY
Governor

August 30, 2004

Ursula Lennox (6SF-LL)
US EPA – Region VI
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Re: Long Term Monitoring at Tar Creek, a part of After Action Monitoring

Dear Ursula:

Please find the analytical results for the 2nd round of samples of the Long Term Monitoring (LTM) project at Tar Creek for the Roubidoux aquifer. The samples were collected in April 2004. The report and table of results are attached for your review. A map with the well locations (Figure 1) is also included.

Please take a look at these data and let me know if you have any comments. Thank you for your attention to this matter. If you have any questions please call me at (405) 702-5124.

Sincerely,

A handwritten signature in black ink that reads "David A. Cates". The signature is written in a cursive style with a long horizontal stroke at the end.

David A. Cates, P.E.
Project Manager
Land Protection Division

Long Term Monitoring Report (Second Round of Semi-annual Roubidoux Samples)
August 2004

Introduction:

The second round of samples of the Long Term Monitoring (LTM) project at Tar Creek for the Roubidoux aquifer were collected in April 2004. The analytical results are shown in Table 1. The first round results for the ten original LTM wells and the baseline samples from the Fernandez well are included in the table. A map with the well locations (Figure 1) is also included.

The primary and secondary MCLs are identified in the header of the table for data comparison. Also, the tolerance limits and Roubidoux background concentrations for the indicator parameters of mine water contamination (**sulfate**: 82 mg/l & 25 mg/l; **iron**: 207 ug/l & 61.5 ug/l; and **zinc**: 43 ug/l & 8.8 ug/l, respectively) are provided in the footnotes. These parameters and their values were determined in Phase I of After Action Monitoring (AAM) of the Roubidoux at Tar Creek and are included in the Phase II AAM report "Summary of Roubidoux Water Quality Tests" (September, 2002).

QA/QC: Blanks, RPD, Cation-Anion Balance:

A change in detection limits should be noted in these second round analytical results. This is a result of the State Environmental Laboratory (SEL) employing a different analytical method for a few metals due to equipment problems. The reporting limits (<0.010 ug/l) for antimony and thallium are greater than the MCLs for these chemicals (6 ug/l and 2 ug/l, respectively). This should not be a problem, however since these chemicals have never been detected above 2 ug/l and 1 ug/l, respectively in previous sampling events. The original analytical method will be run for the next sampling event in October provided the laboratory equipment is repaired.

A small zinc concentration of 21 ug/l was detected in the April 29th field filtered blank. The only well sampled that day was the Fernandez well and the concentrations of dissolved zinc for the sample and duplicate were 89 ug/l and 37 ug/l, respectively. The total zinc concentrations were 299 ug/l and 228 ug/l, respectively.

For the three duplicates taken this round of sampling, the relative percent difference (RPD) calculations showed mostly less than 20 percent difference between the duplicate concentrations and the respective sample concentrations. The total and dissolved zinc, total dissolved solids, and hardness concentrations at the Fernandez well, and total iron concentrations at the Commerce #5 well were the only exceedances of the 20 percent value. The wellhead samples from the Fernandez well are collected at a faucet in the water line exiting a pressure vessel that controls the activation of the downhole pump. The intermittent activation of the well pump by the pressure vessel during purging and sampling, as well as the location of the sampling port after the pressure vessel, may be sources of the sampling error indicated by the RPD values greater than 20 percent at this well.

Cation-anion balance calculations were good (< 10 %) for all samples except for the duplicate at the Fernandez well that calculated to be -14.66 per cent. This is borderline in terms of indicating a sample analysis problem.

Results:

The Commerce #5, the Quapaw #4, and the Rural Water District #4 (Bluehole well) have the best water quality, with specific conductance (SC) values less than 300 uS/cm, and total dissolved solids (TDS) concentrations less than 200 mg/l. The concentrations of the indicator parameters of mine water contamination (sulfate, iron and zinc) are below tolerance limits and are at or below background concentrations in these wells and at the Miami #1 well with the exception of total iron.

