Moscow Test Well, INEL Oversight Program: Aqueous Geochemistry

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Technical Report

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INTRODUCTION

This report presents a summary and interpretation of data gathered during sampling of the Moscow Test Well at Moscow, Idaho during April and May of 1992 . The principal objectives of this chemical survey were to validate sampling procedures with a new straddle packer sampling tool in a previously hydrologically well characterized and simple sampling environment, and to compare analytical results from two independent labs for reproducibility of analytical results. Analytes included a wide range of metals, anions, nutrients, BNA's, and VOC's.

Secondary objectives included analyzing of waters from a large distilled water tank (utilized for all field laboratory purposes as "pure" stock water), of water which passed through a steamer used to clean the packer, and of rinsates from the packer tool itself before it was lowered into the test well. Analyses were also obtained of blanks and spikes for data validation purposes.

Sketch Map of Moscow Test Well Site

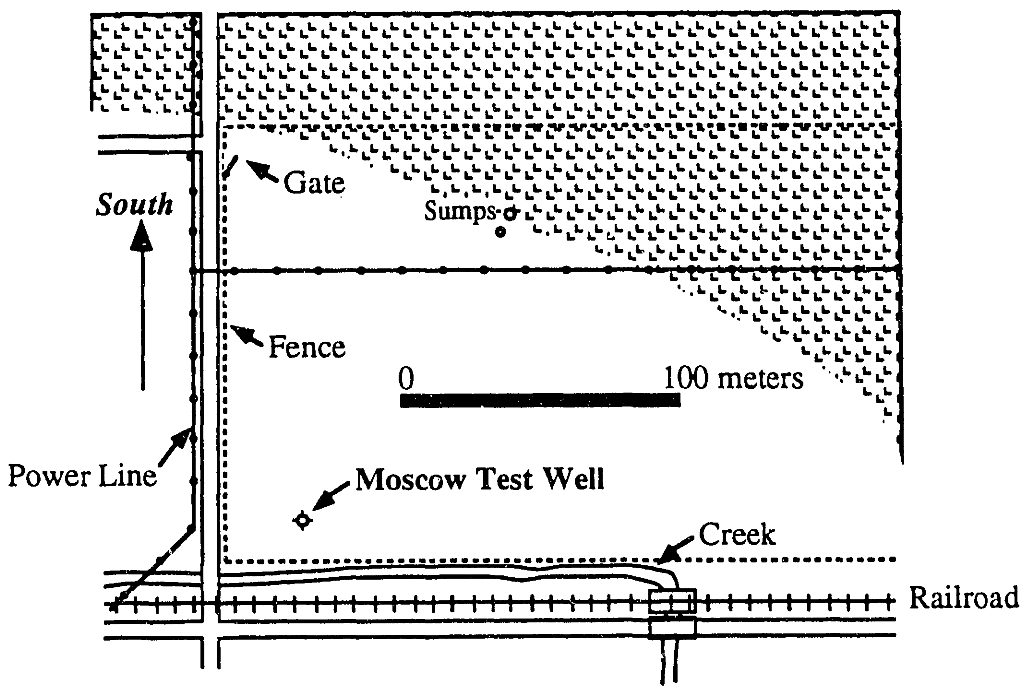

Figure 1. Sketch map of the Moscow Test Well site, Moscow, Idaho. The site is located on pasture land on the northwest corner of the University of Idaho.

A complete listing of analytical results and related data validation information are given in Appendix I. A summary of these data are presented in Table 1.

Aquifer Analyses

Aquifer analyses were obtained first using a bailer to sample at 75' depth, then with the packer tool. The packer was configured to sample at the same depth, with the lower packer inflated, and the upper packer not inflated. The upper packer was not inflated because of mechanical problems.

Summaries of analyses are listed in Table 1. Twenty-two analytes and 26 of 40 inorganic parameters were at or above detection limit. No organic compounds (VOC's or BNA's) were detected. All of the analytes yielded values in the range we expected based upon the general character of the aquifer.

No previous analytical data from this well were available for comparison. An analysis of water from a well located about 100 ESE of the test well yielded values which differ significantly from those obtained in this study (Figure 2). The Moscow Test Well samples vary from one-third to three times the values from the comparison well. However, they are of the same order of magnitude, and we believe the differences are primarily due to the complicated nature of the aquifer rather than rather than anything to do with our sampling procedures.

Comparison of Moscow Test Well with Nearby Well

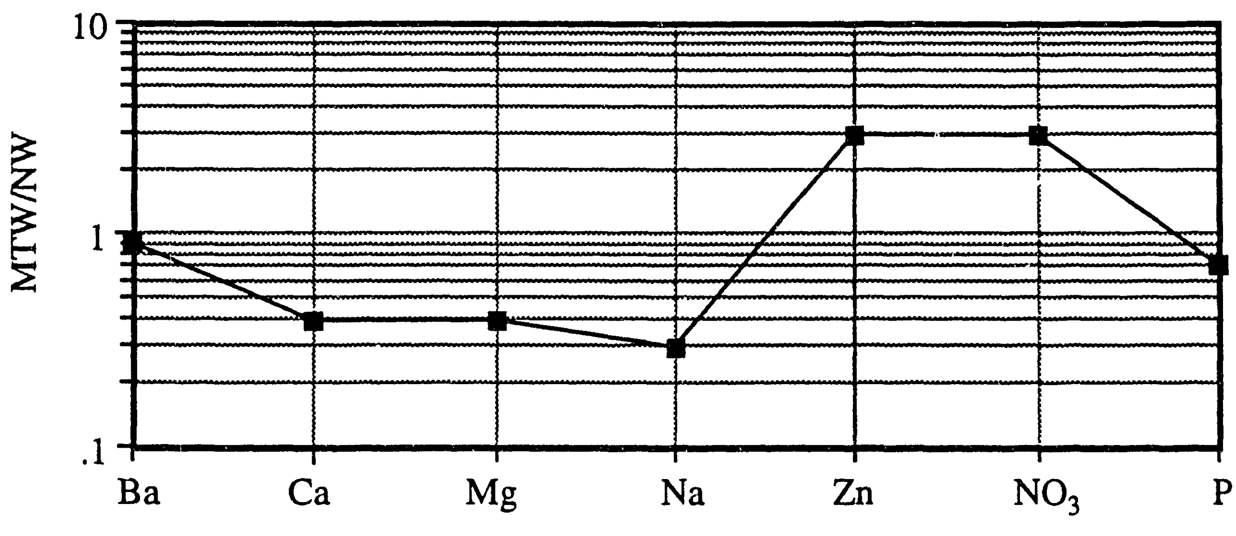

Figure 2. Analyses of ground water from the Moscow Test Well are compared to those of an unnamed well located approximately 100 m east-southeast; means of bailer and packer derived samples are divided by analyses from the nearby well values. Analyses from the nearby well were obtained from J. Kauffman, Univ. of Idaho (personal communication, 1992).

