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MAY - 7 2001

Mr. Dan Wall
Project Manager
Superfund Division
U.S. EPA
Region VII
901 North 5th Street
Kansas City, Kansas 66101

Dear Mr. Wall:

BENCH TEST REPORTS ON IN-SITU CHEMICAL OXIDATION

I have enclosed copies of the four reports we have recently received on the above subject. Although these documents are not deliverables under the FFA, they will serve to form a better understanding of the technology and its potential application at the site. We expect the full scale bid specifications, which you have seen in draft, to be final soon. At that point we will be ready for the Request For Proposal. If you have any questions regarding these documents, please call Tom Pauling at (636)926-7051.

Sincerely,

Pamela Thompson
Project Manager
Weldon Spring Site
Remedial Action Project

Enclosures:
As stated

cc w/enclosure:
Brandon Doster, MDNR
Ben Moore, MDNR

EM-95:TPauling:x7051:emh:5/7/01 (m:TCEBench Reports)

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IT CORPORATION

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WELDON SPRING SITE REMEDIAL ACTION PROJECT

WSSRAP GROUNDWATER OPERABLE UNIT (GWOU) INSITU CHEMICAL OXIDATION TREATMENT BENCH-SCALE TREATABILITY STUDY REPORT

For
WORK PACKAGE 550
STATEMENT OF WORK

MK-Ferguson Group
7295 Highway 94 South
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Prepared By:

IT Corporation
Technology Applications Laboratory
Knoxville, TN

May 3, 2001
IT Project 825930

1.0 INTRODUCTION

Groundwater and aquifer material samples were submitted to IT Corporation's Technology Application Laboratory (TAL) in Knoxville, TN for permanganate treatability testing. The samples were from an area at the Groundwater Operable Unit (GWOU) of the Weldon Spring Site Remedial Action Project (WSSRAP) that was contaminated with trichloroethene (TCE). Bench-scale treatability testing was conducted to determine the feasibility of insitu permanganate oxidation treatment to destroy the TCE and TCE degradation products, cis- and trans-1,2-dichloroethene (1,2-DCE) and vinyl chloride, in the groundwater. The reaction with TCE, the contaminant of concern, is expressed by the following equation:

$$2KMnO_4 + C_2HCl_3 + 4H_2O \rightarrow 2MnO_2(s) + 2CO_2 + 2KCl + HCl$$

In addition to TCE, other contaminants of concern identified in the groundwater include nitroaromatic compounds and nitrate. Permanganate oxidation treatment has been shown to have negligible effect on the oxidation and/or mobilization of nitrates or nitroaromatics. Nitrate analyses of the aqueous phase was performed prior to and after treatment to demonstrate this effect.

The batch slurry tests were also used to evaluate the impact of oxidation treatment on aqueous metal concentrations. At some sites, the application of insitu chemical oxidation (such as with potassium permanganate, or hydrogen peroxide) may mobilize certain metals present in the soil. The most common of these metals is chromium (Cr). Chromium in the soil may be either naturally occurring or anthropogenic and in a chemically reduced, insoluble state such as Cr (III). However, application of permanganate can oxidize the Cr (III) species to a more soluble hexavalent chromium [Cr (VI)] species by the following equation:

$$MnO_4^- + Cr(III) + 4H^+ \rightarrow MnO_2 + Cr(VI) + 2H_2O$$

Chromium analyses were performed to define concerns for mobilization with respect to the 0.1 mg/L total chromium federal guideline level.

For the Weldon Spring Site, there is also a concern that uranium, an identified contaminant of concern, may be oxidized by the application of permanganate and become mobile. The uranium in

the aquifer material of the Weldon Spring Site is likely to be adsorbed on the argillaceous limestone or clay minerals within the aquifer matrix or adsorbed and incorporated into the iron oxyhydroxide coatings on these surfaces of these minerals. Uranium contamination in aquifer materials is typically U(VI), as this is the more mobile valence state in groundwater. Therefore, the uranium associated with the aquifer matrix will likely be U(VI), though some of the uranium may be reduced to U(IV) by sulfate reducing bacteria. There is the potential that the permanganate application may oxidize some of the U(IV). As an additional objective of the testing, uranium analyses were performed to define concerns for mobilization at the site due to permanganate treatment.

In addition, as part of the oxidation process, permanganate is reduced to stable manganese dioxide (MnO_2) solids that remain in the subsurface matrix. The metal analyses performed included manganese (Mn) to determine the amount dissolved in aqueous treatment phases with respect to the secondary drinking water standard (0.05 mg/L).

The treatability study was performed at IT's Technology Applications Laboratory (TAL) in Knoxville, Tennessee.

2.0 SITE LOCATION AND DESCRIPTION

The Weldon Spring Chemical Plant Area is located in St. Charles County, Missouri, approximately 48 km (30 mi.) west of St. Louis, near the junction of U.S. Route 40/61 and State Route 94. The shallow groundwater aquifer beneath the 217-acre Chemical Plant Area comprises the Groundwater Operable Unit (GWOU). This study applies to the southwestern portion of the GWOU.

3.0 DESCRIPTION OF BENCH SCALE TESTING

Bench scale tests included the following:

- characterization of contaminated aquifer material and groundwater samples,
- oxidant demand tests on the aquifer material to define the permanganate-dosing requirement, and
- batch slurry reaction tests to investigate the rate of reaction of permanganate with TCE (C_2HCl_3) in an aquifer environment, and to determine the effect of treatment on aqueous chloride ion, nitrate ion, chromium, manganese and uranium concentrations.

The description of procedures and results obtained for these tests are described in the sections below.

4.0 INITIAL CHARACTERIZATION OF SITE GROUNDWATER AND AQUIFER MATERIAL

Groundwater in 16 1-L glass sample bottles and two (2) 1-gallon plastic bag samples of bedrock were received at the TAL on March 29, 2001. The samples were labeled as listed below.

GW-3034-032801-IT	3/28/01	Groundwater	16 x 1-L	(TDL #2833)
BR-3034-IT	3/28/01	Bedrock	1 x 1-gallon	(TDL #2834)
BR-3035-IT	3/28/01	Bedrock	1 x 1-gallon	(TDL #2835)

At the TAL, the contaminated groundwater was analyzed in triplicate for TCE and TCE degradation products (e.g., cis- and trans-1,2-DCE and vinyl chloride) by modified EPA Method 8021, for dissolved metals (uranium, chromium and manganese) by EPA Method 6010B, and anions (chloride and nitrate) by EPA method 300.0. Results of these analyses are presented in Table 1.

Table 1 – Summary of Initial Characterization Results for Groundwater

Analyte	Groundwater, GW-3034-032801-IT				
	1	2	3	Mean	RSD (%)
VOCs (µg/L):					
Trichloroethene (TCE)	966	972	949	962	1
Cis-1,2-Dichloroethene (cis-DCE)	27	27	25	26	4
Trans-1,2-Dichlrorethene (trans-DCE)	<5	<5	<5	<5	NA
1,1-Dichloroethene (1,1-DCE)	<5	<5	<5	<5	NA
Vinyl Chloride	<5	5	<5	5	NA
Metals, dissolved (mg/L):					
Chromium	<0.035	<0.035	<0.035	<0.035	NA
Manganese	0.330	0.310	0.310	0.320	4
Uranium	<0.250	<0.250	<0.250	<0.250	NA
Anions (mg/L):					
Chloride ion	36.6	40.3	34.5	37.1	8
Nitrate ion (as NO_3^-)	3,510	3,590	3,530	3,540	1

RSD = Relative standard deviation or the standard deviation of replicate analyses expressed as a percentage of the mean concentration.
NA = Not analyzed or not applicable.

The aquifer material to be tested was crushed, composited and homogenized at the TAL at 4°C prior to testing. An aquifer materials composite sample was prepared by combining equal weights of both crushed samples in a large stainless steel bowl. The composite was mixed by hand using a stainless steel spatula until visually homogeneous. After mixing, the composite was placed into a sample bottle and was immediately capped. The compositing and homogenization process was done under refrigeration and in a manner to minimize the amount and time of open exposure of the aquifer material to avoid excessive loss of VOCs from the sample.

A sample of the homogenized aquifer material was analyzed in triplicate for TCE and TCE degradation products using the same method described for the water. In addition, the aquifer material was analyzed for total uranium, chromium and manganese by EPA Method 6010B to assess the potential for generation of aqueous concentrations of these metals during permanganate treatment. The results of these analyses are presented in Table 2.

Table 2 – Summary of Initial Characterization Results for Aquifer Material Composite

Analyte	Aquifer Composite, BR-3034-IT & BR-3035-IT (dry weight basis[a])				
	1	2	3	Mean	RSD (%)
VOCs (µg/kg):					
Trichloroethene (TCE)	<220	<220	<220	<220	NA
Cis-1,2-Dichloroethene (cis-DCE)	<220	<220	<220	<220	NA
Trans-1,2-Dichlrorethene (trans-DCE)	<220	<220	<220	<220	NA
Vinyl Chloride[b]	<5,500	<5,500	<5,500	<5,500	NA
Metals (mg/kg):					
Chromium	7.27	5.92	7.18	6.79	11
Manganese	288	276	278	281	2
Uranium	<13.8	<13.8	<13.8	<13.8	NA

RSD = Relative standard deviation or the standard deviation of replicate analyses expressed as a percentage of the mean concentration.
NA = Not analyzed or not applicable.
[a]Percent solids = 90.9%.
[b]Elevated detection limit due to chemical interference.

5.0 AQUIFER OXIDANT DEMAND TEST

5.1 Oxidant Demand Test Procedure

The oxidant demand test was performed to measure the amount of permanganate that will be consumed by oxidizable species in the aquifer material in the course of treatment to destroy the contaminants of concern (COCs). Since there are other oxidizable species in the site aquifer matrix and groundwater, the consumption of the permanganate by these "non-target" species and the COCs must be determined. The amount of permanganate consumed in reaction with the aquifer species is dependent on the reaction time and the concentration of permanganate to which the aquifer material is exposed. The test was conducted by measuring the loss of permanganate from an aquifer material:water slurry as a function of time at both a low and a high initial permanganate concentration to define the aquifer consumption characteristics.

The test was performed on the aquifer composite in duplicate using two concentrations of permanganate. In one test, 0.8 liter of site groundwater and 200 grams of prepared aquifer material were used. The aquifer material/water mixture was treated with 1.0 grams of potassium permanganate ($KMnO_4$) to provide an initial permanganate concentration of 1,250 mg/L (0.125%). This concentration is on the lower end of the typical permanganate application concentration range. The second test was performed using 200 grams of prepared aquifer material and 0.2 liter of site groundwater and was treated initially with 1.4 grams of $KMnO_4$. This treatment had an initial permanganate concentration of 7,000 mg/L (0.7%). The two tests had different aquifer material to water ratios, but this is not anticipated to affect the oxidant demand results, as the critical parameters are the amount of aquifer material, and the amount and concentration of the permanganate supplied to the aquifer material.

The tests were established in 1-L sample bottles, which were capped and shaken on a shaker table for the duration of the test. In IT's experience this provides adequate agitation to maintain a well-mixed slurry.

The amount of permanganate used in these tests in relation to the aquifer material, 5-7 g $KMnO_4$ per kilogram of aquifer material, is well within the typical range for solids oxidant demand, and was sufficient to provide a persistent permanganate concentration so the total demand was measured.

The solution permanganate concentration was monitored as a function of time for both treatments.

Samples for determination of aqueous permanganate concentration were collected and analyzed at 4, 8, 24, 48, 96 and 168 hours. Results from these analyses were used to determine the amount of permanganate consumed at each sampling point. The amount of permanganate consumed was determined from the difference in amount of permanganate dosed and the amount of permanganate determined from analysis. A graph of grams of $KMnO_4$ consumed per kilogram of aquifer material versus time in hours for both concentrations was prepared for determining dosing requirements for the batch slurry permanganate tests.