Secondary standards were violated in the Picher #5, Picher #6, Quapaw #5, Miami #1, and the Fernandez wells. The total iron concentration at the Miami #1 well is 1,130 ug/l while the dissolved iron (filtered sample) tested only 42 ug/l. As mentioned above, the dissolved iron concentration is below the tolerance limit and Roubidoux background concentration. A similar difference in filtered and unfiltered iron concentrations occurred at this well in the previous sampling event and possibly indicates that rust particles from the steel pipe in the well are affecting the non-filtered water samples.

Lead concentrations were detected again at the Fernandez well. The total lead concentration of 12 ug/l is less than the MCL. All other samples were less than reporting limits for lead concentrations.

Tests of the Quapaw #5 well continue to show that the Roubidoux water near this well is of very poor quality, exceeding secondary standards for iron, manganese, total dissolved solids (TDS), and sulfate. The iron, manganese, TDS, and sulfate concentrations observed are 3,700 ug/l, 50 ug/l, 1,083 mg/l and 455 mg/l, respectively. The manganese concentration (50 ug/l) is at the standard of 50 ug/l. Concentrations for all three of the indicator parameters (455 mg/l, 3,680 ug/l and 208 ug/l, respectively for sulfate, iron and zinc) are greater than tolerance limits at this well. This indicates the Roubidoux is impacted locally by mine water near this well. Although the water is considered treatable, this well and the Picher #6 well are not hooked up to any public water systems.

Concentrations greater than tolerance limits for two of three indicator parameters were observed at the Picher #5 and Picher #6 wells. Specifically, the iron and sulfate concentrations exceeded tolerance limits, but the zinc concentrations did not. The sulfate concentrations were 126 and 156 mg/l for the Picher #5 and 6 wells, respectively. The iron concentrations were 433 and 444 ug/l, respectively.

The higher than normal iron concentrations at the Picher #5 coupled with the low water yield measured at the time of sampling suggested there may be a hole in the production pipe that allows some of the water to circulate out of the pipe, down the casing, into the water column, and back into the pipe through the downhole pump. This re-circulating process allows iron (i.e., rust) from the casing and the outside of the production pipe to enter the produced water. A few days after sampling, the well was taken out of service to pull the downhole equipment as a result of the low water production from the well. Several 'washouts' (i.e., holes) were discovered at the pipe connections and repaired. Then the well was placed back in service. The iron concentrations at the Picher #5 are expected to be less for the next sampling round.

The Picher #6 continues to show improved water quality compared to the first samples collected just after the well was completed. For the next sampling event, the well will be purged for about a week prior to sample collection to test if the initial high concentrations were related to extended well purging. This well is not hooked up to any distribution system and is not used as a public water supply well.

Concentrations greater than tolerance limits for one of the three indicator parameters were observed at the Picher #7 well. This is a standby well for both Picher and Cardin public water systems. The sulfate concentration of 112 mg/l exceeded the tolerance limit of 82 mg/l. Actually, all three wells in Picher had sulfate concentrations greater than the tolerance limit indicating possible impacts from mine water to the Roubidoux near Picher.

Table 1 – Analytical Results for Tar Creek Long Term Monitoring of Roubidoux Wells