TABLE 1. Summary of Geochemical Data from Moscow Test Well

Sample Label	MTW #1	MTW #2	MTW #3	MTW #4	MTW #5	MTW #6	MTW #7	MTW #8	MTW #9	MTW #10	MTW #11	MTW #12	MTW #13	MTW #15	MTW #14
Sample Type	Bailer-at 75'	Bailer-at 75'	Bailer-at 75'	Wash gun	Wash gun	?Packer 75'	?Packer 75'	Rinsate	Rinsate	Rinsate	DI water tank	DI water tank	Spike	Spike	Spike
Date Collected	4/13/92	5/15/92	5/15/92	5/15/92	5/15/92	5/13/92	5/13/92	4/14/92	5/14/92	5/14/92	5/14/92	5/14/92	4/14/92	5/13/92	4/14/92
Lab	State Lab	DataChem	State Lab	DataChem	State Lab	DataChem	State Lab	State Lab	DataChem	State Lab	DataChem	State Lab	State Lab	State Lab	DataChem
Al (µg/l)		<60		<60		<60			<60		<60				<60
Sb (µg/l)		<60		<60		<60			<60		<60				<60
As (µg/l)	<10	<100	<10	<100	<10	<100	<10	<10	<100	<10	<100	<10	<10		<100
Ba (µg/l)	200	150	100	<20	<100	140	100	<100	<20	<100	<20	<100	100		100
Be (µg/l)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5		<5
Cd (µg/l)	<1	<10	<1	<10	<1	<10	<1	1	<10	<1	<10	<1	4.5		<10
Ca (mg/l)	110	100	107.5	<0.5	<0.1	99	102.5	0.1	<0.5	0.5	<0.5	<0.1	4.8		5
Cr (µg/l)	<2	<20	<2	<20	<2	<20	<2	<2	<20	<2	<20	<2	5		<20
Co (µg/l)		<10		<10		<10			<10		<10				<10
Cu (µg/l)	10	<20	10	<20	<10	<20	10	<10	<20	10	<20	<10	20		<20
Fe (µg/l)	40	<20	20	<20	<10	<20	80	60	<20	20	<20	<10	110		70
Pb (µg/l)	30	<50	22	<50	<5	<50	<5	<5	<50	<5	<50	<5	<5		<50
Li (µg/l)		<10		<10		80			<10		<10				<10
Mg (mg/l)	40	38	38.5	<0.5	<0.1	36	37	0.1	<0.5	0.1	<0.5	<0.1	5		4.7
Mn (µg/l)	90	90	90	<20	20	70	70	<10	<20	10	<20	<10	<10		<20
Hg (µg/l)	<0.5		<0.5		<0.5		<0.5	<0.5		0.5		<0.5	<0.5		
Mo (µg/l)		<20		<20		<20			<20		<20				<20
Ni (µg/l)	<10	<50	10	<50	<10	<50	11	<10	<50	<10	<50	<10	11		<50
K (µg/l)	5.7	5.9	5.4	<0.1	<0.1	5.2	5.3	<0.1	0.1,	0.1	<0.1	0.1	5.1		4.4
Se (µg/l)	<5	<0.2	<5	<0.2	<5	<0.2	<5	<5	<0.2	<5	<0.2	<5	<5		<0.2
Ag (µg/l)	<1	<10	<1	<10	<1	<10	<1	<1	<10	<1	<10	<1	<1		<10
Na (mg/l)	38.8	33	37.5	0.5	0.4	31	35	0.6	<1	0.8	<0.5	0.5	5.1		4.9
Sr (µg/l)	500	480	513	<5	<1	450	475	<1	0.7	2.5	<5	<1	3.2		<5
Tl (µg/l)		<200		<200		<200			<200		<200				<200
Va (µg/l)		<10		<10		10			<10		<10				<10
Zn (µg/l)	14	10	10	50	46	30	10	67	40	44	<10	5	14		20
Total N µg/l	3.29		3.09		<5	3.4	3.72	<5		0.01		<5	<5	<5	40
Kjeldahl N (mg/l)	0.33		0.32		0.05	<0.05	0.23	0.27		0.08		0.07	0.09	<0.05	<0.05
P (mg/l)	0.06		<0.05		<0.05	4.9	<0.05	<0.05		0.06		<0.05	5.13	5.94	4.90
TDS		610		20		590			30		30				160
Spec. Cond. (µhos/cm)	859		930		2		870	3.2		7		2	223	217	
Hardness in mg/l	420		420		<2		402	<2		4		<2	<2	<2	
HCO3- (mg/l)		410		<7		380			<7		<7				<7
Alkalinity in mg/l	359		347		1		334	2		3		<1	<1	<1	
B- (ug/l)	153		142		<80		146			<80		<80	<80	<80	
Cl- (mg/l)	69	75	69	<0.2	<1	75	69	<1	0.3	<1	<0.2	<1	21	19	22
Fl- (mg/l)	<0.1	0.7	<0.1	<0.2	0.18	0.6	0.23	<0.1	<0.2	<0.1	<0.2	<0.1	0.93	1.01	1.1
Br- (mg/l)		<0.2		<0.2		0.8			<0.2		<0.2				<0.2
NO3 (mg/l)		3		<0.05		3.2			<0.05		<0.05				<0.05
SO4 (mg/l)	47	40	49	<0.2	<1	39	41	<1	<0.2	2	<0.2	<1	63	58	60

Data Comparison

Packer and bailer analyses are compared in Figure 3. Averages of bailer samples analyses (where at above detection limit levels) are divided by similarly averaged packer samples. Therefore, samples plotting in the top half of the diagram (i.e. with values more than 1) are enriched in bailer samples, those with values less than one are enriched in packer samples. With a few prominent exceptions, packer and bailer samples either correlate to within analytical uncertainties, or are consistent with each other (at values below recorded detection limits).

Seven analytes yielded differences well outside the range which could be expected from sampling and analytical uncertainties (Figure 2). The most prominent of these are Pb, Li, N and Br. These differ by factors of three to eight (Li).

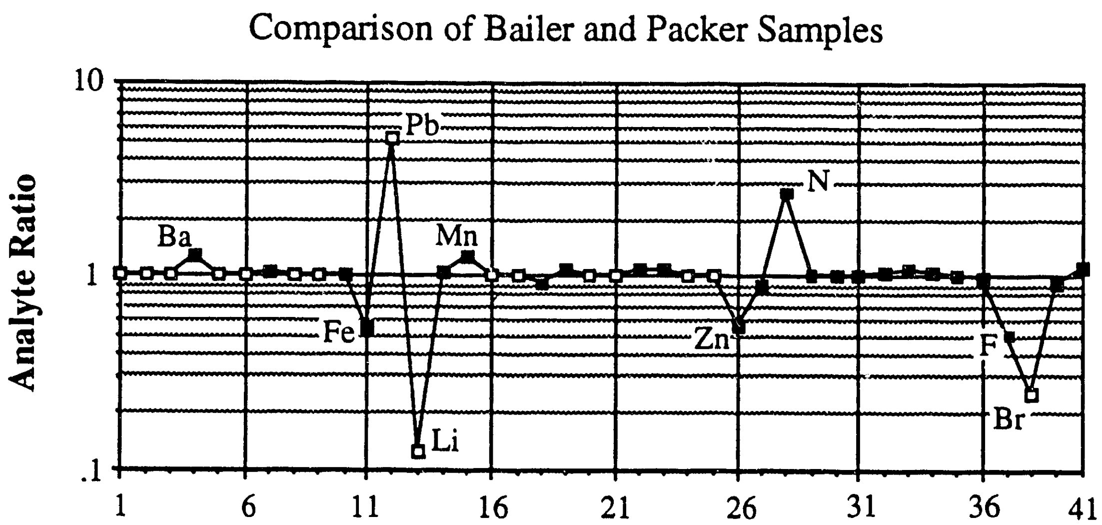

Figure 3. Analyte concentrations from bailer samples are divided by the respective concentrations for packer samples for comparision purposes. Analytes are listed by number, in the same order as they are listed in Table 1, beginning with Al (analyte 1). Open squares are for cases in which one analyte is below detection limit; therefore these are limiting values. Analytes which yielded concentration differences beyond what was expected for sampling and analysis uncertainties are highlighted by name.