5.2 Oxidant Demand Test Results

The complete data sets including plots of the permanganate consumption versus time are provided in Appendix A. Figures 1a and 1b in Appendix A show the consumption curves for the low concentration permanganate demand, and Figures 2a and 2b show the consumption curves for the high concentration permanganate demand.

The consumption of permanganate by the aquifer material/groundwater slurry was extremely low. The plots showed some fluctuation because the error associated with the permanganate analysis may have exceeded the change in concentration due to consumption between time points. There was also an apparent dip in the consumption at the 24-hour sampling point in all four tests. This is characteristic for these plots and is believed to be due to incomplete dissolution of the solid $KMnO_4$ reagent added at the beginning of the test. Approximately 90-95 percent of the permanganate dissolves readily in the first few minutes of mixing, but there is typically a residual, which requires between 8 and 24 hours to dissolve completely. At the 24-hour sample point the dissolution of the residual permanganate can cause an increase in concentration, if the matrix consumption is low, and this results in a decrease in the amount of permanganate calculated as consumed.

The bulk of the permanganate consumption typically occurs in the first 48 hours, and the curves level off after that time and remain at a relatively constant value. For this reason, the average of the consumption values for the 48, 96 and 168 hour time points was calculated as the total consumption for each test to obtain a statistically more accurate result. The results for the total demand are summarized in Table 3.

Table 3 – Summary of 168-Hour Aquifer Oxidant Demand Results					
Aquifer Material Composite: BR-3034-IT / BR-3035-IT	$KMnO_4$ Concentration (mg/L)	Aquifer Material/Groundwater Slurry Oxidant Demand for 168 Hours (g $KMnO_4$/kg solid[a])			
		1	2	Mean	RPD (%)
Low $KMnO_4$ Conc.	1,250	0.44	0.43	0.44	2
High $KMnO_4$ Conc.	7,000	0.99	0.79	0.89	22
Average	**4,125**			**0.67**	

[a]Aquifer material composite as received. Percent solids = 90.9%.
RPD = Relative percent difference or the difference between duplicate results expressed as a percentage of the average of the results.

The oxidant demand for the aquifer material composite ranged from 0.44 g $KMnO_4$/kg solids after 168 hours at the low permanganate concentration to 0.89 g $KMnO_4$/kg solids at the high concentration. The average was 0.67 g $KMnO_4$/kg solids. These values are well below the typical soil oxidant demand range of 5-15 g $KMnO_4$/kg soil, and this would be expected for a low organic bedrock matrix.

The reproducibility of the oxidant demand tests was acceptible as the relative percent differences (RPDs) for the test duplicates were less than 25 percent.

6.0 SLURRY PERMANGANATE REACTION TEST

6.1 Test Design

The objectives of the slurry permanganate batch reaction tests were the following:

- measure the rate and extent of permanganate reaction with TCE
- measure the aqueous concentration of uranium and chromium produced by permanganate oxidation of these metals in the aquifer material,
- measure the aqueous concentration of manganese resulting from permanganate treatment of aquifer material/groundwater slurries,
- verify permanganate consumption data from the aquifer oxidant demand tests, and
- collect pH and ORP behavior data for reference in pilot- and field-scale application.

The test objectives were met using 1:1 aquifer material composite and groundwater slurries in batch reactions similar to the aquifer oxidant demand test. The aquifer material and groundwater used in these tests were from TCE contaminated locations at the site. The slurry reactions were conducted

in duplicate using two permanganate concentrations, 1,000 mg/L or 0.10 percent permanganate (low concentration), and 3,850 mg/L or 0.39 percent (high concentration). These concentrations covered the practical range of application concentrations, and provided a factor of about 4 difference to observe concentration effects. Control tests without permanganate addition were also performed as a comparison to the treatment tests.

The aquifer material:groundwater slurries were allowed to react with permanganate at the two concentrations for 72 hours, which based on IT's experience has been sufficient to provide greater than 99 percent reduction of TCE levels. Two sampling points at 8 and 72 hours were used to monitor the reaction of permanganate with TCE. At each sampling point, the residual permanganate concentration, the solution ORP and pH were determined, and then the reaction mixture was chemically quenched, and analyzed for TCE and TCE degradation products. At the 72-hour sampling the aqueous phase from the tests were analyzed for chloride and nitrate ion and total dissolved Cr, Mn and U.

6.2 Test Procedure

Each sample point in the experiment was set up in duplicate in individual 220 mL centrifuge bottles. The test was performed by adding 130 grams aquifer material composite and 130 mLgroundwater quantities to the test bottles and then adding the calculated amount of permanganate (as potassium permanganate) to each bottle to produce the desired initial permanganate concentrations. As detailed in Table 4. A small volume of headspace was left in each bottle to allow for slurry mixing. All bottles were mixed continuously on a shaker table until sampled. Some volatilization of TCE is anticipated into the bottle headspace and is lost during the procedure as well as from other procedural handling steps in this test. However, the procedures developed, including the use of Control tests without permanganate, have been the most practical to date, and have demonstrated sufficient control of VOC losses to meet testing objectives.

Table 4 – Experimental Details				
Test Condition 1:1 aquifer material:groundwater slurry 130 g:130 mL	**$KMnO_4$ Dose (g)**	**$KMnO_4$/Soil Ratio (g/kg soil)**	**Nominal $KMnO_4$ Stoichiometry for TCE Reaction**	**Initial $KMnO_4$ Aqueous Conc. (mg/L)**
Control –no permanganate	0.0	0	0	0
Low permanganate	0.13	1.00	380x	1,000 (917)[a]
High permanganate	0.50	3.85	1500x	3,850 (3,530)[a]

[a]Corrected for contribution to aqueous volume from the moisture in the aquifer material (9.1%).

Control tests (no permanganate added) were established in parallel to the permanganate treated tests. The tests were also conducted in duplicate and sampled at T = 0, and T = 72 hours. The control tests were treated in an identical manner as the treated tests, except that no permanganate was added. The bottles were opened and recapped at the time of dosing and quenching and sampled in the same manner as the treated tests.

For each sample point, one bottle was sacrificed for analysis. Each bottle sacrificed was opened and a 15 to 20 mL aliquot was withdrawn for oxidant reduction potential (ORP), pH and unreacted permanganate measurements. For the T0 control and 72-hour samples, an additional 20 to 30 mL aliquot of the solution was withdrawn and quenched by addition of a slight stoichiometric excess of sodium maleate to react with the residual permanganate in the sample. Sodium maleate is used to mimic aquifer organic material and does not produce a reducing environment, which can affect U, Cr and Mn chemistry. The quenched solutions were then analyzed for dissolved Cr, Mn and U. For all samples, the remaining sample slurry was chemically quenched by addition of a slight stoichiometric excess of manganese sulfate to react with residual permanganate. Manganese sulfate was used because it is not an organic compound and from our experience it does not interfere with the VOC analysis. When the quench reactions were complete, the bottles were centrifuged to produce separate aquifer solids and aqueous fractions. The aqueous phase was transferred to VOA vials for TCE and TCE degradation product analysis by modified EPA Method 8021. The T0 Control and the 72-hour samples were also analyzed for chloride and nitrate ions by EPA Method

300.0. Any excess aqueous phase was then decanted from the solids in the test bottles and 65 mLs of methanol was added to each bottle to extract VOCs. The solids were extracted by shaking the bottle for 2 minutes. The bottle extractions were then centrifuged and the methanol fractions were collected in vials for VOC analysis. The methanol extracts were analyzed by modified EPA Method 8021B to obtain aquifer material concentrations.

Table 5 tabulates the slurry batch tests that were performed and samples that were collected.

Table 5 - Treatability Study Batch Tests

Test Condition	Aquifer and Water Samples[a] (Time in Hour)		
	0[b]	8	72[b]
Control (no permanganate)	XX		XX
Permanganate at low concentration		XX	XX
Permanganate at high concentration		XX	XX

[a]Aqueous samples analyzed for ORP, pH, $KMnO_4$ and chlorinated organics. Aquifer material samples analyzed for chlorinated organics.
[b]In addition to the other analyses the aqueous samples were also analyzed for chloride and nitrate ion and total dissolved U, Cr, and Mn.

6.3 Analytical Measurements

All samples generated during the bench-scale study were analyzed at the TAL in Knoxville per the following methods.

Measurement of Oxidation/Reduction Potential (ORP), pH and Residual (Unreacted) Permanganate

ORP readings of slurry test aqueous solutions were taken using a standard ORP platinum/reference electrode (SCE). The operation of the electrochemical measurement system was checked by reading a standard ORP solution at +430 mV.

The pH readings of slurry test aqueous solutions were taken using a standard combination glass membrane pH/reference electrode. The electrochemical measurement system was calibrated daily using standard pH buffer solutions at pH 4, 7 and 10 prior to taking readings.

Residual permanganate in the slurry test aqueous solution was determined by comparing the absorbance at 526 nanometer wavelength of an aliquot of the solution to that for a prepared standard of permanganate in ionized (DI) water of known concentration. The aliquot of the slurry test supernate was filtered through a 0.2 μm syringe filter and diluted in DI water, if necessary, to produce an aqueous solution containing between 10 and 60 milligrams per liter (mg/L) of permanganate for reading.

Total and Dissolved Metals Analysis

Dissolved metals analysis of water samples were performed at the TAL using SW-846 Method 3015 for sample preparation (microwave digestion) and Method 6010B for Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP) analysis. For each treated water the solution was quenched by addition of sodium maleate to destroy unreacted permanganate. The quenched sample solutions were then filtered through a 0.45 μm pore size filter and analyzed for Cr, Mn and U. Aquifer material samples were analyzed for total metals and were prepared for ICP analysis (Method 6010B) using SW-846 Method 3051 (microwave digestion).

Chloride and Nitrate Ion Analyses

Water samples were analyzed for chloride and nitrate by ion chromatography using EPA Method 300.0. Treated waters were first quenched with manganese sulfate to destroy unreacted permanganate and then barium hydroxide to reduce the sulfate concentration.

TCE and TCE Degradation Product Analyses

The aqueous samples and aquifer solids methanol extracts were analyzed at the TAL for TCE, cis-1,2-DCE trans-1,2-DCE and vinyl chloride using a modified EPA SW-846 Method 8021. This method uses a purge-and-trap technique for sample introduction into a gas chromatograph (GC), which provided analyte separation. A flame ionization detector (FID) was used for quantification.

6.4 Test Results

The results from test measurements and sample analyses for TCE, metals and anions are summarized in Table 6. Table 7 contains sample analysis results for TCE and TCE degradation products.

The TCE results show that it was rapidly degraded by permanganate at both concentrations tested. TCE was not detected in any of the treated samples, even for the 8-hour low permanganate concentration treatments. All treated samples were below the detection limits of 5 μg/L for the waters and 110 μg/kg for the aquifer solids. The results demonstrate 99 percent or greater reduction of aqueous concentrations starting from values in the range of 458 to 701 μg/L.

Some cis-1,2-DCE in the range of 15 to 110 μg/L and vinyl chloride in the range of 5 to 18 μg/Lwere also found in the groundwater and were treated by the permanganate in a similar manner as the TCE. All of the treated water samples were below the 5 μg/L detection limit for these compounds.

The 72-hour permanganate consumptions in the batch tests were somewhat less than those observed in the oxidant demand tests. The oxidant demand tests predicted a matrix consumption of 0.44 to 0.89 grams of $KMnO_4$ per kilogram of solids. The batch tests demonstrated permanganate consumptions from 0 to 0.4 grams of $KMnO_4$ per kilogram of solids in 72-hours. At these low levels it is difficult to compare the values given the potential errors involved. The batch values, however, would more than likely stabilize at a higher value and be closer to the demand test values if the tests continued for 168 hours like the oxidant demand tests.

Chloride ion (Cl^-) concentrations in the groundwater and treated water samples ranged from 34.9 to 64.0 mg/L. One treated water value of 598 mg/L was obtained, but it is suspected that this sample was mistakenly collected in a vial that had HCl preservative added for VOC sample collection. The chloride values in the groundwater were too high to be able to detect the approximate 1 mg/L chloride produced from VOC oxidation. There may have been some detectable increase in values for the treated samples, and this may be from oxidation of other chlorinated organics in the water, but it also could be due to chloride impurities in the permanganate and quench reagents.