Analytical Data for Tar Creek Long Term Monitoring of Roubidoux Wells

WELL	DATE	Spec Cond (Field) uS/cm	Temp (Field) °C	pH (Field)	D.O. mg/l	Alk (Field) CaCO ₃ mg/l	Alkalinity CaCO ₃ mg/l	Chloride Cl mg/l	Sulfate SO ₄ mg/l	Tot Dis Sol TDS mg/l	Hardness CaCO ₃ mg/l	Calcium Ca mg/l	Magnesium Mg mg/l	Sodium Na mg/l	Potassium K mg/l
		MCL(SMCL)						(250)	(250)	(500)					
Cardin #1:		SW SE SE 19-T29N-R23E; N 36 58 23.3, W 94 51 07.2, EL 817													
11/6/03	Totals	595	17.6	6.47	n.a.	145	149	27.1	134	388	281	61	30	17	3
	Dissolved	-	-	-	-	-	-	-	-	-	-	61	30	17	3
4/27/04	Totals	334	19.6	7.43	3.48	150	138	14.5	93.3	319	231	50	24	12	3
	Dissolved	-	-	-	-	-	-	-	-	-	-	50	24	12	3
	Averages	465	18.6	6.95	3.48	148	144	20.8	113.7	354	256	56	27	15	3
Commerce #4:		NW NE NW 6-T28N-R23E; N 36 56 31.9, W 94 52 21.1, EL 812													
11/6/03	Totals	615	17.9	6.42	n.a.	153	150	37.9	119	383	260	61	26	28	3
	Dissolved	-	-	-	-	-	-	-	-	-	-	57	25	27	3
4/27/04	Totals	403	18.7	7.75	3.39	218	144	59.5	107	409	252	54	24	35	3
	Dissolved	-	-	-	-	-	-	-	-	-	-	56	25	35	3
	Averages	509	18.3	7.09	3.39	186	147	48.7	113.0	396	256	57	25	31	3
Commerce #5 MW:		NW SE NW 6-T28N-R23E; N 36 56 19.4, W 94 52 17.9, EL 812													
11/6/03	Totals	294	17.7	7.29	n.a.	108	112	15.6	12	155	127	26	13	11	2
	Dissolved	-	-	-	-	-	-	-	-	-	-	26	13	11	2
4/27/04	Totals	252	18.9	7.82	5.75	158	111	< 10	11.8	158	122	25	13	8	2
	Dissolved	-	-	-	-	-	-	-	-	-	-	25	13	8	2
* 4/27/04	Totals	252	18.9	7.82	5.75	158	111	< 10	11.8	158	123	25	13	8	2
	Dissolved	-	-	-	-	-	-	-	-	-	-	26	13	8	2
	Averages	266	18.5	7.64	5.75	141	111	11.9	11.9	157	124	26	13	9	2
Fernandez Well:		SE NW NW 24-T29N-R23E; N 36 59 04.7, W 94 46 20.3, EL 852													
7/30/03	Dis Met	370	18.2	8.19	n.a.	na	145.0	11.1	126.0	368	na	60	29	8	2
10/6/03	Totals	257	18.3	7.08	n.a.	130	98.9	< 10.0	14.0	148	124	26	14	5	2
	Dissolved	-	-	-	-	-	-	-	-	-	-	26	14	5	2
* 10/6/03	Totals	257	18.3	7.08	n.a.	130	98.6	< 10.0	16.4	132	126	26	14	5	2
	Dissolved	-	-	-	-	-	-	-	-	-	-	26	14	5	2
11/4/03	Totals	252	17.1	7.83	n.a.	115	114.0	< 10.0	16.4	138	126	27	14	5	2
	Dissolved	-	-	-	-	-	-	-	-	-	-	27	14	5	2
12/19/03	Totals	415	14.8	6.64	n.a.	125	147.0	< 10.0	85.5	274	213	46	23	8	2
	Dissolved	-	-	-	-	-	-	-	-	-	-	46	24	8	2
4/29/04	Totals	427	17.3	7.5	2.27	134	128	< 10.0	56.3	233	185	43	22	7	2
	Dissolved	-	-	-	-	-	-	-	-	-	-	28	15	6	2
* 4/29/04	Totals	427	17.3	7.5	2.27	134	144	< 10.0	103	328	236	39	20	7	2
	Dissolved	-	-	-	-	-	-	-	-	-	-	28	15	6	2
	Averages	344	17	7.40	2.27	128	125.1	10.2	59.7	232	168	34	18	6	2
Miami #1:		SW NE SW 30-T28N-R23E; N 35 52 30.9, W 94 52 23.4; EL 790													
11/4/03	Totals	500	15.7	7.15	n.a.	na	117.0	83.6	12.4	262	133	30	15	50	3
	Dissolved	-	-	-	-	-	-	-	-	-	-	30	15	50	3
* 11/4/03	Totals	500	15.7	7.15	n.a.	na	116.0	84.5	12.5	264	135	29	14	49	3
	Dissolved	-	-	-	-	-	-	-	-	-	-	30	15	50	3
4/27/04	Totals	413	19.6	8.27	3.3	120	112	78.8	12.6	265	133	29	14	47	3
	Dissolved	-	-	-	-	-	-	-	-	-	-	28	14	45	2
	Averages	471	17.0	7.52	3.30	120	115	82.3	12.5	264	134	29	15	49	3
Picher #5-MW:		SE SE NE 29-T29N-R23E; N 36 57 55.6, W 94 49 54.7; GL(topo) 815.													
11/5/03	Totals	590	14	6.52	n.a.	na	140	25.6	135	381	278	61	29	18	3
	Dissolved	-	-	-	-	-	-	-	-	-	-	59	28	18	3
4/27/04	Totals	536	20.7	7.33	3.19	142	134	28.3	126	384	253	55	26	19	3
	Dissolved	-	-	-	-	-	-	-	-	-	-	55	27	18	3
	Averages	563	17.4	6.93	3.19	142	137	27.0	130.5	383	266	58	28	18	3