Variations among most of the metals exhibit a pattern of enrichments and depletion's (defined as bailer/packer concentration) which are difficult to account for. Pb, and to a lesser extent Ba and Mn show enrichment, whereas Fe, Li and Zn exhibit depletion's. Analyses of blanks, spikes, and stock DI water would seem to rule out gross analytical error or preparation procedures as the cause of the differences. Three possibilities are suggested. First, that the differences result from real variations in aquifer chemistry. Second, that they result from an unknown source of contamination. Third, subtle analytical errors resulting from measurements made near detection limits.

Lithium, Bromide and Kjeldahl nitrogen anomalies may be better explained. Lithium and bromide are both below detection limits for bailer derived samples and occur at concentrations of 80 and 800 µg/l in packer samples. On a molar basis the concentrations of Li and Br are 11.5 and 10.1 µmol/l; these concentrations are probably identical to within analytical uncertainties. The fact that both lithium and bromide are present in packer samples, and do not occur in any other samples, indicates that these elements were incompletely removed by purging after introduction of the LiBr tracer into the "packed" interval.

It is also possible that these differences are natural variations in the aquifer system. However, the fact that they are present in the samples in stoichoimetrically balanced proportions with respect to the tracer makes such an origin unlikely.

Incomplete LiBr tracer removal may be a significant problem in future sampling proceedures. This is particularly important for measurements which may reach the sub-ppb range (i.e. by ICP-MS), as trace metal contaminants from the tracer may occur at measureable levels. It is therefore recommended to obtain lot analyses of the LiBr tracer for metals of interest.

Finally, Kjeldahl nitrogen is significantly higher in bailer than packer samples. We believe this is probably because of contamination of the bailer from waters shallow in the well.

Interlab comparisons

Two independent labs produced data for a variety of metals and anions using different analytical techniques. For example, the State Lab and DataChem analyzed for metals respectively using Furnace AA and ICP techniques. Analytical results are compared in Figure 4. For common analytes most of the lab results compare favorably, generally to within analytical uncertainties.

Possible exceptions may include F, Sr and Zn. Zn and F concentration ratios (State Lab divided by DataChem values) are significantly low for packer samples, and Sr is high for a rinsate sample. However, their is no consistent pattern of enrichment or depletion. Both labs yielded similar results for bailer and packer samples for Sr and Zn. Similarly; F spike values are within 10% of each other for both labs and of the actual prepared value, indicating good precision and accuracy. We have no adequate explanation for the three observed excursions, and therefore recommend that future work includes sending of a subset of samples to both labs to evaluate whether this is a recurring problem.

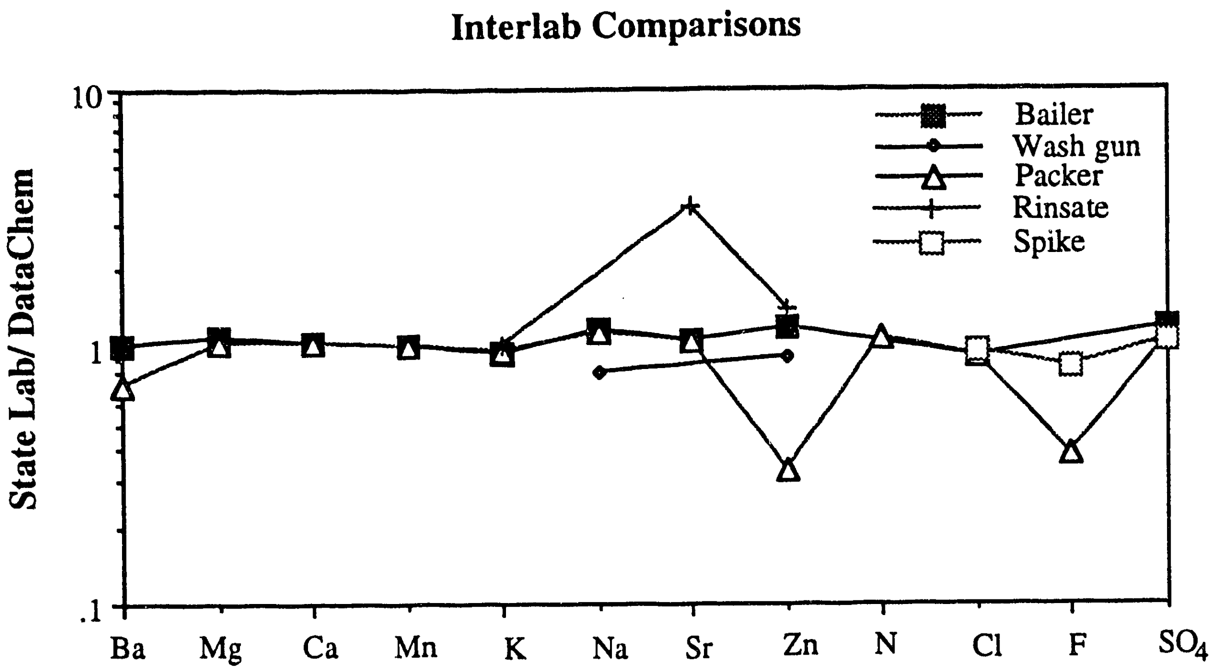

Figure 4. A comparison of analyte values for the Idaho State Lab and for DataChem. Comparisons are shown for analytes for which the State Lab and DataChem received duplicate samples and which yielded concentrations above detection limits for the respective labs.

Blanks and Spikes

Several blank and spiked samples were analyzed along with other samples. Composite summaries of the analyses are listed in Table 1. Complete data on these samples is listed in Appendix I.

There are two types of blank samples. One set, for metals, anions, and nutrients, was prepared in the field using stock distilled water, and adding preservatives, in a manner identical to the other samples. The second, for VOC's and BNA's, was prepared in Boise at the Bureau of Laboratories, Idaho Department of Health and Welfare. They were mailed to the field station at Moscow, Idaho, during operations. They were then relabeled in the normal course of work at the well site and returned to Boise as unknowns along with other samples.

Spiked solutions were prepared in Boise at the Bureau of Laboratories, Idaho Department of Health and Welfare. They were mailed to the field station at Moscow, Idaho, during operations. They were then relabeled in the normal course of work at the well site and returned to the respective labs as unknowns along with other samples. Spike concentrations are listed in Table 2.