Nitrate ion concentrations in the groundwater and treated water samples were not impacted by permanganate treatment. Concentrations were consistently in the range of 3,080 to 3,720 mg NO_3^-/L

The slurry ORP measurements were consistent with permanganate concentrations. They were

greater than +550 mV in the presence of a permanganate concentration, and in the absence of permanganate (the control tests) the slurry ORPs were at about +400 mV or below.

The pH data show did not show an impact on pH due to permanganate treatment. The groundwater and treated water samples all had pH values within the range of 7.12 to 7.60.

Metal analyses were in progress and not completed at the time of this report and will be reported at a later date in a report addendum.

7.0 QA/QC MEASURES

All tests were performed in duplicate and the agreement between duplicate tests was good as summarized in Table 3 for the soil oxidant demand tests and Tables 6 and 7 for the slurry permanganate reactions. Table 8 summarizes the precision of the duplicate test results where positive values were determined.

Table 8 – Summary of Duplicate Test Result Precisions for the Slurry Permanganate Reactions

Test Parameter	Number of Positive Result Test Pairs	Relative Percent Differences (%)
TCE in Water	2	14, 15
Cl^- in Treated Water	3	2, 0, 19
NO_3^- in Treated Water	4	11, 3, 8, 4
$KMnO_4$ Consumed	2	13, 46

RPD = Relative percent difference or the difference between duplicate results expressed as a percentage of the average of the results.

8.0 CONCLUSIONS

Test data indicate that permanganate reaction with TCE, cis-1,2-DCE and vinyl chloride present in the site groundwater occurs rapidly and are destroyed to below detectable levels (<5 μg/L) in groundwater and aquifer environment within the first 8 hours of treatment. A permanganate

concentration of 1,000 mg/L or above will accomplish this performance.

The aquifer oxidant demand was 0.44 to 0.89 grams $KMnO_4$ per kg aquifer solids. This is an exceptionally low level and indicates that permanganate reagent would be used efficiently on site to treat VOCs rather than react with the aquifer matrix. Typical soil oxidant demand for a permanganate treatment site that must be taken into account for determining reagent doses ranges from 5 to 15 g $KMnO_4$/kg soil.

Chloride and nitrate ion concentrations in the groundwater as well as pH of the groundwater are not impacted by permanganate treatment.

Metal analyses on treated waters were not complete at the time of this writing. Conclusions regarding metal oxidation and mobilization issues will be addressed in a report addendum.

Based on the results available from these tests permanganate treatment to destroy VOC contamination is expected to be highly successful. Treatment conditions are favorable because of the following:

1. Demonstrated rapid degradation of site VOC,
2. Low aquifer oxidant demand, which minimizes permanganate cost and allows efficient use of permanganate reagent, even at low concentrations, and
3. No adverse impact demonstrated on chloride and nitrate ion concentrations and groundwater pH.

Appendix A

Soil Oxidant Demand Data

Table 6
Summary of Batch Reaction Test Data for MK Ferguson WSSRAP
Permanganate Oxidation Bench Test

PROJECT # 825930.01000000

Date: 05/04/01			TCE		Dissolved Metals (Aqueous)			Chloride	Nitrate[a]	$KMnO_4$			
		Time	Soil	Water	Chromium	Manganese	Uranium	Water	Water	Residual (Aqueous)	Consumed		ORP
Test	Sample Point	Hours	dry wt basis ug/Kg	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	g/kg soil	p H	mV vs. SCE(+)
Groundwater	GW	NA	NA	962	<0.035	0.32	<0.250	37.1	3540	NA	NA	NA	NA
Aquifer Material	AQ	NA	<220	NA				NA	NA	NA	NA	NA	NA
Control	CT0 A	0	<220	611				34.9	3080	NA	NA	7.12	352
	CT0 B	0	<220	701				35.5	3430	NA	NA	7.17	343
	CT72 A	72	146	471				46.9	3360	NA	NA	7.48	385
	CT72 B	72	144	545				46.9	3470	NA	NA	7.51	405
Low $KMnO_4$	LT8 A	8	<110	<5				NA	NA	856	0.066	7.12	563
1,000 mg/L	LT8 B	8	<110	<5				NA	NA	1136	-0.239	7.14	575
	LT72A	72	<110	<5				64.0	3720	885	0.034	7.53	572
	LT72 B	72	<110	<5				53.1	3420	1015	-0.110	7.60	574
High $KMnO_4$	HT8 A	8	<110	<5				NA	NA	3370	0.17	7.15	594
3,850 mg/L	HT8 B	8	<110	<5				NA	NA	3390	0.15	7.25	596
	HT72A	72	<110	<5				598[b]	3480	3300	0.25	7.52	605
	HT72 B	72	<110	<5				54.6 / 51.9	3610 / 3630	3150	0.41	7.38	598

NA = Not analyzed or Not applicable

[a]Concentration as nitrate (NO_3^-)

[b]Sample suspected of being contaminated with HCl preservative.

Note: Soil quantitation limits were set based on the high soil method of sample analysis and the lowest standard for instrument calibration. Water quantitation limits were based on the lowest standard for instrument calibration and are limited by the FID detector.

Geo-Cleanse International, Inc.

DRAFT
Bench Scale Test Report
Geo-Cleanse® Treatment Program

Weldon Springs Site
Missouri

Prepared for:
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1.0 INTRODUCTION

MK-Ferguson, Inc. (MK-F) has identified an underground discharge of organic compounds (primarily chlorinated hydrocarbons) in groundwater at the Weldon Springs site. Based upon a preliminary review of site characterization data provided by MK-F, Geo-Cleanse International, Inc. (GCI) believes that geologic and hydrogeologic conditions are appropriate and the site is amenable to treatment of the known organic contamination by permanganate in-situ chemical oxidation (PISCO) utilizing the Geo-Cleanse® Process. The Geo-Cleanse® Process is an in-situ injection technology to inject chemical oxidants to the subsurface to oxidize hydrocarbon organic contaminants to substituent carbon dioxide and water (see Section 1.2).

1.1 Oxidant Selection

Based upon review of the supplied documents, GCI recommended permanganate as the selected oxidant for application at the site, as opposed to Fenton's reagent, for several reasons including (but not limited to):

(1) Permanganate is much longer-lived than Fenton's reagent, which increases the ability to distribute the reagent and destroy the TCE under conditions of relatively large fracture volume and rapid groundwater flow regimes.

(2) Permanganate is a more efficient oxidant than Fenton's reagent under conditions of relatively low (<5,000 ug/L) TCE concentrations.

(3) Permanganate is much less sensitive to groundwater pH, alkalinity or iron concentration than is Fenton's reagent. Under conditions present at the Weldon Springs Site, no additional reagent amendments (other than the permanganate solution) are anticipated to be required for treatment.

(4) Fenton's reagent requires a mildly acidic pH condition, low alkalinity and elevated iron concentration for effective treatment. The mildly acidic condition will be difficult to achieve under the aquifer and bedrock conditions present at the site. Although iron could be maintained in solution through the use of iron chelators, these chelators may themselves be of environmental concern. Furthermore, dissolved bicarbonate (present as long as groundwater is alkaline) is an effective radical scavenger, inhibiting treatment of low (<1 mg/L) dissolved VOC concentrations, even when iron is maintained in solution.

Only relatively dilute (much less than 1%) permanganate solutions will be likely be necessary to deliver the required oxidant charge because the contaminant concentrations at the site are relatively low. Sodium permanganate is preferred over potassium permanganate when the required permanganate mass is very large, because the solubility of sodium permanganate (up to 40%) is much higher than potassium permanganate (less than 6%). Potassium permanganate is also preferred over sodium permanganate primarily because potassium permanganate is approximately ¼ of the price (per unit of oxidizing power, or mole of permanganate) of sodium permanganate. Potassium permanganate is delivered as a powder, and reagent preparation is conducted inside a mobile injection treatment unit operated by GCI.

1.2 Permanganate Oxidation

Permanganate (MnO_4^-) is widely used for drinking and wastewater treatment, and has been recently evaluated at several sites for in-situ destruction of organic contaminants in soil and groundwater (e.g., U.S. EPA, 1998). Permanganate ion is most frequently used as potassium permanganate ($KMnO_4$; solubility approximately 65 grams per liter [g/L] at 20°C) or sodium permanganate ($NaMnO_4$; solubility approximately 400 g/L at 20°C). Permanganate is considered a strong oxidizer ($E° = +1.7$ volts [V]) and readily oxidizes TCE ($Cl_2C{=}CHCl$), the primary contaminants present at the Weldon Springs site, with the following basic stoichiometric relationship:

$$2MnO_4^- + Cl_2C{=}CHCl \rightarrow 2CO_2 + 2MnO_2 + 3Cl^- + H^+ \qquad (1)$$

where CO_2 is carbon dioxide, MnO_2 is manganese dioxide (which precipitates as an insoluble solid), Cl^- is chloride ion, and H^+ is hydronium ion, O_2 is oxygen and H_2O is water. The systematics and pathway of permanganate oxidation of TCE is not well known. Huang et al. (1999) found that TCE oxidation was generally complete in 60 to 90 minutes, and reported a rate constant for equation 1 of approximately 0.9 $M^{-1}s^{-1}$. Intermediate oxidation products are reported to include formic, glycolic, glyoxylic and oxalic acids, which are subsequently oxidized to carbon dioxide (Yan and Schwartz, 1998). The most detailed studies to date are those of Yan and Schwartz (1999, 2000). Yan and Schwartz (1999, 2000) proposed a reaction scheme for oxidation of chlorinated ethylenes (including TCE and cis-1,2-DCE) which generates aldehydes and carboxylic acids as intermediate products (Figure 1-1). Yan and Schwartz (1999, 2000) found that the permanganate reaction rates with chlorinated ethylenes increase with decreasing chlorination, i.e., vinyl chloride reacts more rapidly than TCE. Yan and Schwartz (1999) reported that the reaction was pseudo-first order with respect to both TCE and permanganate, and second-order overall, with a second-order rate constant of 0.66 $M^{-1}s^{-1}$.

Precipitated MnO_2 is also environmentally active. Solid MnO_2 can be reduced and dissolved by certain organic compounds, resulting in oxidation and destruction of the organic compound. For example, Laha and Luthy (1990) report oxidation of aniline and other aromatic amines, catechol, and quinones by colloidal suspensions of solid MnO_2. Manganese dioxide also undergoes ion-exchange reactions with dissolved metals. Metal adsorption is sensitive to pH, but under near-neutral conditions (pH of 5 to 8), MnO_2 is capable of adsorbing heavy metals such as hexavalent chromium, cadmium, and copper (Vella, 1998).

Permanganate also reacts with oxidizable metals and certain natural organic compounds in soil and groundwater. For example, MnO_4^- oxidizes Fe^{+2} to Fe^{+3}:

$$3Fe^{+2} + MnO_4^- + 4H^+ \rightarrow MnO_2 + 3Fe^{+3} + 2H_2O \qquad (3)$$

Relatively higher concentrations of oxidizable metals or other compounds, therefore, act to increase oxidant demand and reduce permanganate efficiency. Permanganate is not a thermodynamically favorable form of manganese in groundwater systems due to the presence of oxidizable organic and transition metals, thus the potential migration of permanganate solutions is limited.

1.3 Bench Test Objectives and Overview

Prior to conducting a field pilot test, MKF requested a bench test to confirm effectiveness of the proposed technology and to attempt to evaluate the potential impact of permanganate in-situ chemical oxidation on groundwater quality. The purposes of this document are to:

(1) Describe the fundamental basis for application of PISCO to TCE, identified by MKF as the primary contaminant of concern at the site.

(2) Describe the objectives, methods, and results of bench scale treatability tests conducted with Geo-Cleanse® PISCO reagents on groundwater and rock samples from the Weldon Springs site.