WELL	DATE	Antimony Sb mg/l	Arsenic As mg/l	Cadmium Cd mg/l	Chromium Cr mg/l	Iron Fe mg/l	Lead Pb mg/l	Manganese Mn mg/l	Mercury Hg mg/l	Nickel Ni mg/l	Selenium Se mg/l	Thallium Tl mg/l	Zinc Zn mg/l	CAT / AN BALANCE % Error
		0.006	0.01	0.005	0.1	(0.3)	0.015	0.05	0.002	0.1	0.05	0.002	(5)	
Cardin #1:														
	11/6/03	< 0.002	< 0.002	< 0.002	< 0.010	0.101	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	0.022	-1.58
		< 0.002	< 0.002	< 0.002	< 0.010	0.098	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	
	4/27/04	< 0.010	< 0.010	< 0.005	< 0.005	0.132	< 0.010	0.009	0.00005	< 0.010	< 0.010	< 0.010	0.033	-0.39
		< 0.010	< 0.010	< 0.005	< 0.005	0.112	< 0.010	0.009	< 0.00005	< 0.010	< 0.010	< 0.010	< 0.005	
		0.006	0.006	0.004	0.008	0.111	0.008	0.010	0.0001	0.010	0.010	0.006	0.018	-0.98
Commerce #4:														
	11/6/03	< 0.002	< 0.002	< 0.002	< 0.010	0.095	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	-0.50
		< 0.002	< 0.002	< 0.002	< 0.010	0.086	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	
	4/27/04	< 0.010	< 0.010	< 0.005	< 0.005	0.087	< 0.010	0.009	< 0.00005	< 0.010	< 0.010	< 0.010	< 0.005	-3.94
		< 0.010	< 0.010	< 0.005	< 0.005	0.085	< 0.010	0.010	< 0.00005	< 0.010	< 0.010	< 0.010	< 0.005	
		0.006	0.006	0.004	0.008	0.088	0.008	0.010	0.0001	0.010	0.010	0.006	0.008	-2.22
Commerce #5 MW:														
	11/6/03	< 0.002	< 0.002	< 0.002	< 0.010	0.080	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	-0.53
		< 0.002	< 0.002	< 0.002	< 0.010	0.048	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	0.010	
	4/27/04	< 0.010	< 0.010	< 0.005	< 0.005	0.093	< 0.010	< 0.010	0.00005	< 0.010	< 0.010	< 0.010	< 0.005	-0.53
		< 0.010	< 0.010	< 0.005	< 0.005	0.034	< 0.010	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.010	< 0.005	
	* 4/27/04	< 0.010	< 0.010	< 0.005	< 0.005	0.114	< 0.010	< 0.010	0.00005	< 0.010	< 0.010	< 0.010	< 0.005	-0.53
		< 0.010	< 0.010	< 0.005	< 0.005	0.039	< 0.010	< 0.010	0.00005	< 0.010	< 0.010	< 0.010	< 0.005	
		0.007	0.007	0.004	0.007	0.068	0.008	0.010	0.0001	0.010	0.010	0.007	0.007	-0.53
Fernandez Well:														
	7/30/03	na	na	na	na	0.410	0.056	< 0.010	na	< 0.010	na	na	0.239	-0.46
	10/6/03	< 0.002	< 0.002	< 0.002	< 0.010	0.208	0.017	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	0.050	3.20
		< 0.002	< 0.002	< 0.002	< 0.010	0.288	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	0.067	