TABLE 2. Spike Concentrations[a]

Metals -	Ba	Ca	Cd	Cr	Cu	Fe	K	Mg	Na	Ni	Pb	Zn
μg/l	100	5,000	5	5	20	100	5,000	5,000	5,000	10	5	10
Anions -	Cl	Fl	SO_4									
mg/l	20	1	20									
Nutrients -	NO_3 as N		Total P									
mg/l	5		5									
VOC's -	Regulated VOC's listed in Table 2: 5 μg/l[b] Tetrachlorethene: 5 μg/l[b]											
BNA's -	All BNA's listed in Table 2: 5 μg/l											

a. Spike solutions prepared at the Bureau of Laboratories, Idaho Dept. of Health and Welfare; they were mailed to the field at Moscow, Idaho, during operations. They were then relabeled in the course of this project and returned to the State Lab and to DataChem Lab as unknowns along with other samples.
b. One spike solution, labeled MTW#16 in Table 1, was spiked with 20 μg/l of the respective VOC analytes (W. Baker, personal communication, 1992).

Inorganic blanks samples are listed in Table 1 as DI water tank samples, samples MTW#11 and 12, sent respectively to the DataChem and the State Lab. All parameters register at below detection limits, except for K, Na, Zn, P, and Kjeldahl N. All are at low concentrations, but are well above detection limits. It seems clear that the stock deionized water tank contained minor but significant levels of contamination by these elements.

Additional samples were taken from the steam sprayer, used to clean the packer before insertion into the well. Little additional contamination seems to have occurred in water which passed through the cleaner with the exception of Zn. Concentrations of several metals are compared from the DI reservoir, spray gun and rinsate from the packer to compare and contrast various sources of contamination (Figure 5). Note that zinc increases by a factor of 10 from the DI stock to spray gun. No other significant variation was noted. We have no direct evidence of where Zn may have entered the water, however on possibility is that the water came in contact with solder within the water heater.

The packer itself is obviously contaminated with a variety of substances. Fortunately, with the possible exception of Na, all appear to be at low concentration levels, and were presumably removed from the packer during the cleaning process.

Spiked samples analyses from the State Lab compare favorably with prepared concentrations for all but two inorganic analytes (Figure 6). All analytes are within analytical uncertainties excepting SO4 and possibly Zn,

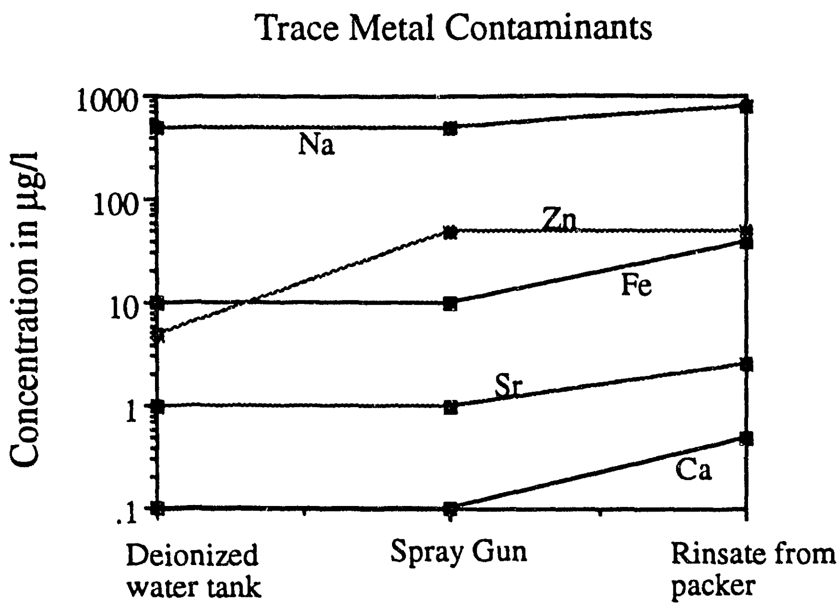

Figure 5. Selected trace element contents from solutions sampled from the main deionized water tank, from the spray gun used to steam clean the packer, and from water which drained off the packer during the steam cleaning process.

which are low by 70% and 30%, respectively. These results are very good given that the complex nature of the spiked solutions may have given rise to sample instability (J. Dodd, personal communication, 1992). The low sulfate is a concern, and particular attention should be directed at the analyte in future work to determine if it is consistently low.

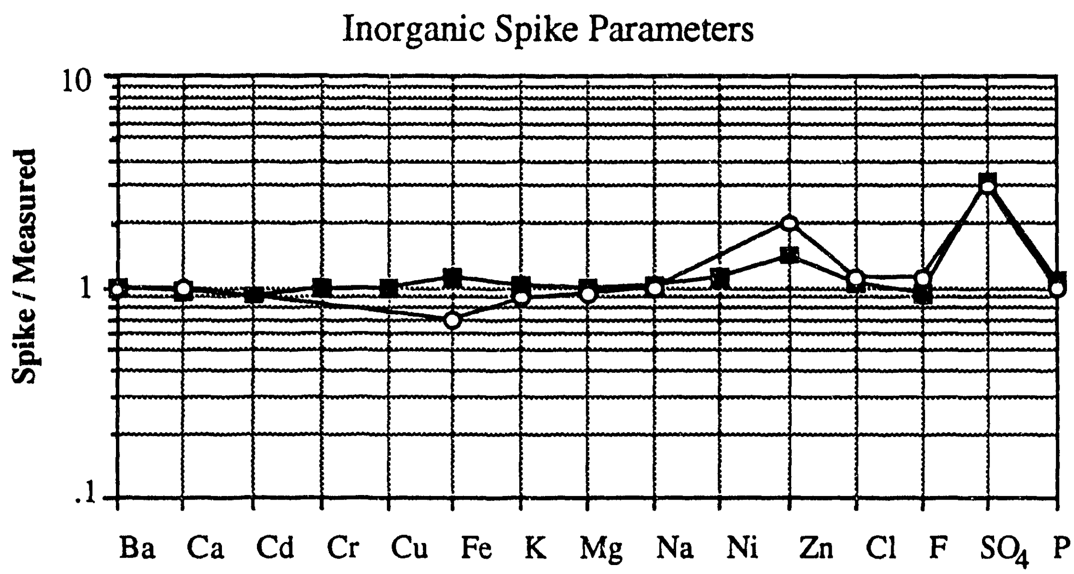

Figure 6. Prepared spike concentrations are divided by measured values for a variety of inorganic analytes. Only those analytes registering at above detection limits are shown. State Lab - closed squares; DataChem - open circles.

VOC spikes also yielded acceptable analyses. Analyzed values are compared to the prepared concentrations in Figure 6. Considerable scatter occurs in one set of analyses. This spike was prepared with spike concentrations of 5 ppb; the other was prepared with 20 ppb spike concentrations (W. Baker, personal communication, 1992). The apparently random scatter at the lower concentration suggests that the State's system is working at near detection limits at the 5 ppb level.