(3) Draw conclusions regarding overall applicability of PISCO on the contaminants present and under the geological and hydrological characteristics present at the Weldon Springs site.

Three types of bench tests were conducted to evaluate the potential effects and applicability of PISCO at the Weldon Springs site. The specific tests conducted included total oxidant demand tests, aquifer impact tests, and contaminant oxidation tests. The total oxidant demand tests were intended to

evaluate oxidant demand from naturally present oxidizable metals and organics, and from the targeted contaminants. Aquifer impact tests were conducted to evaluate the potential impact of permanganate treatment on inorganic groundwater quality, specifically upon dissolved metals concentration. Finally, contaminant oxidation tests were conducted to confirm that permanganate would oxidize TCE to concentrations below the ARAR of 5 ug/L, and utilize the resulting data (in conjunction with the ORP data) to evaluate reagent requirements.

2.0 MATERIALS AND METHODS

2.1 Sample Collection

Samples were collected by MKF personnel and delivered under standard chain of custody protocols to GCI. A 5 L groundwater sample identified by MKF as GW-3030-032701-GC, collected on March 27, 2001, was supplied in five 1,000-mL amber glass bottles preserved on ice but not otherwise preserved (i.e., no acid or other preservative was added). Two groundwater core samples identified by MKF as BR-3035-GC-135 and BR-3035-GC-36, collected (from an archived core) on March 28, 2001, were provided, individually packaged in a plastic Ziploc®-type bag and stored on ice but not otherwise preserved. Samples were delivered by overnight express mail and received at GCI on March 29, 2001.

2.2 Total Oxidant Demand Tests

Four 200-mL aliquots of groundwater were transferred to 400-mL Pyrex beakers containing a Teflon-coated magnetic stirrer. A charge of 4, 6, 8 and 10 mL of a 711 mg/L permanganate solution (standardized with sodium permanganate) was added to each beaker and ORP measured after thoroughly mixing the amended groundwater sample. ORP was measured at approximately 1-hr intervals for 8 hours, then at approximately 2-hr intervals starting the next day. The samples were allowed to react until ORP was stable. A plot was prepared of the final ORP versus volume of permanganate added. The volume of permanganate added to achieve a stable ORP was the quantity of permanganate solution required to oxidize all reactant species in the 200-mL groundwater sample. Bedrock samples were not included in these tests because the available surface area does not significantly affect total oxidant demand.

2.3 Aquifer Impact Tests

A natural fracture face of the bedrock (derived from the bedrock cores) was suspended within polyethylene cable ties in a 1,000-mL volume of site groundwater in a 2,000 mL Pyrex beaker. The unnatural, cut surfaces of the core section (representing the sides of the core) were coated with non-reactive polyurethane (Minwax® Fast-Drying Clear Gloss) to isolate these surfaces from reagent exposure. The full, natural fracture face was fully immersed in the amended groundwater. A 20 mL charge of 711 mg/L sodium permanganate (standardized with sodium oxalate; see below) was added to the groundwater (resulting in a net 13.9 mg/L concentration of sodium permanganate in the test solution, which was targeted based upon the total oxidant demand test results; see Section 3.1) and allowed to react while gently stirring with a Teflon-coated stir bar. The experiment was concluded after 48 hours, and the solution was filtered (0.45-micron) and analyzed for target analyte list metals (23 metals) plus uranium (uranium results will be reported separately). The target analyte list metals (except mercury) were analyzed by EPA Method 200.7. Mercury was analyzed by Method 245.1. This test was conducted on

each bedrock sample submitted to GCI. A method blank was prepared by adding 20 mL of the stock 711 mg/L permanganate to 1,000 mL of deionized water, to evaluate the metals concentration in the reagent at the identical concentration utilized in the tests.

2.4 Contaminant Oxidation Tests

The final set of tests was conducted to ensure that permanganate can oxidize the targeted compound (TCE) at the site to levels below the ARAR of 5 ug/L, and estimate the permanganate requirement for the site. For this test, six 250-mL aliquots of groundwater were transferred to 250 mL Pyrex media bottles. Media bottles were selected because they are effectively vapor-tight to mitigate volatilization. Five bottles received permanganate amendments, one test each with approximately 0.6, 1, 2, 5 and 10 times the *stoichiometric* oxidant demand. Stoichiometric oxidant demand was based upon equation 1, which assumed a 220 µg/L TCE concentration (based upon pre-test data supplied by MKF). Equation 1 predicts a stoichiometric mass ratio for $NaMnO_4$:TCE of 2.2:1. For a 250 mL volume of groundwater and a 711 mg/L solution of permanganate, the volume of permanganate solution for each test was 100 µL (0.6 x stoichiometric), 170 µL (1 x stoichiometric), 340 µL (2 x stoichiometric), 850 µL (5 x stoichiometric), and 1,700 µL (10 x stoichiometric). One bottle was utilized as a method blank, which received no oxidant but was otherwise treated exactly as a sample, to represent the baseline condition. The solutions will be allowed to react in the dark for 48 hours, after which an aliquot was collected for VOC analysis by EPA Method 8260.

2.5 General Analytical Methods

Bench test experiments were conducted at GCI's Remediation Technology Testing Laboratory. Laboratory facilities include a dedicated fume hood, refrigerated sample storage, a Hach DR-2010 data logging spectrophotometer, micropipettors, glass electrode pH meters, thermometers, analytical balances, reagents, and all associated glassware and other facilities necessary for proper cleaning, storage, sampling, analyses and other experimental procedures required for these tests.

All laboratory materials to which the samples or reagents came into contact were composed of Pyrex, stainless steel, Teflon, or polyethylene (as dictated by the analytical procedure), and were cleaned with deionized water and Alconox and then triple-rinsed with deionized water prior to use. Solution volumes were measured with Class A graduated cylinders, volumetric flasks or a calibrated micropipette. Sample or reagent masses were measured with calibrated analytical balances. Solution pH was measured to ±0.01 pH units with a glass electrode meter calibrated daily. All reagents were reagent grade or better, and only deionized water was used in all experiments.

A stock sodium permanganate solution (with a target of approximately 500 mg/L sodium permanganate) was prepared by diluting 3.75 mL of 40% technical grade $NaMnO_4$ solution to 3,000 mL with deionized water. This solution was then standardized (with a result of 711 mg/L $NaMnO_4$) by titration with sodium oxalate. In order to measure residual sodium permanganate in test solutions, secondary standards at 0.711 mg/L, 3.56 mg/L, 7.11 mg/L, and 35.6 mg/L sodium permanganate were prepared by dilution of the 711 mg/L stock solution. Absorbance was measured at 546 nm using matched 25 mL glass cells. A linear regression was calculated by least squares regression of the absorbance (independent variable) and known concentration (dependent variable), against which the samples were compared to measure sodium permanganate concentration in the sample.

3.0 RESULTS AND DISCUSSION

3.1 Total Oxidant Demand Tests

The total oxidant demand test results are presented in Figures 3-1 (full scale) and 3-2 (reduced scale to exhibit in greater detail the results with ORP greater than 550 mV). The ORP results exhibit patterns that are very similar in all four tests (Figure 3-1), but the quantitative results for each successively increasing permanganate concentration are offset from each other (i.e., the trends are parallel but do not converge). The baseline ORP ranged from 239 to 245 mV prior to permanganate addition. After addition of 4 to 10 mL of 711 mg/L sodium permanganate, the ORP increased to range from 536 to 574 mV (Figure 3-1). The ORP than decreased over a period of 4 hours (with minimum ORP values ranging from 551 to 565 mV), after which ORP then increased (without additional permanganate amendments). The next morning, ORP had dropped again in all four tests, however the parallel trends were maintained, indicating that the permanganate demand had been satisfied after addition of less than 4 mL of 711 mg/L sodium permanganate (equivalent to a 13.9 mg/L solution $NaMnO_4$).

3.2 Aquifer Impact Tests

The aquifer impact results for target analyte list metals and residual permanganate results are presented in Table 3-1. The sodium permanganate concentration established in the samples was 13.9 mg/L (based upon the results of the total oxidant demand tests described in Section 3.1). Results for the Method Blank (a sample with identical sodium permanganate concentration as the test samples, but diluted with deionized water rather than site groundwater) indicate that only sodium and manganese were present at relatively high concentrations. The only other metal detected was zinc, with a concentration of 81 μg/L. Therefore, metals in the permanganate amendment would not contribute significantly to any metals detected in the treatment solutions (derived by dissolution from the rock core fragment).

Post-treatment analysis of the samples exposed to the bedrock core yielded calcium, magnesium, and sodium in the treated water samples. Most significantly, primary metals of concern when working with permanganate (for example, chromium, lead, and mercury) remained at non-detectable levels. The treated samples yielded calcium and magnesium (representing hardness in the groundwater sample utilized), and potassium (unknown origin). Thus establishing an approximately 14 mg/L sodium permanganate concentration satisfies total oxidant demand (based upon the ORP titration; Section 3.1) and does not produce significant quantities of liberated metals from either the permanganate or the rock sample.

3.3 Contaminant Oxidation Tests

Analytical results for VOCs and residual sodium permanganate are presented in Table 3-2. The total chlorinated VOC results (sum of TCE and cis-1,2-dichloroethene concentrations) are presented graphically in Figure 3-3. The background concentration of chlorinated VOCs (taken as the sum of TCE and cis-1,2-dichloroethene concentrations) was 229.6 mg/L. The VOC concentration decreased progressively (and linearly) with increasing permanganate addition, with a TCE concentration less than the ARAR of 5 μg/L established at approximately a mass ratio equivalent to approximately 10 times the stoichiometric amount. The 10x test was addition of 1.7 mL of 711 mg/L sodium permanganate to a 250 mL volume, thus the net sodium permanganate concentration in the test solution was approximately 4.8 mg/L.

4.0 CONCLUSIONS

The following general conclusions were reached based upon the analytical results of the bench tests:

(1) The total oxidant demand of groundwater from the Weldon Springs site (based upon ORP measurements) was satisfied after establishing a sodium permanganate concentration of 13.9 mg/L.

(2) Calcium, magnesium, manganese, potassium and sodium were the only metals detected in water samples with 13.9 mg/L sodium permanganate and with a core section from the site immersed in the groundwater for 48 hours. This indicates that many metals of potential concern during PISCO (e.g., chromium, lead, mercury, etc.) were not detectable in the concentrations of permanganate that are likely to be used at this site.

(3) A stoichiometric mass ratio of $NaMnO_4$:VOC of approximately 10:1 resulted in greater than 99% oxidation of trichloroethene and cis-1,2-dichloroethene (to a concentration of 2.0 µg/L, below the ARAR of 5 µg/L). For the 220 µg/L TCE concentration in the test samples, this corresponded to establishing a concentration of approximately 4.8 mg/L of sodium permanganate.

Based upon these results, PISCO treatment of the TCE plume at the site is a viable technology to for TCE oxidation and to achieve the ARAR value of 5 mg/L. The estimated 10:1 mass ratio of permanganate:VOC is anticipated to represent the integrated treatment target at the site.