	* 10/6/03	< 0.002	< 0.002	< 0.002	< 0.010	0.287	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	0.065	2.34
		< 0.002	< 0.002	< 0.002	< 0.010	0.224	0.008	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	0.033	
	11/4/03	< 0.002	< 0.002	< 0.002	< 0.010	0.316	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	0.083	-2.35
		< 0.002	< 0.002	< 0.002	< 0.010	0.246	0.013	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	0.070	
	12/19/03	< 0.002	< 0.002	< 0.002	< 0.010	0.319	0.026	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	0.236	-4.30
		< 0.002	< 0.002	< 0.002	< 0.010	0.464	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	0.464	
	4/29/04	< 0.010	< 0.010	< 0.005	< 0.005	0.359	< 0.010	0.006	0.00006	< 0.010	< 0.010	< 0.010	0.299	3.60
		< 0.010	< 0.010	< 0.005	< 0.005	0.238	0.012	< 0.005	< 0.00005	< 0.010	< 0.010	< 0.010	0.089	
	* 4/29/04	< 0.010	< 0.010	< 0.005	< 0.005	0.359	< 0.010	0.006	< 0.00005	< 0.010	< 0.010	< 0.010	0.228	-14.66
		< 0.010	< 0.010	< 0.005	< 0.005	0.249	< 0.010	< 0.005	< 0.00005	< 0.010	< 0.010	< 0.010	0.037	
		0.005	0.005	0.003	0.008	0.305	0.014	0.009	0.0001	0.010	0.010	0.004	0.151	-1.80
Miami #1:														
	11/4/03	< 0.002	< 0.002	< 0.002	< 0.010	0.372	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	0.010	0.29
		< 0.002	< 0.002	< 0.002	< 0.010	0.062	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	
	* 11/4/03	< 0.002	< 0.002	< 0.002	< 0.010	0.057	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	-1.58
		< 0.002	< 0.002	< 0.002	< 0.010	< 0.020	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	
	4/27/04	< 0.010	< 0.010	< 0.005	< 0.005	1.130	< 0.010	0.012	0.00005	< 0.010	< 0.010	< 0.010	< 0.005	-0.03
		< 0.010	< 0.010	< 0.005	< 0.005	0.042	< 0.010	< 0.005	0.00005	< 0.010	< 0.010	< 0.010	< 0.005	
		0.005	0.005	0.003	0.008	0.281	0.007	0.010	0.0001	0.010	0.010	0.004	0.008	-0.44
Picher #5-MW:														
	11/5/03	< 0.002	< 0.002	< 0.002	< 0.010	0.232	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	-0.32
		< 0.002	< 0.002	< 0.002	< 0.010	0.213	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	
	4/27/04	< 0.010	< 0.010	< 0.005	< 0.005	0.433	< 0.010	0.007	0.00005	< 0.010	< 0.010	< 0.010	< 0.005	-2.62
		< 0.010	< 0.010	< 0.005	< 0.005	0.390	< 0.010	0.007	0.00008	< 0.010	< 0.010	< 0.010	< 0.005	
		0.006	0.006	0.004	0.008	0.317	0.008	0.009	0.0001	0.010	0.010	0.006	0.008	-1.47