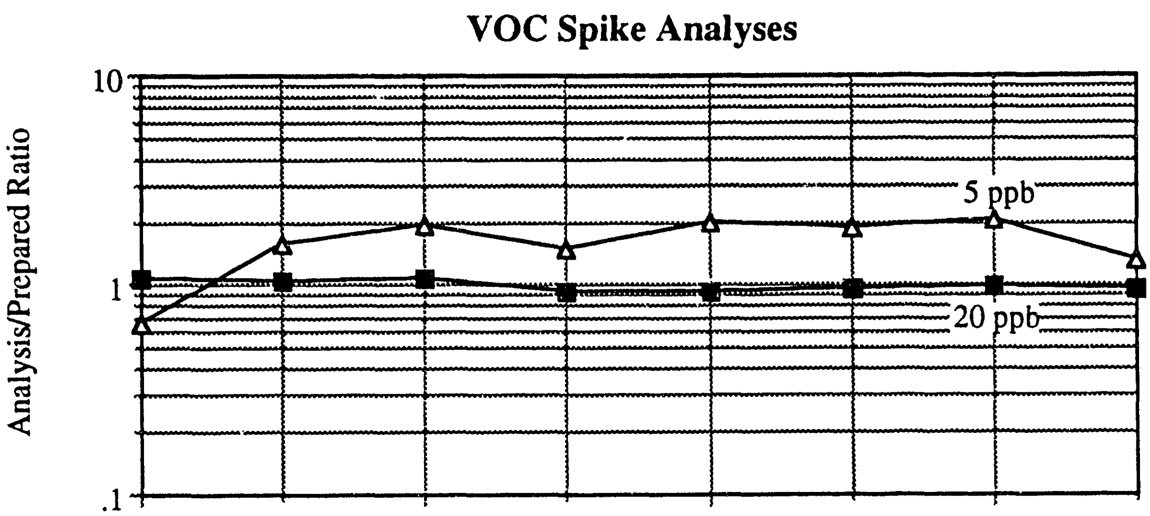

Figure 7. Prepared spike concentrations are divided by measured values for eight regulated VOC's listed in Appendix I. Two types of spikes were analyzed, one at 5 µg/ml (shown as ppb) , the other at 20 µg/ml.

No BNA spikes yielded analyses registering at above detection limits (Appendix I lists the analytes). The apparent absence of BNA's probably resulted from laboratory problems, which have since been corrected (W. Baker, personal communication, 1992).

Conclusions

Results of the Moscow Test are generally satisfactory. However, several significant problems were identified. First, several analytes yielded discordant results (Sr, Zn, F, and possibly SO_4). We therefore recommend that at least a subset of samples be analysed at an independent lab, using different analytical methods where possible. Second, significant deviations were identified between bailer and packer which could not be adequately accounted for (Fe, Pb, Zn). Additional work should be done to identify the source of variation among these analytes: for example, to determine whether sporadic sources of contamination or analytical problems may be involved. Thirdly, the steam cleaner appears to be a significant source of Zn contamination. It may not be possible to completely eliminate this source of contamination, but it should be considered in future interpretations of Zn data. Fourth, BNA determinations from the State Lab are below specifications.

The problem has been identified, and corrective measures taken. However, this should be verified in future work with additional spikes. Finally, significant amounts of LiBr tracer remain in the well water under the sampling conditions employed in this pilot study. The amounts are large enough to exceed natural water concentrations of both Li and Br. Residual tracer could present a problem for other analytes if methods with detection limits to picograms per liter (e.g., ICP-MS) are used. Since we hope to do this in the future, we should obtain lot analyses for relevant constituents from the LiBr stock.

APPENDIX 1. Tabulation of geochemical data from Moscow Test Well.