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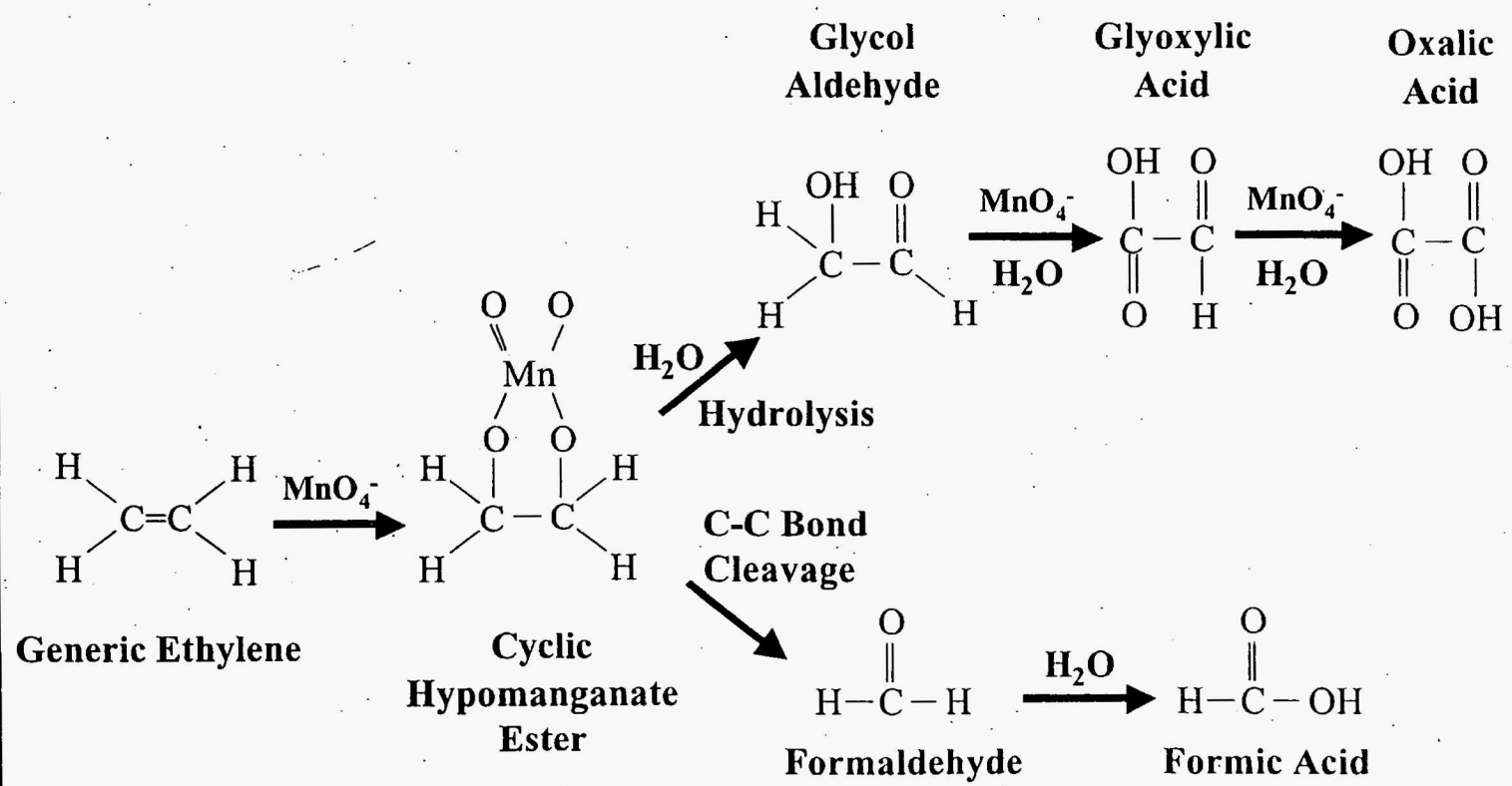

Reference: Yan & Schwartz (1999)

FIGURE 1-1. Permanganate Oxidation Pathway for Trichloroethene

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Figure 3-1. Oxidant Demand Test Results

(Full Data Set)

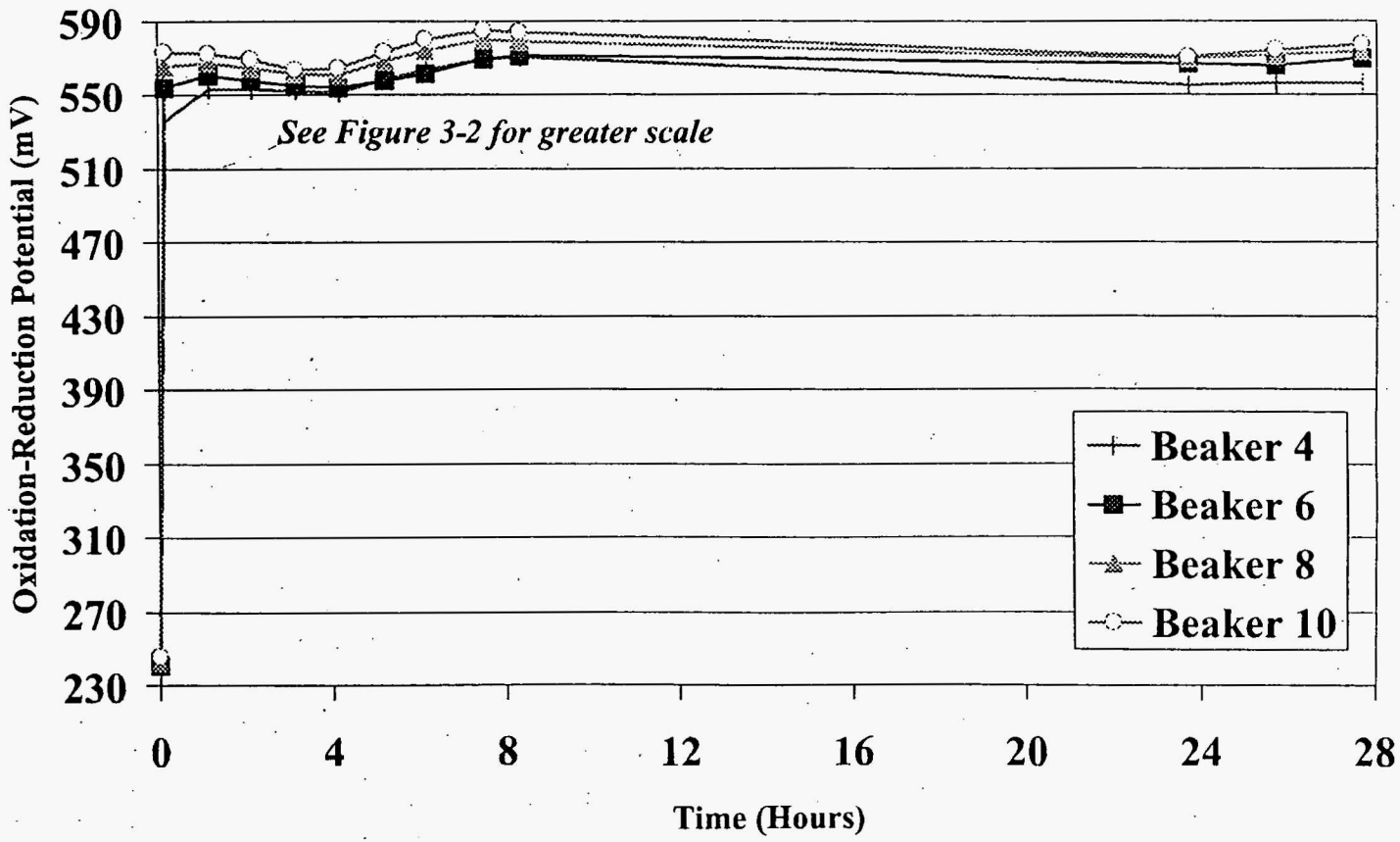

Figure 3-2. Oxidant Demand Test Results

(ORP >550 mV)