WELL	DATE		Spec Cond (Field) uS/cm	Temp (Field) °C	pH (Field)	D.O. mg/l	Alk (Field) CaCO ₃ mg/l	Alkalinity CaCO ₃ mg/l	Chloride Cl mg/l	Sulfate SO ₄ mg/l	Tot Dis Sol TDS mg/l	Hardness CaCO ₃ mg/l	Calcium Ca mg/l	Magnesium Mg mg/l	Sodium Na mg/l	Potassium K mg/l	
			MCL(SMCL)						(250)	(250)	(500)						
Picher #6 MW:			SE NW NW 21-T29N-R23E; N 36 59 00.7, W 94 49 38.7, EL 824 Topc														
	12/9/03	Totals	537	18.2	6.83	n.a.	135	143	< 10	150	380	280	65	29	13	2	
		Dissolved	-	-	-	-	-	-	-	-	-	-	60	27	12	2	
*	12/9/03	Totals	537	18.2	6.83	n.a.	135	142	< 10	150	381	277	64	29	13	2	
		Dissolved	-	-	-	-	-	-	-	-	-	-	61	27	12	2	
	4/27/04	Totals	555	20.9	7.26	4.92	157	143	< 10	156	407	293	63	29	14	2	
		Dissolved	-	-	-	-	-	-	-	-	-	-	62	29	13	2	
		Averages	543	19.1	6.97	4.92	142	143	10.0	152.0	389	283	63	28	13	2	
Picher #7 MW:			aka: PICHER - CARDIN MW; NW SE SW 20-T29N-R23E; N 36 58 28.2, W 94 50 38.3, EL 81!														
	11/5/03	Totals	563	14.7	6.89	n.a.	na	145	< 10	141	374	284	60	31	12	3	
		Dissolved	-	-	-	-	-	-	-	-	-	-	59	31	12	3	
	4/27/04	Totals	480	20.2	7.5	4.35	105	134	12.6	112	335	237	51	26	12	3	
		Dissolved	-	-	-	-	-	-	-	-	-	-	49	26	12	3	
		Averages	522	17.5	7.20	4.35	105	140	11.3	126.5	355	261	55	29	12	3	
Quapaw #4:			NW NW NW 1-T28N-R23E; N 36 56 33.4, W 94 47 11.2, EL Topo 84!														
	11/6/03	Totals	249	17.7	7.03	n.a.	107	109	< 10	11.1	129	120	25	13	5	1	
		Dissolved	-	-	-	-	-	-	-	-	-	-	24	13	5	1	
*	11/6/03	Totals	249	17.7	7.03	n.a.	107	109	< 10	11.1	131	121	24	13	5	1	
		Dissolved	-	-	-	-	-	-	-	-	-	-	25	13	5	1	
	4/28/04	Totals	275	19.4	7.31	2.29	146	107	< 10	11.8	152	122	25	13	8	2	
		Dissolved	-	-	-	-	-	-	-	-	-	-	24	13	7	2	
		Averages	258	18.3	7.12	2.29	120	108	10.0	11.3	137	121	25	13	6	1	
Quapaw #5 MW:			SW SW NE 35-T29N-R23E; N 36 57 04.4, W 94 47 07.3, EL 850 Topc														
	11/6/03	Totals	1427	18.5	6.41	n.a.	265	250	102	401	1050	751	146	70	58	8	
		Dissolved	-	-	-	-	-	-	-	-	-	-	147	71	59	8	
	4/28/04	Totals	1372	21.7	6.87	1.75	260	254	104	455	1083	754	148	71	59	8	
		Dissolved	-	-	-	-	-	-	-	-	-	-	147	72	58	7	
		Averages	1400	20.1	6.64	1.75	263	252	103.0	428.0	1067	753	147	71	59	8	
RWD4 #4			(aka: Blue hole Well): NE SE SW 30-T29N-R24E; N 36 57 38.7, W 94 44 56.3, EL Topo 90!														
	11/7/03	Totals	283	17.7	6.65	n.a.	110	114	14.8	< 10.0	133	135	27	15	6	2	
		Dissolved	-	-	-	-	-	-	-	-	-	-	27	15	6	2	
*	11/7/03	Totals	283	17.7	6.65	n.a.	110	114	14.6	< 10.0	136	134	27	16	6	2	
		Dissolved	-	-	-	-	-	-	-	-	-	-	27	16	6	2	
	4/28/04	Totals	273	19.9	7.42	3.34	124	110	15.2	< 10.0	160	135	26	15	6	2	
		Dissolved	-	-	-	-	-	-	-	-	-	-	26	15	6	2	
*	4/28/04	Totals	273	19.9	7.42	3.34	124	110	15.2	< 10.0	159	132	25	15	6	2	
		Dissolved	-	-	-	-	-	-	-	-	-	-	26	15	6	2	
		Averages	278	18.8	7.04	3.34	117	112	15.0	10.0	147	134	26	15	6	2	