APPENDIX I Moscow Test Well Data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	Moscow Test								Metals Analyses (ug/l)															
2																								
3	Sample	Type	Purpose	Sampled By-	Date	Time	Depth	Lab	Al (ug/	Sb (ug/	As (ug/	Ba (ug/	Be (ug/	Cd (ug/	Ca (µg/l)	Cr (ug/	Co (ug/	Cu (ug/	Fe (ug/	Pb (ug/	Li (ug/	Mg (µg	Mn (ug	Hg (ug
4	9106001	Metals-dis	Bailer-at 75'	MM, JF, JW	4/13/92	16:41	75'	State Lab			<10	200	<5	<1	110	<2		10	40	30		40,000	90	<0.5
5	9106002	Metals-tot	Bailer-at 75'	MM, JF, JW	4/13/92	17:12	75'	State Lab			<10	200	<5	<1	110,000	<2		10	80	19		39,500	100	<0.5
6	9106003	NIT	Bailer-at 75'	MM, JF, JW	4/13/92	17:33	75'	State Lab																
7	9106004	Anions	Bailer-at 75'	MM, JF, JW	4/13/92	17:23	75'	State Lab																
8	9106005	BNA	Bailer-at 75'	MM, JF, JW	4/13/92	18:00	75'	State Lab																
9	9106006	BNA	Rinsate off packer	MM, JF, JW	4/14/92	10:15	n/a	State Lab																
10	9106007	Anions	Rinsate off packer	MM, JF, JW	4/14/92	10:15	n/a	State Lab																
11	9106008	Metals-dis	Rinsate off packer	MM, JF, JW	4/14/92	10:15	n/a	State Lab			<10	<100	<5	1	100	<2		<10	60	<5		100	<10	<0.5
12	9106009	Metals-tot	Rinsate off packer	MM, JF, JW	4/14/92	10:15	n/a	State Lab			<10	<100	<5	1	<100	<2		<10	80	<5		<100	10	<0.5
13	9106010	NIT	Rinsate off packer	MM, JF, JW	4/14/92	10:15	n/a	State Lab																
14	9106011	VOC	Rinsate off packer	MM, JF, JW	4/14/92	10:15	n/a	State Lab																
15	9106012	VOC	Bailer-at 75'	MM, JF, JW	4/14/92	11:15	n/a	State Lab																
16	9106013	VOC	Spike	MM, JF, JW	4/14/92	11:30	n/a	State Lab																
17	9106014	NIT	Spike	MM, JF, JW	4/14/92	11:35	n/a	State Lab																
18	9106015	NIT	Spike	MM, JF, JW	4/14/92	11:35	n/a	DataChem																
19	9106016	Metals-dis	Blank	MM, JF, JW	4/14/92	11:40	n/a	DataChem	<60	<60	<100	100	<5	<10	5,000	<20	<10	<20	70	<50	<10	4,700	<20	
20	9106017	Metals-dis	Spike	MM, JF, JW	4/14/92	11:40	n/a	DataChem	<60	<60	<100	<20	<5	<10	<500	<20	<10	<20	<20	<50	<10	<500	<20	
21	9106018	Anions	Spike	MM, JF, JW	4/14/92	11:42	n/a	State Lab																
22	9106019	Anions	Spike	MM, JF, JW	4/14/92	11:47	n/a	DataChem																
23	9106020	NIT	Blank	MM, JF, JW	4/14/92	12:02	n/a	State Lab																
24	9106021	NIT	Blank	MM, JF, JW	4/14/92	12:04	n/a	DataChem																
25	9106022	Metals-dis	Spike	MM, JF, JW	4/14/92	12:16	n/a	State Lab			<10	100	<5	4.5	4800	5		20	110	<5		500	<10	<0.5
26	9106023	Metals-dis	Blank	MM, JF, JW	4/14/92	12:37	n/a	State Lab			<10	<100	<5	<1	<100	<2		<10	<10	<5		<100	<10	<0.5
27	9106024	BNA	Spike	MM, JF, JW	4/14/92	14:46	n/a	State Lab																
28	9106025	BNA	Blank	MM, JF, JW	4/14/92	14:55	n/a	State Lab																
29	9106026	Metals-tot	DI water tank	JKO	5/14/92	not recorded	n/a	DataChem	<60	<60	<100	<20	<5	<10	<500	<20	<10	<20	<20	<50	<10	<500	<20	
30	9106027	Metals-tot	DI water tank	JKO	5/14/92	not recorded	n/a	State Lab			<10	<100	<5	<1	<100	<2		<10	<10	<5		<100	<10	<0.5
31	9106028	Metals-dis	DI water tank	JKO	5/14/92	not recorded	n/a	DataChem	<60	<60	<100	<20	<5	<10	<500	<20	<10	<20	<20	<50	<10	<500	<20	
32	9106029	Metals-dis	DI water tank	JKO	5/14/92	not recorded	n/a	State Lab			<10	<100	<5	<1	<100	<2		<10	<10	<5		<100	<10	<0.5
33	9106030	Anions	DI water tank	JKO	5/14/92	not recorded	n/a	DataChem																
34	9106031	Anions	DI water tank	JKO	5/14/92	not recorded	n/a	State Lab																
35	9106032	NIT	DI water tank	JKO	5/14/92	not recorded	n/a	State Lab																
36	9106033	Metals-tot	?Lower packer in	JKO	5/13/92	not recorded	75'?	DataChem	<60	<60	<100	140	<5	<10	98,000	<20	<10	<20	80	<50	70	36,000	70	
37	9106034	Metals-tot	?Lower packer in	JKO	5/13/92	not recorded	75'?	State Lab			<10	200	<5	<1	105,000	<2		10	100	<5		37,000	70	<0.5
38	9106035	Metals-dis	?Lower packer in	JW	5/13/92	not recorded	75'?	DataChem	<60	<60	<100	140	<5	<10	99,000	<20	<10	<20	<20	<50	80	36,000	70	
39	9106036	Metals-dis	?Lower packer in	JW	5/13/92	not recorded	75'?	State Lab			<10	100	<5	<1	102,500	<2		10	80	<5		37,000	70	<0.5
40	9106037	Anions	?Lower packer in	JKO	5/13/92	not recorded	75'?	DataChem																
41	9106038	Anions	?Lower packer in	JKO	5/13/92	not recorded	75'?	State Lab																
42	9106039	NIT	?Lower packer in	JKO	5/13/92	not recorded	75'?	DataChem																
43	9106040	NIT	?Lower packer in	JKO	5/13/92	not recorded	75'?	State Lab																
44	9106041	BNA	?Lower packer in	JKO	5/13/92	not recorded	75'?	State Lab																
45	9106042	VOC	?Lower packer in	JKO	5/13/92	not recorded	75'?	State Lab																
46	9106043(du	VOC	Blank	JKO	5/15/92	14:00	n/a	State Lab																
47	9106043(du	VOC	Blank	JW	5/13/92	13:05	n/a	State Lab																
48	9106044 (d	VOC	Spike	JKO	5/15/92	14:03	n/a	State Lab																
49	9106044(du	VOC	Spike	JW	5/13/92	13:07	n/a	State Lab																
50	9106045	Metals-tot	Rinsate from lowe	JKO	5/14/92	not recorded	n/a	DataChem	<60	<60	<100	<20	<5	<10	700	<20	<10	<20	130	<50	<10	<500	<20	

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
51	9106046	Metals-tot	Rinsate from lowe	JKO	5/14/92	not recorded	n/a	State Lab			<10	<100	<5	<1	600	<2		10	190	<5		100	20	<0.5
52	9106047	Metals-dis	Rinsate from lowe	JKO	5/14/92	not recorded	n/a	DataChem	<60	<60	<100	<20	<5	<10	<500	<20	<10	<20	<20	<50	<10	<500	<20	
53	9106048	Metals-dis	Rinsate from lowe	JKO	5/14/92	not recorded	n/a	State Lab			<10	<100	<5	<1	500	<2		10	20	<5		100	10	<0.5
54	9106049	Anions	Rinsate from lowe	JKO	5/14/92	not recorded	n/a	DataChem																
55	9106050	Anions	Rinsate from lowe	JKO	5/14/92	not recorded	n/a	State Lab																
56	9106051	Discarded	Discarded	Discarded	Discarded	Discarded	n/a																	
57	9106052	NIT	Rinsate from lowe	JKO	5/14/92	not recorded	n/a	State Lab																
58	9106053	BNA	Rinsate from lowe	JKO	5/14/92	not recorded	n/a	State Lab																
59	9106054	VOC	Rinsate from lowe	JKO	5/14/92	not recorded	n/a	State Lab																
60	9106055	BNA	Blank	JKO	5/13/92	13:05	n/a	State Lab																
61	9106056	BNA	Spike	JKO	5/13/92	13:05	n/a	State Lab																
62	9106057	Anion	Spike	JKO	5/13/92	13:05	n/a	State Lab																
63	9106058	Phosphorous	Spike	JKO	5/13/92	13:05	n/a	State Lab																
64	9106059	Metals-tot	Bailer sample - 75	JKO	5/15/92	13:30	75'	DataChem	<60	<60	<100	160	<5	<10	100,000	<20	<10	<20	<20	<50	<10	38,000	90	
65	9106060	Metals-tot	Bailer sample - 75	JKO	5/15/92	13:33	75'	State Lab			<10	200	<5	<1	107,500	<2		10	50	<5		38,500	90	<0.5
66	9106061	Metals-dis	Bailer sample - 75	JKO	5/15/92	13:36	75'	DataChem	<60	<60	<100	150	<5	<10	100,000	<20	<10	<20	<20	<50	<10	38,000	90	
67	9106062	Metals-dis	Bailer sample - 75	JKO	5/15/92	13:39	75'	State Lab			<10	100	<5	<1	107,500	<2		10	20	22		38,500	90	<0.5
68	9106063	Anions	Bailer sample - 75	JKO	5/15/92	13:45	75'	DataChem																
69	9106064	Anions	Bailer sample - 75	JKO	5/15/92	13:48	75'	State Lab																
70	9106065	NIT	Bailer sample - 75	JKO	5/15/92	13:51	75'	State Lab																
71	9106066	BNA	Bailer sample - 75	JKO	5/15/92	13:55	75'	State Lab																
72	9106067	VOC	Bailer sample - 75	JKO	5/15/92	13:57	75'	State Lab																
73	9106068	Metals-tot	Wash gun	JKO	5/15/92	12:00	n/a	DataChem	<60	<60	<100	<20	<5	<10	<500	<20	<10	<20	190	<50	<10	<500	<20	
74	9106069	Metals-tot	Wash gun	JKO	5/15/92	12:00	n/a	State Lab			<10	<100	<5	<1	<100	2		<10	110	<5		<100	20	<0.5
75	9106070	Metals-dis	Wash gun	JKO	5/15/92	12:00	n/a	DataChem	<60	<60	<100	<20	<5	<10	<500	<20	<10	<20	<20	<50	<10	<500	<20	
76	9106071	Metals-dis	Wash gun	JKO	5/15/92	12:00	n/a	State Lab			<10	<100	<5	<1	<100	<2		<10	<10	<5		<100	20	<0.5
77	9106072	Anions	Wash gun	JKO	5/15/92	12:00	n/a	DataChem																
78	9106073	Anions	Wash gun	JKO	5/15/92	12:00	n/a	State Lab																
79	9106074	NIT	Wash gun	JKO	5/15/92	12:00	n/a	State Lab																