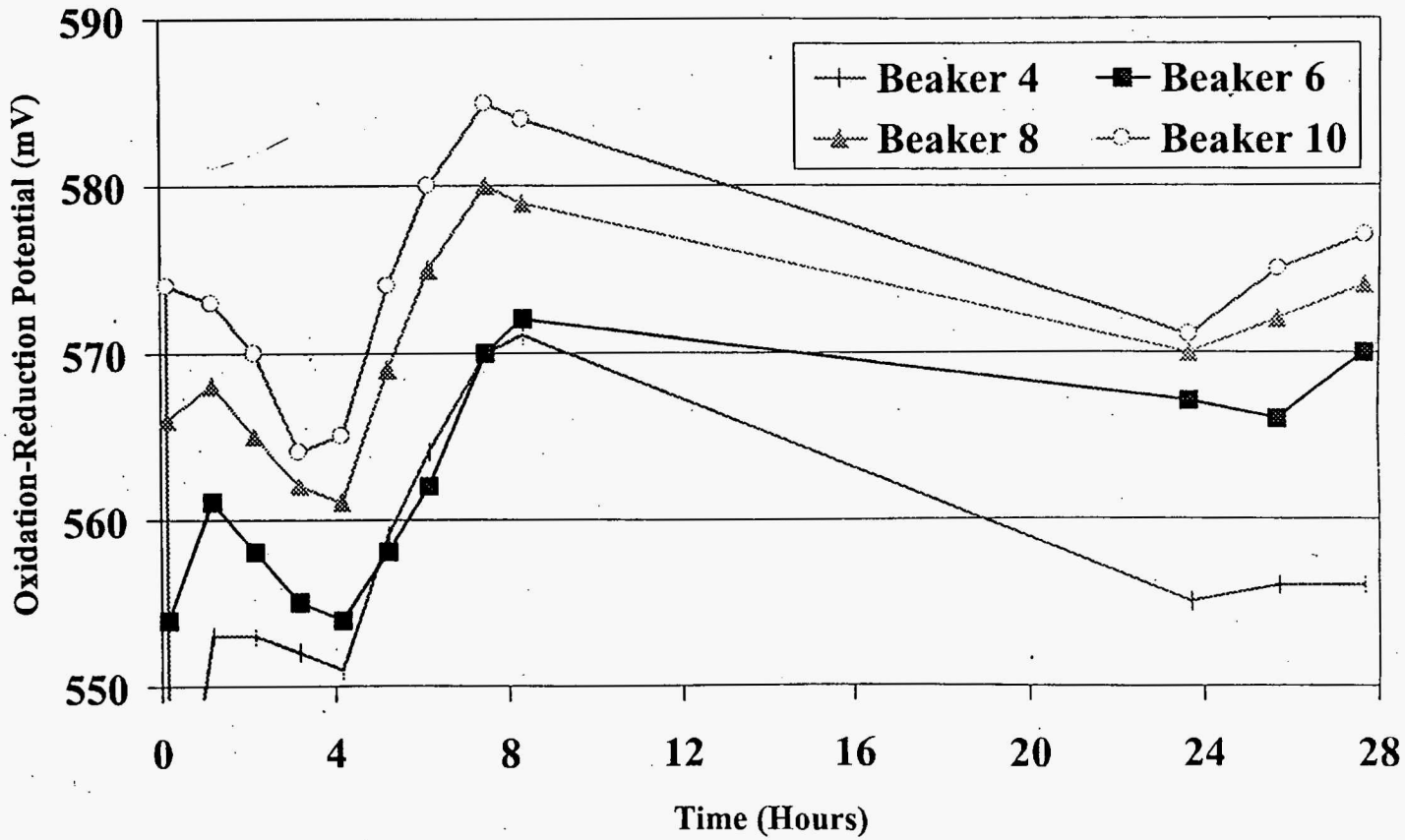

Figure 3-3. VOC Oxidation Test Results

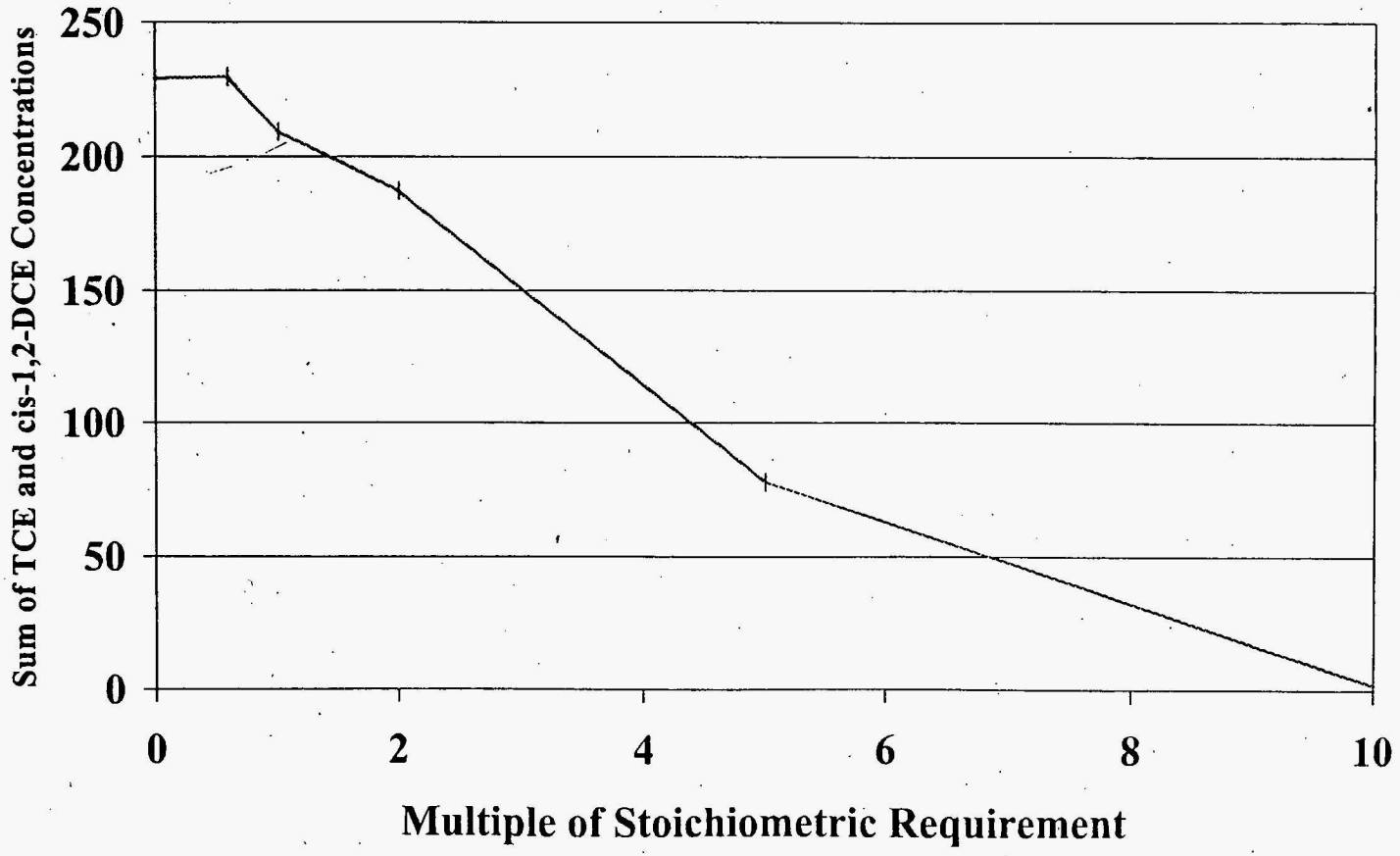

Table 3-1. Target Analyte List Metals and Permanganate Results

Analyte	Method Blank (ug/L)	BR-3030-GC-135 (ug/L)	BR-3030-GC-36 (ug/L)
Aluminum	ND (<100)	ND (<100)	ND (<100)
Antimony	ND (<7.5)	ND (<7.5)	ND (<7.5)
Arsenic	ND (<4)	ND (<4)	ND (<4)
Barium	ND (<25)	ND (<25)	ND (<25)
Beryllium	ND (<10)	ND (<10)	ND (<10)
Cadmium	ND (<2)	ND (<2)	ND (<2)
Calcium	ND (<1,000)	**100,000**	**110,000**
Chromium (total)	ND (<25)	ND (<25)	ND (<25)
Cobalt	ND (<10)	ND (<10)	ND (<10)
Copper	ND (<25)	ND (<25)	ND (<25)
Iron	ND (<150)	ND (<150)	ND (<150)
Lead	ND (<5)	ND (<5)	ND (<5)
Magnesium	ND (<1,000)	**39,000**	**41,000**
Manganese	**3,300**	**180**	**1,600**
Mercury	ND (<0.21)	ND (<0.21)	ND (<0.21)
Nickel	ND (<25)	ND (<25)	ND (<25)
Potassium	ND (<500)	**3,600**	**3,600**
Selenium	ND (<25)	ND (<25)	ND (<25)
Silver	ND (<10)	ND (<10)	ND (<10)
Sodium	**4,100**	**190,000**	**200,000**
Thallium	ND (<5)	ND (<5)	ND (<5)
Vanadium	ND (<25)	ND (<25)	ND (<25)
Zinc	**81**	ND (<25)	ND (<25)
Sodium Permanganate	**13,700**	**470 J**	**5,890**

Notes:

Bold font indicates analyte was positively detected.

ND indicates analyte was not detected with the quoted PQL.

PQL is the practical quantitation limit quoted by the analytical laboratory.

J indicates the analyte was positively detected at an estimated concentration less than the PQL.

Table 3-2. Volatile Organic Compound Oxidation Test Results

Compound	Test 1 Method Blank	Test 2 0.6x Stoichiometric 100 uL $NaMnO_4$	Test 3 1x Stoichiometric 170 uL $NaMnO_4$	Test 4 2x Stoichiometric 340 uL $NaMnO_4$	Test 5 5x Stoichiometric 850 uL $NaMnO_4$	Test 6 10x Stoichiometric 1,700 uL $NaMnO_4$
1,1,1-Trichloroethane	ND (<0.23)	ND (<0.23)	ND (<0.23)	ND (<0.23)	ND (<0.23)	ND (<0.23)
1,1,2,2-Tetrachloroethane	ND (<0.27)	ND (<0.27)	ND (<0.27)	ND (<0.27)	ND (<0.27)	ND (<0.27)
1,1,2-Trichloroethane	ND (<0.37)	ND (<0.37)	ND (<0.37)	ND (<0.37)	ND (<0.37)	ND (<0.37)
1,1-Dichloroethane	ND (<0.24)	ND (<0.24)	ND (<0.24)	ND (<0.24)	ND (<0.24)	ND (<0.24)
1,1-Dichloroethene	ND (<0.33)	ND (<0.33)	ND (<0.33)	ND (<0.33)	ND (<0.33)	ND (<0.33)
1,2-Dichloroethane	ND (<0.13)	ND (<0.13)	ND (<0.13)	ND (<0.13)	ND (<0.13)	ND (<0.13)
1,2-Dichloropropane	ND (<0.18)	ND (<0.18)	ND (<0.18)	ND (<0.18)	ND (<0.18)	ND (<0.18)
2-Butanone	ND (<0.87)	ND (<0.87)	ND (<0.87)	ND (<0.87)	ND (<0.87)	ND (<0.87)
2-Chloroethylvinylether	ND (<0.80)	ND (<0.80)	ND (<0.80)	ND (<0.80)	ND (<0.80)	ND (<0.80)
2-Hexanone	ND (<0.32)	ND (<0.32)	ND (<0.32)	ND (<0.32)	ND (<0.32)	ND (<0.32)
4-Methyl-2-Pentanone	ND (<0.28)	ND (<0.28)	ND (<0.28)	ND (<0.28)	ND (<0.28)	ND (<0.28)
Acetone	ND (<2.7)	ND (<2.7)	ND (<2.7)	ND (<2.7)	ND (<2.7)	ND (<2.7)
Acrolein	ND (<3.2)	ND (<3.2)	ND (<3.2)	ND (<3.2)	ND (<3.2)	ND (<3.2)
Acrylonitrile	ND (<2.1)	ND (<2.1)	ND (<2.1)	ND (<2.1)	ND (<2.1)	ND (<2.1)
Benzene	ND (<0.27)	ND (<0.27)	ND (<0.27)	ND (<0.27)	ND (<0.27)	ND (<0.27)
Bromodichloromethane	ND (<0.15)	ND (<0.15)	ND (<0.15)	ND (<0.15)	ND (<0.15)	ND (<0.15)
Bromoform	ND (<0.15)	ND (<0.15)	ND (<0.15)	ND (<0.15)	ND (<0.15)	ND (<0.15)
Bromomethane	ND (<0.31)	ND (<0.31)	ND (<0.31)	ND (<0.31)	ND (<0.31)	ND (<0.31)
Carbon Disulfide	ND (<0.27)	ND (<0.27)	ND (<0.27)	ND (<0.27)	ND (<0.27)	ND (<0.27)
Carbon Tetrachloride	ND (<0.21)	ND (<0.21)	ND (<0.21)	ND (<0.21)	ND (<0.21)	ND (<0.21)
Chlorobenzene	ND (<0.28)	ND (<0.28)	ND (<0.28)	ND (<0.28)	ND (<0.28)	ND (<0.28)
Chloroethane	ND (<0.49)	ND (<0.49)	ND (<0.49)	ND (<0.49)	ND (<0.49)	ND (<0.49)
Chloroform	**2.1**	**2.2**	**1.9**	**2.0**	**2.1**	**2.1**
Chloromethane	ND (<0.51)	ND (<0.51)	ND (<0.51)	ND (<0.51)	ND (<0.51)	ND (<0.51)
Cis-1,2-Dichloroethene	**9.6**	**9.8**	**9.1**	**7.3**	**1.4**	**ND (<0.27)**
Cis-1,3-Dichloropropene	ND (<0.18)	ND (<0.18)	ND (<0.18)	ND (<0.18)	ND (<0.18)	ND (<0.18)
Dibromochloromethane	ND (<0.22)	ND (<0.22)	ND (<0.22)	ND (<0.22)	ND (<0.22)	ND (<0.22)
Ethylbenzene	ND (<0.58)	ND (<0.58)	ND (<0.58)	ND (<0.58)	ND (<0.58)	ND (<0.58)
m- & p-Xylenes	ND (<0.90)	ND (<0.90)	ND (<0.90)	ND (<0.90)	ND (<0.90)	ND (<0.90)
Methylene Chloride	ND (<1.5)	ND (<1.5)	ND (<1.5)	ND (<1.5)	ND (<1.5)	ND (<1.5)
o-Xylene	ND (<0.52)	ND (<0.52)	ND (<0.52)	ND (<0.52)	ND (<0.52)	ND (<0.52)
Styrene	ND (<0.44)	ND (<0.44)	ND (<0.44)	ND (<0.44)	ND (<0.44)	ND (<0.44)
Tetrachloroethene	ND (<0.30)	ND (<0.30)	ND (<0.30)	ND (<0.30)	ND (<0.30)	ND (<0.30)
Toluene	ND (<0.19)	ND (<0.19)	ND (<0.19)	ND (<0.19)	ND (<0.19)	ND (<0.19)
Trans-1,2-Dichloroethene	ND (<0.34)	ND (<0.34)	ND (<0.34)	ND (<0.34)	ND (<0.34)	ND (<0.34)
Trans-1,3-Dichloropropene	ND (<0.23)	ND (<0.23)	ND (<0.23)	ND (<0.23)	ND (<0.23)	ND (<0.23)
Trichloroethene	**220**	**220**	**200**	**180**	**77**	**2.0**
Vinyl Chloride	ND (<0.55)	ND (<0.55)	ND (<0.55)	ND (<0.55)	ND (<0.55)	ND (<0.55)
Sodium Permanganate	ND (<300)	ND (<300)	ND (<300)	ND (<300)	**1,420**	**3,390**

Environmental
Resources
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May 2, 2001

Mr. Vernon D. Logan
Subcontract Administrator
Morrison Knudsen Corporation
MK Ferguson Group
Weldon Spring Site Remedial Action Project
7295 Highway 94 South
St. Charles, MO 63304

RE: Weldon Spring Site Remedial Action Project
Ground Water Operable Unit (GWOU)
Insitu Chemical Oxidation Treatment Bench Scale Testing Results
Potassium Permanganate and Sodium Persulfate
MK Ferguson Purchase Order No. 3589-0000-32713
ERM Project No. FV201.00

Dear Mr. Logan:

INTRODUCTION

Environmental Resources Management's (ERM's) Remediation Technology Group (RTG) is pleased to submit this report summarizing the results of the bench scale treatability study performed using weathered bedrock and ground water samples from the Weldon Spring Site Remedial Action Project (WSSRAP) located in Weldon Spring, St. Charles County, Missouri. The tests associated with this study were designed to investigate the effectiveness of two chemical oxidants, potassium permanganate and sodium persulfate, to treat the primary contaminant of concern (COC), trichloroethene (TCE) in ground water at the WSSRAP and to determine the oxidant demand of each weathered bedrock sample. Additionally, the effect of chemical oxidation on the dissolved concentrations of the secondary COCs, uranium, nitroaromatics, and nitrate, was determined during the performance of the bench scale treatability tests.