NOTE: 1) Detection limits used in calculation of means; 2) total and dissolved metals concentrations used in calculation of means; 3) means are in bold type
4) Duplicate samples are highlighted with asterisk near date of sample; 5) a box indicates an MCL or SMCL violation; 6) shaded box is a Roubidoux background val
7) underline indicates a value detected in blank; 8) na indicates not analyzed; 9) dash indicates not relevant; 10) Italics indicates value > Tolerance Limi
11) Indicator parameters of mine water contamination with tolerance limits and Roubidoux background concentration: **Sulfate** (82 / 25 mg/l); **Iron** (207 / 61.5 ug/l); **Zinc** (43 / 8.8 ug/l).

WELL	DATE	Antimony Sb mg/l	Arsenic As mg/l	Cadmium Cd mg/l	Chromium Cr mg/l	Iron Fe mg/l	Lead Pb mg/l	Manganese Mn mg/l	Mercury Hg mg/l	Nickel Ni mg/l	Selenium Se mg/l	Thallium Tl mg/l	Zinc Zn mg/l	CAT / AN BALANCE % Error
		0.006	0.01	0.005	0.1	(0.3)	0.015	0.05	0.002	0.1	0.05	0.002	(5)	
Picher #6 MW:														
	12/9/03	< 0.002	0.002	< 0.002	< 0.010	0.464	< 0.005	0.013	< 0.00005	< 0.010	< 0.010	< 0.001	0.016	-0.13
		< 0.002	0.002	< 0.002	< 0.010	0.337	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	0.015	
*	12/9/03	< 0.002	0.002	< 0.002	< 0.010	0.460	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	0.014	-0.37
		< 0.002	0.002	< 0.002	< 0.010	0.337	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	0.016	
	4/27/04	< 0.010	< 0.010	< 0.005	< 0.005	0.444	< 0.010	0.011	0.00005	< 0.010	< 0.010	< 0.010	0.015	-1.57
		< 0.010	< 0.010	< 0.005	< 0.005	0.414	< 0.010	0.011	0.00005	< 0.010	< 0.010	< 0.010	0.019	
		0.005	0.005	0.003	0.008	0.409	0.007	0.011	0.0001	0.010	0.010	0.004	0.016	-0.69
Picher #7 MW:														
	11/5/03	< 0.002	< 0.002	< 0.002	< 0.010	0.166	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	0.24
		< 0.002	< 0.002	< 0.002	< 0.010	0.160	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	
	4/27/04	< 0.010	< 0.010	< 0.005	< 0.005	0.078	< 0.010	0.005	0.00005	< 0.010	< 0.010	< 0.010	< 0.005	-0.76
		< 0.010	< 0.010	< 0.005	< 0.005	0.072	< 0.010	< 0.005	0.00005	< 0.010	< 0.010	< 0.010	< 0.005	
		0.006	0.006	0.004	0.008	0.119	0.008	0.008	0.0001	0.010	0.010	0.006	0.008	-0.26
Quapaw #4:														
	11/6/03	< 0.002	< 0.002	< 0.002	< 0.010	< 0.020	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	-2.49
		< 0.002	< 0.002	< 0.002	< 0.010	< 0.020	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	
*	11/6/03	< 0.002	< 0.002	< 0.002	< 0.010	< 0.020	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	-3.47
		< 0.002	< 0.002	< 0.002	< 0.010	< 0.020	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	
	4/28/04	< 0.010	< 0.010	< 0.005	< 0.005	< 0.020	< 0.010	< 0.005	0.00005	< 0.010	< 0.010	< 0.010	0.005	0.94
		< 0.010	< 0.010	< 0.005	< 0.005	< 0.020	< 0.010	< 0.005	< 0.00005	< 0.010	< 0.010	< 0.010	< 0.005	
		0.005	0.005	0.003	0.008	0.020	0.007	0.008	0.0001	0.010	0.010	0.004	0.008	-1.67
Quapaw #5 MW:														
	11/6/03	< 0.002	0.005	< 0.002	< 0.010	3.720	< 0.005	0.046	< 0.00005	< 0.010	< 0.010	< 0.001	0.222	-1.40
		< 0.002	0.005	< 0.002	< 0.010	3.690	< 0.005	0.047	< 0.00005	< 0.010	< 0.010	< 0.001	0.213	
	4/28/04	< 0.010	< 0.010	< 0.005	< 0.005	3.680	< 0.010	0.050	< 0.00005	< 0.010	< 0.010	< 0.010	0.208	-4.43
		< 0.010	0.011	< 0.005	< 0.005	3.580	< 0.010	0.049	< 0.00005	< 0.010	< 0.010	< 0.010	0.194	
		0.006	0.008	0.004	0.008	3.668	0.008	0.048	0.0001	0.010	0.010	0.006	0.209	-2.91
RWD4 #4														
	11/7/03	< 0.002	< 0.002	< 0.002	< 0.010	0.044	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	-0.17
		< 0.002	< 0.002	< 0.002	< 0.010	0.038	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	
*	11/7/03	< 0.002	< 0.002	< 0.002	< 0.010	0.045	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	1.33
		< 0.002	< 0.002	< 0.002	< 0.010	0.038	< 0.005	< 0.010	< 0.00005	< 0.010	< 0.010	< 0.001	< 0.010	
	4/28/04	< 0.010	< 0.010	< 0.005	< 0.005	0.026	< 0.010	< 0.005	0.00005	< 0.010	< 0.010	< 0.010	< 0.005	0.16
		< 0.010	< 0.010	< 0.005	< 0.005	0.027	< 0.010	< 0.005	0.00005	< 0.010	< 0.010	< 0.010	< 0.005	
*	4/28/04	< 0.010	< 0.010	< 0.005	< 0.005	0.025	< 0.010	< 0.005	0.00005	< 0.010	< 0.010	< 0.010	< 0.005	-0.72
		< 0.010	< 0.010	< 0.005	< 0.005	0.029	< 0.010	< 0.005	< 0.00005	< 0.010	< 0.010	< 0.010	< 0.005	
		0.006	0.006	0.004	0.008	0.034	0.008	0.008	0.0001	0.010	0.010	0.006	0.008	0.15