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	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT
1												Nutrients						Hardness		Total alkalinity	Anions	
2												Total Nitrate	Total N	Total Kjelda	Total Phosph.		Spec. cond	as CaCO3	HCO3-	in µg/l		
3	Mo (ug	Ni (ug/l	K (µg/l)	Se (ug/l	Si	Ag (ug/	Na (µg/l)	Sr (ug/l	Tl (ug/l	Va (ug/	Zn (ug/	as N	(NO3-N & N	N as N µg/l	as P (µg/l)	TDS,µg/L	umhos/cm	in µg/l	(µg/l)	(as CaCO3)	B- (ug/l)	Cl- (µg/l)
4		<10	5,700	<5		<1	38,800	500			14											
5		10	5,600	<5		<1	37,500	417			15											
6													3,290	330	60							
7																	859	420,000		359,000	153	69,000
8																						
9																						
10																	3.2	<2,000		2,000		<1,000
11		<10	<100	<5		<1	600	<1			67											
12		<10	100	<5		<1	300	<1			61											
13													<5	270	<50							
14																						
15																						
16																						
17													<5	90	5,130							
18													40	<50	<10							
19	<20	<50	4,800, 4000	<0.2		<10	4,800, 5,000	<5	<200	<10	20											
20	<20	<50	<100	<0.2		<10	<500	<5	<200	<10	<10											
21																	223	<2,000		<1,000	<80	21,000
22																160,000			<7000			22,000
23													<5	<50	<50							
24													<10	<50	4,900							
25		11	5,100	<5		<1	5.1	3.2			14											
26		<10	<100	<5		<1	<100	<1			<2											
27																						
28																						
29	<20	<50	<100, <100	<0.2		<10	<500, <500	<5	<200	<10	<10											
30		<10	<100	<5		<1	300	<1			2											
31	<20	<50	<100, <100	<0.2		<10	<500, <500	<5	<200	<10	<10											
32		<10	100	<5		<1	500	<1			5											
33																30,000			<7000			<200
34																	2	<2,000		<1,000	<80	<1000
35													<5	70	<50							
36	<20	<50	5,600, 5000	<0.2		<10	33,000, 31,000	450	<200	10	<10											
37		12	5,200	<5		<1	35,000	400			9											
38	<20	<50	5,400, 5000	<0.2		<10	31,000, 31,000	450	<200	10	30											
39		11	5,300	<5		<1	35,000	475			10											
40																590,000			380,000			75,000
41																	870	402,000		334,000	146	69,000
42													3,400	<50	4,900							
43													3,720	230	<50							
44																						
45																						
46																						
47																						
48																						
49																						
50	<20	<50	<1000, <100	<0.2		<10	<1,000, <500	<5	<200	<10	50											

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	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT
51		<10	100	<5		<1	600	4.2			53											
52	<20	<50	<1000, <100	<0.2		<10	700	0.7, <5	<200	<10	40											
53		<10	100	<5		<1	800	2.5			44											
54																30,000			<7,000			300
55																	7	4,000		3,000	<80	<1,000
56																						
57													10	80	60							
58																						
59																						
60																						
61																						
62																	217	<2,000		<1,000	<80	19,000
63													<5	<50	59,400							
64	<20	<50	5,600, 6000	<0.2		<10	31,000, 34,000	480	<200	<10	<10											
65		10	5,500	<5		<1	35,000	500			17											
66	<20	<50	5,700, 6000	<0.2		<10	33,000, 33,000	480	<200	<10	10											
67		10	5,400	<5		<1	37,500	513			10											
68																610,000			410,000			75,000
69																	930	420,000		347,000	142	69,000
70													3,090	320	<50							
71			<100				<500															
72																						
73	<20	<50	<1000, <100	<0.2		<10	<1,000, <500	<5	<200	<10	60											
74		<10	<100	<5		<1	300	<1			39											
75	<20	<50	<1000, <100	<0.2		<10	<1,000, <500	<5	<200	<10	50											
76		<10	<100	<5		<1	400	<1			46											
77																20,000			<7,000			<200
78																	2	<2,000		1,000	<80	<1,000
79													<5	50	<50							

	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI
1					VOC's										
2					Analyst and		THM's (Trihalomethanes)				Regulated VOC's				
3	Fl- (µg/l)	Br- (µg/l)	NO3 (µg/	SO4 (µg/	analyst comments	Method #	Bromodichlorome	Bromoform (ug/l)	Chloroform (ug/l)	Dibromochlorom	Vinyl chloride (u	1,1-Dichloroethe	1,1,1-Trichloroet	Carbon tetrachlor	Benzene (ug/l)
4															
5															
6															
7	<100			47,000											
8															
9															
10	<100			<1,000											
11															
12															
13															
14					W. Baker	502.2	nd	nd	nd	nd	nd	nd	nd	nd	nd
15					W. Baker	502.2	nd	nd	nd	nd	nd	nd	nd	nd	nd
16					NOTE: written comment that "sample lost - no duplicate for re-analysis" (no signature or date given to this comment)										
17															
18															
19															
20															
21	930			63,000											
22	1,100	<200	<50	60,000											
23															
24															
25															
26															
27															
28															
29															
30															
31															
32															
33	<200	<200	<50	<200											
34	<100			<1000											
35															
36															
37															
38															
39															
40	600	800	3,200	39,000											
41	230			41,000											
42															
43															
44															
45					W. Baker	502.2	nd	nd	nd	nd	nd	nd	nd	nd	nd
46					W. Baker (possible lab contaminatio		nd	nd	nd	nd	nd	nd	nd	nd	nd
47					W. Baker (possibl	502.2	nd	nd	nd	nd	nd	nd	nd	nd	nd
48					W. Baker (probabl	502.2	nd	nd	nd	nd	3.24	7.84	9.49	7.41	10
49					W. Baker	502.2	nd	nd	nd	nd	21.2	20.6	21.8	18.6	18.5
50															