The goal of using insitu chemical oxidation (ISCO) in the field is to achieve the Applicable, Relevant, and Appropriate Requirements (ARAR) for TCE, which is the U.S. Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL) of 5 μg/L. An additional goal is to not mobilize the secondary COCs during the oxidation of TCE.

SUPPLY OF GROUND WATER AND BEDROCK SAMPLES

Personnel from MK Ferguson performed the field sampling work to collect the weathered bedrock and ground water samples to be used by ERM's Remedial Technology Center (RTC) in performing the bench scale treatability tests. MK Ferguson personnel collected the samples on March 28, 2001, packed them on ice, and shipped them using standard chain-of-custody procedures to ERM's RTC in West Chester, Pennsylvania. The weathered bedrock and soil samples arrived at the RTC on March 29, 2001.

MK Ferguson personnel supplied two weathered bedrock samples and one ground water sample for the study. Approximately 6.5 kilograms (14.3 pounds) of weathered bedrock designated "BR3034" were received in three plastic bags. Approximately 7.4 kilograms (16.3 pounds) of weathered bedrock designated "BR3035" were received in three plastic bags. Ten 1-liter bottles of ground water designated "GW3034" were also received. The sample containers were inspected for integrity and radioactivity. No counts were observed with a Geiger counter. The samples were then logged in and placed in refrigerated storage.

BENCH SCALE TREATABILITY TESTS

The basic experimental design for the WSSRAP bench scale chemical oxidation treatability study consisted of five phases of work. These phases were as follows:

1. Initial characterization of the two weathered bedrock and single ground water samples;

2. Determination of chemical oxidation effectiveness against the primary COC with: (a) potassium permanganate alone, and (b) a combination of sodium persulfate and ferrous iron;

3. Determination of chemical oxidation effectiveness against the secondary COCs with: (a) potassium permanganate alone, and (b) a combination of sodium persulfate and ferrous iron;

4. Determination of total matrix oxidant demand for each weathered bedrock sample using: (a) potassium permanganate alone, and (b) sodium persulfate alone; and

5. Determination of the solubility of secondary COCs in the weathered bedrock using: (a) potassium permanganate alone, and (b) a combination of sodium persulfate and ferrous iron.

PHASE I - INITIAL CHARACTERIZATION OF SITE MATERIALS

Initial Characterization Procedures

Prior to beginning the actual treatability experiments, the weathered bedrock samples and ground water were processed and chemically characterized as described in the sections below.

Weathered Bedrock - The two bedrock samples, BR3034 and BR3035, were mechanically crushed individually. Each sample was then screened to a uniform size (10-mm screen) to remove debris, and mixed by hand to apparent homogeneity. The processed bedrock samples were then refrigerated in sealed containers with minimal headspace and used in all subsequent tests.

Crushing and screening of the weathered bedrock was necessary to create materials of similar physical composition for use in the tests. The similarity of the starting materials allows for the direct comparison of data generated from each weathered bedrock sample.

Processed weathered bedrock samples, BR3034 and BR3035 were each analyzed for:

- Chemical Oxygen Demand (MCAWW Method 410.1);
- Total Organic Carbon (US EPA SW846 Method 9060);
- Nitroaromatics (US EPA SW846 Method 8330);
- Nitrate (US EPA SW846 Method 9056); and
- Uranium (US EPA SW846 Method 908).

All analytical tests were performed by CompuChem Laboratories (CompuChem) of Cary, North Carolina, except for the uranium analysis. CompuChem subcontracted the uranium analyses to Paragon Analytics, Inc. (Paragon) of Fort Collins, Colorado.

Ground Water - Ground water sample, GW3034, was analyzed for:

- Volatile Organic Aromatics (US EPA CLP SOW OLM04.2);
- Nitroaromatics (US EPA SW846 Method 8330);
- Nitrate (US EPA SW846 Method 9056);
- Dissolved Uranium (US EPA SW846 Method 908);
- pH (US EPA SW846 Method 9040);
- Total Organic Carbon (TOC) (US EPA SW846 Method 9060);
- Chemical Oxygen Demand (COD) (MCAWW Method 410.1);
- Alkalinity as Carbonate (MCAWW Method 310.1); and
- Alkalinity as Bicarbonate (MCAWW Method 310.1).

All analytical tests were performed by CompuChem, except for the uranium analysis, which was subcontracted to Paragon.

The samples for uranium analysis were sent for overnight delivery to Paragon on Friday, March 30, 2001. These samples arrived in good

condition on Saturday, March 31, 2001. The samples for the remaining analyses were sent for overnight delivery to CompuChem. These coolers were delivered to the laboratory on Monday, April 2, 2001, instead of Saturday, March 31, 2001. CompuChem notified David Robinson of ERM that these coolers arrived out of temperature (at 7°C, rather than 4°C as required), and that the nitrate samples were out of the standard 48-hour holding time. A decision was made by ERM to proceed with all analyses in order to meet the project schedule and to consider the data generated provisional. The status of these data were discussed with Barb Duletsky, the MK Ferguson Project Manager, on April 6, 2001.

Characterization Sample Results

Results of the bedrock and ground water analyses are shown in Table 1. Only those compounds detected above the practical quantitation limit (PQL) are shown in the table. Copies of the laboratory analytical reports are contained in Appendix A.

The ground water sample from GW3034 contained 640 µ/L of TCE, the primary COC, along with lower concentrations of several other volatile organic aromatics (VOAs). For the secondary COC, only quantifiable levels of nitrate (785 mg/L) and uranium (3.93 ± 0.53 µ/L) were found in the ground water. The ground water was at a near-neutral pH (7.46) and contained low levels of organic material as shown by the 69.6 mg/L concentration of Total Organic Carbon and a Chemical Oxygen Demand of 20.2 mg/L.

The weathered bedrock sample from BR3034 contained acetone at an estimated concentration of 8 µg/kg. No other VOAs or nitroaromatic compounds were detected in sample BR3034. This finding may be questionable since acetone was also detected in the method blank, which would suggest that the acetone may be a laboratory artifact. Nitrate, at 7.63 mg/kg, and uranium, at 0.72 ± 0.10 µg/kg, were also present in sample BR3034. This bedrock sample also exhibited a high

Total Organic Carbon concentration of 110,500 mg/kg, and a relatively low Chemical Oxygen Demand of 26.4 mg/kg.

The weathered bedrock sample from BR3035, contained acetone and 2-butanone at estimated concentrations of 4 µg/kg and 2 µg/kg, respectively. No other VOAs or nitroaromatic compounds were detected in sample BR3035. These findings may be questionable since acetone and 2-butanone were also detected in the method blank, which would suggest that they may be laboratory artifacts.. Nitrate, at 3.6 mg/kg, and uranium, at 0.84 µg/kg, were also present. This bedrock also exhibited a high Total Organic Carbon concentration of 113,000 mg/kg, and a relatively low Chemical Oxygen Demand of 3.0 mg/kg

Finalization of the Treatability Study Work Plan

On April 6, 2001, a conference call was made by George Skladany and David Robinson of ERM to Barb Duletsky of MK Ferguson to discuss the Initial Characterization results and proposed changes in the treatability study work plan. Four issues were discussed: (1) the status and use of the initial characterization provisional data; (2) provisions for spiking nitroaromatics into the site bedrock/ground water samples due to the absence of nitroaromatics from these materials; (3) conducting the oxidation efficiency tests in two separate stages: one for the primary COC and a complementary experiment for the secondary COCs; and (4) analyzing for nitroaromatics as part of the bedrock solubilization tests.

1. Ms. Duletsky commented that the initial characterization results were similar to those independently obtained by MK Ferguson on similar samples. With respect to the sample temperature and holding time issues, ERM offered to provide new samples for analyses should that be deemed necessary. A decision was made to use the provisional data since new "Time = 0" samples would be submitted with each new treatability experiment.

2. Since the effect of the chemical oxidants on the secondary COC was one of the major concerns of the study, the lack of nitroaromatic compounds in either the bedrock or ground water samples was discussed. In order to investigate the effect of permanganate and persulfate on nitroaromatic compounds, it was decided to spike the ground water to contain these compounds. It was determined that a certified chromatography standard solution of these standards would be purchased from Restek Corporation (Restek) of Bellafonte, Pennsylvania. The targeted spiking concentration was set at 10 μ/L for each nitroaromatic compound.

   Each processed bedrock sample contained quantifiable concentrations of nitrate and uranium, but no nitroaromatics. Due to the difficulty in spiking solid matrices with organics, a decision was made to use the processed bedrock materials, as is, in the treatability tests without modification.

3. Approval was received to conduct the oxidation efficiency experiments with each oxidant in two experiments. The first experiment, to evaluate volatile organic destruction only, would be conducted in 40-mL VOA vials. The second experiment, to investigate oxidant effects on the secondary COCs, would react the ground water in the specific bottles supplied to the analytical laboratory for analyses (separate 100-mL bottles for nitrate and uranium analyses and a 1-liter bottle for nitroaromatics analysis).

4. Lastly, even though nitroaromatic compounds were not detected in either processed bedrock sample, it was decided that the bedrock solubilization test aqueous phases were also to be analyzed for nitroaromatic compounds.

PHASE II - DETERMINATION OF PERMANGANATE AND PERSULFATE OXIDATION EFFICIENCIES

The effectiveness of potassium permanganate or sodium persulfate to individually oxidize the primary COC and secondary COCs was determined in separate experiments. A flowchart for the primary COC experiments is shown in Figure 1. A flowchart for the secondary COCs experiments is provided in Figure 2.

The oxidation efficiency experiments were designed to demonstrate whether a COC could be oxidized by potassium permanganate or sodium persulfate. The specific rates of reaction involved and the minimal concentration of oxidant needed to effect a change in a COC were not considered in these tests. The experiments were conducted using a single excess concentration of either potassium permanganate or sodium persulfate.

Potassium Permanganate Experiments

Separate bench scale tests were conducted to evaluate the effect of potassium permanganate on the primary and secondary COCs.

Permanganate Oxidation Efficiency for the Primary COC - This test was designed to investigate the effect of potassium permanganate on volatile organics only. A portion of ground water from sample GW3034 was reacted at a single potassium permanganate concentration of 0.5% (5,000 mg/L). "Control" samples of ground water without the addition of permanganate were also monitored during the experiment.

On April 9, 2001, the experiment was set up using 40-mL glass VOA vials. Three vials were set up at the beginning of the experiment using ground water only. These "Time = 0" vials were cooled and shipped on ice to the analytical laboratory. Two of the three vials were separately analyzed in order to obtain duplicate "Time = 0" volatile organic concentrations.

Three additional vials were filled with ground water. Potassium permanganate was added to the vials until a concentration of 5,000 mg/L was obtained in the ground water. These vials were then sealed without headspace, incubated at room temperature (approximately 20°C), and periodically mixed by hand over a 7-day period. Three additional vials were filled with ground water only, and contained zero headspace. These vials served as the experimental control for the permanganate efficiency test.

On April 16, 2001, the permanganate efficiency test vials and control vials were cooled and shipped on ice to the analytical laboratory. The laboratory analyzed two permanganate-treated vials and two control vials for volatile organics in order to provide duplicate results for each "Time Final" condition.

Data from duplicate samples for this experiment are provided in Table 2-A. As expected, the "Time = 0" samples showed high concentrations of TCE present (510 and 540 μ/L), along with much lower concentrations of five other volatile organics. The "Time Final" TCE concentration remained essentially unchanged (490 and 500 μ/L), while the TCE concentrations in the permanganate-treated samples were below the PQL of 10 μ/L.