NOTE: 1) Detection limits used in calculation of means; 2) total and dissolved metals concentrations used in calculation of means; 3) means are in bold type
4) Duplicate samples are highlighted with asterisk near date of sample; 5) a box indicates an MCL or SMCL violation; 6) shaded box is a Roubidoux background val
7) underline indicates a value detected in blank; 8) na indicates not analyzed; 9) dash indicates not relevant; 10) Italics indicates value > Tolerance Limi
11) Indicator parameters of mine water contamination with tolerance limits and Roubidoux background concentration: **Sulfate** (82 / 25 mg/l); **Iron** (207 / 61.5 ug/l); **Zinc** (43 / 8.8 ug/l).

Figure 1 – Map of Site and Long Term Monitoring Wells

List of Long Term Monitoring Wells

1. **Miami # 1:** SW NE SW S30-T28N-R23E (N 36° 52' 30.9'' W 94° 52' 23.4''); Public Water Supply Well.
2. **Commerce # 5:** NW SE NW S6-T28N-R23E (N 36° 56' 19.4'' W 94° 52' 17.9''); Monitoring Well.
3. **Commerce # 4:** NW NE NW S6-T28N-R23E (N 36° 56' 31.9'' W 94° 52' 21.1''); Public Water Supply Well.
4. **Cardin # 1:** SW SE SE S19-T29N-R23E (N 36° 58' 23.3'' W 94° 51' 07.2''); Public Water Supply Well.
5. **Picher # 6:** SE NW NW S21-T29N-R23E (N 36° 59' 00.7'' W 94° 49' 38.7''); Monitoring Well.
6. **Picher # 7 (aka Picher-Cardin Well):** NW SE SW S20-T29N-R23E (N 36° 58' 28.2'' W 94° 50' 38.3''); Stand-By Well.
7. **Picher # 5:** SE SE NE S29-T29N-R23E (N 36° 57' 55.6'' W 94° 49' 54.7''); Public Water Supply Well.
8. **RWD4 # 4 (aka Bluehole Well):** NE SE SW S30-T29N-R24E (N 36° 57' 38.7'' W 94° 44' 56.3''); Public Water Supply Well.
9. **Quapaw # 5:** SW SW NE S35-T29N-R23E (N 36° 57' 04.4'' W 94° 47' 07.3''); Monitoring Well.
10. **Quapaw # 4:** NW NW NW S1-T28N-R23E (N 36° 56' 33.4'' W 94° 47' 11.2''); Public Water Supply Well.
11. **Fernandez Well:** SE NW NW S24-T29N-R23E (N 36° 59' 04.7'' W 94° 46' 20.3''); Domestic Drinking Water Well.