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	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI
51															
52															
53															
54	<200	<200	<50	<200											
55	<100			2,000											
56															
57															
58															
59															
60															
61															
62	1,010			58,000											
63															
64															
65															
66															
67															
68	700	<200	3,000	40,000											
69	<100			49,000											
70															
71					BNA analyst's comments: a large amount of molecular sulfur present.										
72					W. Baker	502.2	nd	nd	nd	nd	nd	nd	nd	nd	nd
73															
74															
75															
76															
77	<200	<200	<50	<200											
78	180			<1,000											
79															

	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV
1													
2				Unregulated VOC's									
3	1,2-Dichloroethar	Trichloroethylene	1,4 -Dichlorobenz	Bromobenzene (u	Bromochlorometh	Bromomethane (u	n-Butylbenzene (u	sec-Butylbenzene	tert-Butylbenzene	Chlorobenzene (u	Chloroethane (ug/	Chloromethane (u	2-Chlorotoluene (
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
15	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
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31													
32													
33													
34													
35													
36													
37													
38													
39													
40													
41													
42													
43													
44													
45	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
46	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
47	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
48	9.42	10.2	6.55	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
49	19	19.5	19.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
50													

	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV
51													
52													
53													
54													
55													
56													
57													
58													
59													
60													
61													
62													
63													
64													
65													
66													
67													
68													
69													
70													
71													
72	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
73													
74													
75													
76													
77													
78													
79													

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	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI
1													
2													
3	4-Chlorotoluene (	1,2-Dibromo-3-ch	1,2-Dibromoethan	Dibromoethane (u	1,2-Dichlorobenz	1,3-Dichlorobenz	Dichlorodifluoron	1,1-Dichloroethan	cis-1,2-Dichloroe	trans-1,2-Dichlor	1,2-Dichloroprop	1,3-Dichloroprop	2,2-Dichloroprop
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
15	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													
31													
32													
33													
34													
35													
36													
37													
38													
39													
40													
41													
42													
43													
44													
45	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
46	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
47	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
48	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
49	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	
50													

	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI
51													
52													
53													
54													
55													
56													
57													
58													
59													
60													
61													
62													
63													
64													
65													
66													
67													
68													
69													
70													
71													
72	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
73													
74													
75													
76													
77													
78													
79													

	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV
1													
2												1,1,1,2-Tetrachlor	1,1,2,2-Tetrachlor
3	1,1-Dichloroprop	cis-1,3-Dichlorop	trans-1,3-Dichlor	Ethylbenzene (ug	Hexachlorobutadi	Isopropylbenzene	p-Isopropyltouene	Methylene chlorid	Napthalene (ug/l)	n-Propylbenzene	Styrene (ug/l)		
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
15	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													
31													
32													
33													
34													
35													
36													
37													
38													
39													
40													
41													
42													
43													
44													
45	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
46	nd	nd	nd	nd	nd	nd	nd	3.09 (see analyst c	nd	nd	nd	nd	nd
47	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
48	nd	nd	nd	nd	nd	nd	nd	6.31 (see analyst c	nd	nd	nd	nd	nd
49	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
50													

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	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV
51													
52													
53													
54													
55													
56													
57													
58													
59													
60													
61													
62													
63													
64													
65													
66													
67													
68													
69													
70													
71													
72	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
73													
74													
75													
76													
77													
78													
79													

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	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI
1												BNA's	
2													
3	Tetrachloroethene	Toluene (ug/l)	1,2,3-Trichlorobe	1,2,4-Trichlorobe	1,1,2-Trichloroeth	Trichlorofluorom	1,2,3-Trichloropr	1,2,4-Trimethylbe	1,3,5-Trimethylbe	m-Xylene + p-Xy	o-Xylene (ug/l)	Acenaphthene	Acenaphthylene,
4													
5													
6													
7													
8												nd	nd
9												nd	nd
10													
11													
12													
13													
14	nd	169	nd	nd	nd	nd	nd	nd	nd	nd	nd		
15	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27												nd	nd
28												nd	nd
29													
30													
31													
32													
33													
34													
35													
36													
37													
38													
39													
40													
41													
42													
43													
44												nd	nd
45	nd	0.4	nd	nd	nd	nd	nd	nd	nd	nd	nd		
46	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		
47	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		
48	6.82	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		
49	18.4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		
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APPENDIX I Moscow Test Well Data

	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI
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72	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		
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APPENDIX I Moscow Test Well Data

	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV
1													
2													
3	Aldrin	Aniline, µg/L	Anthracene	Aroclor-1016	Aroclor-1221	Aroclor-1232	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260	Benzoic acid	Benz(a)anthracen	Benzo(b)fluoranth
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	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV
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APPENDIX I Moscow Test Well Data

	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI
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3	Benzo(k)fluoranth	Benzo(g,h,i)peryl	Benzo(a)pyrene	Benzyl alcohol	a-BHC	b-BHC	d-BHC	g-BHC (Lindane)	Bis(2-chloroethox	Bis (2-chloroethy	Bis(2-chloroisopr	Bis(2-ethylhexyl)	4-Bromophenyl p
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APPENDIX I Moscow Test Well Data

	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI
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	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV
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3	Butyl benzyl phth	Chlordane	4-Chloro-3-methy	1-Chloronaphthal	2-Chloronaphthal	2-Chlorophenol	4-Chlorophenyl p	Chrysene	4,4'-DDD	4,4'-DDE	4,4'-DDT	Dibenz(a,h)anthra	Dibenzofuran
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	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV
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	EW	EX	EY	EZ	FA	FB	FC	FD	FE	FF	FG	FH	FI
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3	Di-n-butyl phthal	3,3'-Dichlorobenz	2,4-Dichlorophen	Dieldrin	Diethyl phthalate,	2,4-Dimethylpher	Dimethyl phthala	4,6-Dinitro-2-met	2,4-Dinitrophenol	2,4-Dinitrotoluen	2,6-Dinitrotoluen	Diphenylamine	1,2-Diphenylhydr
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	EW	EX	EY	EZ	FA	FB	FC	FD	FE	FF	FG	FH	FI
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3	Di-n-octyl phthal	Endosulfan I	Endosulfan II	Endosulfan sulfat	Endrin	Endrin aldehyde	Endrin ketone	Fluoranthene	Fluorene	Heptachlor	Heptachlor epoxi	Hexachlorobenze	Hexachlorobutadi
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APPENDIX I Moscow Test Well Data

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	FW	FX	FY	FZ	GA	GB	GC	GD	GE	GF	GG	GH	GI
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3	Hexachlorocyclop	Hexachloroethane	Indeno(1,2,3-cd)p	Isophorone	2-Methjylnaphtha	Naphthalene	2-Nitroaniline	3-Nitroaniline	4-Nitroaniline	Nitrobenzene	2-Nitrophenol	4-Nitrophenol	N-Nitrosodimethy
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	FW	FX	FY	FZ	GA	GB	GC	GD	GE	GF	GG	GH	GI
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	GJ	GK	GL	GM	GN	GO	GP	GQ	GR	GS	GT
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3	N-Nitrosodipheny	N-Nitrosodi-n-pro	Pentachlorophenol	Phenanthrene	Phenol	Pyrene	Toxaphene	1,2,4-Trichlorobe	2,4,5-Trichloroph	2,4,6-Trichloroph	Trifluralin
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