Permanganate Treatment for the Secondary COCs - This complementary experiment was designed to investigate whether treatment with permanganate would cause a change in the dissolved concentrations of the secondary COCs. While the permanganate concentration added remained constant at 5,000 mg/L, significantly larger volumes of site ground water were treated. This greater volume of water was needed so the analytical laboratory could meet the desired low analytical detection limits for the secondary COCs.

The following "Time = 0" ground water samples were prepared on April 9, 2001: (1) nitroaromatics (one 1-liter glass bottle); (2) nitrate (one 100-mL glass bottle); and (3) uranium (one 100-mL glass bottle).

Since the ground water as supplied did not contain any nitroaromatic compounds, the one liter bottle for nitroaromatics analysis was spiked with 10 uL of the standard 1,000 μ/mL nitroaromatic mixture. This volume of spiking solution theoretically resulted in a final concentration of 10 μ/L for each of the nitroaromatic compounds present. All bottles were cooled and shipped on ice to the appropriate analytical laboratories on April 9, 2001. Each bottle was analyzed to provide single "Time = 0" concentrations of uranium, nitrate, and nitroaromatics.

The remainder of the permanganate experiment was initiated on April 9, 2001. A 1-liter glass bottle was filled with ground water, spiked with the nitroaromatic solution as performed previously, and then brought to a concentration of 5,000 mg/L of potassium permanganate. Two 100-mL glass bottles were each filled with ground water and brought to a concentration of 5,000 mg/L of potassium permanganate. Similar control bottles containing ground water only were also prepared on the same day.

Both permanganate-treated and control bottles were incubated at room temperature and were periodically mixed by hand over a 7-day period. On April 16, 2001, all of the permanganate-treated and control bottles were cooled and shipped on ice to the appropriate analytical laboratories for determination of dissolved uranium, nitrate, and nitroaromatics levels.

Data from this experiment are provided in Table 3-A. The "Time = 0" sample showed the presence of nitroaromatic compounds at concentrations very close to the desired spiking level of 10 μ/L, except for RDX (present at only 0.4 μ/L) and tetryl (present at only 0.49 μ/L). In the "Time Final" control, 6 of the 14 nitroaromatic compounds were present below the PQLs, while the remaining 8 compounds showed little decrease in concentration. With the permanganate-treated sample, 10 of the compounds were present below their respective PQLs; the remaining 4 compounds were each present at concentrations below their "Time = 0" levels. While permanganate appears to have a

beneficial effect in reducing at least some nitroaromatic compound concentrations, additional work would be recommended before drawing more definitive conclusions from this experiment.

Sodium Persulfate with Iron Experiments

Separate bench scale tests were conducted to evaluate the effect of sodium persulfate on the primary and secondary COCs.

Persulfate with Iron Oxidation Efficiency for Primary COC - A ground water sample from GW3034 was reacted at a single sodium persulfate concentration of 11,150 mg/L and 500 mg/L of ferrous iron. This persulfate concentration corresponds to the same number of chemical oxidation equivalents as present in the 5,000 mg/L potassium permanganate solution used previously, which allows for a direct comparison of both oxidants. Ferrous iron acts as a catalyst for this reaction, and was provided in order to allow potential oxidation reactions to occur within the timeframe imposed on the test.

The "Time = 0" samples from the previously described permanganate oxidation efficiency test were also used as the starting contaminant concentrations for this experiment. In addition, the corresponding "Time Final" control samples from the permanganate efficiency test were also used with this experiment.

Three VOA vials were filled with ground water and brought to a concentration of 11,150 mg/L of sodium persulfate and 500 mg/L of ferrous iron on April 9, 2001. These vials were sealed without headspace, incubated at room temperature, and periodically mixed by hand for 7 days. On April 16, 2001, the samples were cooled and shipped on ice to the analytical laboratory. Two of the vials were analyzed in order to provide duplicate persulfate-treated volatile organics concentrations for the experiment.

Data from duplicate samples for this experiment are provided in Table 2-B. For TCE, the "Time = 0" (510 and 540 µ/L) and "Time Final"

concentrations remained essentially unchanged (490 and 500 μ/L), while the persulfate-treated samples were below the PQL of 10 μ/L and at an estimated 2 μ/L, respectively.

Persulfate with Iron Treatment for Secondary COCs - This complementary experiment was designed to investigate whether treatment with persulfate and iron would cause a change in the dissolved concentrations of the secondary COCs. While the persulfate and iron concentrations added remained constant at 11,150 and 500 mg/L, respectively, significantly larger volumes of site ground water were treated. This greater volume of water was needed so that the analytical laboratory could meet the desired low analytical detection limits for the secondary COCs.

The "Time = 0" and "Time Final" samples prepared for the similar permanganate treatment experiment described above served the same function for this test.

On April 9, 2001, a 1-liter glass bottle was filled with ground water, spiked with the nitroaromatic solution as performed previously, and brought to a concentration of 11,150 mg/L sodium persulfate and 500 mg/L ferrous iron. Two 100-mL glass bottles were each filled with ground water and brought to similar concentrations of persulfate and iron.

The bottles were incubated at room temperature and periodically mixed by hand over a 7-day period. On April 16, 2001, the persulfate-treated bottles were cooled and shipped on ice to the appropriate analytical laboratories for analysis of uranium, nitroaromatics, and nitrate.

Results from this experiment are provided in Table 3-B. The "Time = 0" sample shows the presence of nitroaromatic compounds at concentrations close to the desired spiking level of 10 μ/L, except for RDX (present at only 0.4 μ/L) and tetryl (present at only 0.49 μ/L). In the "Time Final" control, 6 of the 14 nitroaromatic compounds were

present below the PQLs, while the remaining 8 compounds showed little decrease in concentration. With the persulfate-treated sample, 12 of the compounds were present below their respective PQLs. Of the remaining 2 compounds, one was present at essentially its starting concentration while the second showed a decrease relative to its "Time = 0" level. While persulfate appears to have a beneficial effect in reducing at least some nitroaromatic concentrations, additional work would be recommended before drawing more definitive conclusions from this experiment.

PHASE III - TOTAL WEATHERED BEDROCK OXIDATION DEMAND TESTS

Since permanganate and persulfate may react with many organic and inorganic materials naturally present in the weathered bedrock, the results of these tests were used to estimate the total mass of each oxidant consumed per unit volume of site bedrock. If this demand is high, the economics of permanganate and/or persulfate treatment will need to be carefully considered. A flowchart for the demand experiments is provided in Figure 3.

It should be noted that the total oxidant demand tests would most likely overestimate the mass of oxidant consumed by the weathered bedrock materials. These tests react a known mass of bedrock particles with a much greater volume of a particular oxidizing solution. Since the total rock surface area exposed to the oxidizing solution is greater than that of an equal mass of larger-sized rocks or pebbles, more complete oxidation can occur. The test is biased to maximize the amount of oxidant consumed, and this bias must be considered when interpreting the experimental results.

Total Weathered Bedrock Permanganate Demand

This standard demand test was performed separately on processed weathered bedrock samples BR3034 and BR3035.

Each processed bedrock sample was reacted with a range of potassium permanganate concentrations in order to determine its individual total permanganate demand. The permanganate concentrations used in the test were selected to bracket the anticipated permanganate demand of the processed bedrock. The tests were initiated on April 2, 2001.

For each test, 25 grams of wet-weight processed bedrock was added to each of ten 50-mL centrifuge tubes. An appropriate volume of a stock 5% potassium permanganate solution was then added to each tube, and distilled water was added to bring the total liquid volume in each tube to approximately 40 mL. The ten tubes make up a mass series ranging from 1 to 500 mg of potassium permanganate per tube; each tube in the series contains twice the permanganate mass as the preceding tube.

All centrifuge tubes were incubated at room temperature (approximately 20°C) and mixed by hand periodically over a 15-day reaction period, ending on April 17, 2001. At the end of the reaction period, the Oxidation-Reduction Potential (ORP) of each slurry was measured and recorded. The tubes were then centrifuged to produce distinct solid and aqueous fractions. The color of the aqueous phase in each tube was visually determined and recorded. Solutions containing residual permanganate were pink to purple in color, while solutions in which the starting mass of permanganate was exhausted were colorless.

The raw data from this experiment is provided in Appendix B. A summary of the results, reported as the range of grams of potassium permanganate consumed per kilogram of wet-weight bedrock, are shown in Table 4-A.

Bedrock BR3034 exhibited a relative low total oxidant demand range of 0.15 to 0.31 grams per kilogram of wet-weight bedrock. Scaled up, this demand would theoretically correspond to the need for 0.41 to 0.84 pounds of permanganate to treat a cubic yard of bedrock, assuming a bedrock density of 100 pounds per cubic foot and a porosity of 30%. This low total oxidant demand is economically favorable from a field implementation perspective.

Bedrock BR3035 exhibited the same low total oxidant demand range of 0.15 to 0.31 grams per kilogram of wet-weight bedrock, or 0.41 to 0.84 pounds of permanganate per cubic yard of bedrock.

Total Bedrock Persulfate Demand

This standard demand test was performed separately on processed weathered bedrock sample BR3034 and BR3035.

The processed bedrock was reacted with a range of sodium persulfate concentrations in order to determine their individual total persulfate demand. The persulfate concentrations used in the test were selected to bracket the anticipated persulfate demand of the processed bedrock. Supplemental ferrous iron is not used in this test because it interferes with the determination of residual persulfate at the completion of the experiment. The tests were initiated on April 2, 2001.

The experiment was conducted by adding 25 grams of wet-weight processed bedrock to ten 50-mL centrifuge tubes. An appropriate volume of a stock sodium persulfate solution was added to each tube, and distilled water added to bring the total liquid volume in each tube to approximately 40 mL. The ten tubes make up a persulfate mass series ranging from 2.5 to 1,250 mg of sodium persulfate per tube. Each tube in the series contains twice the mass of persulfate as the preceding tube. On a chemical equivalent basis, the concentrations of persulfate used in this test are equal to the concentrations of permanganate used in its oxidant demand test.

All centrifuge tubes were incubated at room temperature (approximately 20°C) and mixed by hand over a 15-day reaction period, ending on April 17, 2001. At the end of the reaction period, the pH and ORP of each slurry was measured and recorded. The tubes were then centrifuged to form distinct solid and aqueous fractions. The presence of residual persulfate in each aqueous fraction was determined using a colorimetric test. If residual persulfate was present, the test solution

turned blue in color. Aqueous fractions without residual persulfate remained colorless in the test.

The raw data from this experiment are provided in Appendix B. A summary of the results, reported as the range of grams of sodium persulfate consumed per kilogram of wet-weight bedrock, are shown in Table 4-B.

Bedrock BR3034 exhibited a very low total oxidant demand of less than 0.09 grams per kilogram of wet-weight bedrock. Scaled up, this demand would theoretically correspond to the need for less than 0.24 pounds of persulfate to treat a cubic yard of bedrock, assuming a soil density of 100 pounds per cubic foot and a porosity of 30%. The low total oxidant demand is economically favorable from a field implementation perspective.

Bedrock BR3035 exhibited the same low total oxidant demand range of less than 0.09 grams per kilogram of wet-weight bedrock, or less than 0.24 pounds of persulfate per cubic yard of bedrock.

PHASE IV - WEATHERED BEDROCK SOLUBILIZATION TESTS

These tests were performed to determine whether permanganate or persulfate treatment of the bedrock would result in the release of any secondary COCs from the rock matrix to the surrounding liquid. A flowchart for this experiment is provided in Figure 4.

Permanganate Solubilization Test

Each processed bedrock sample was individually tested in this experiment. In order to determine whether dissolved secondary COCs levels increase upon exposure to an oxidant, both "Time = 0" and "Time Final" control dissolved phase COC concentrations were determined.

On April 9, 2001, the " Time = 0" reaction flasks were prepared for each bedrock sample by adding 300 grams of wet-weight processed weathered bedrock to 1,500 mL of distilled water. Each slurry was then mixed at room temperature for 60 minutes, at which time it was centrifuged to produce distinct solid and aqueous fractions. The aqueous fractions were carefully removed, placed into appropriate sample bottles, and refrigerated. On April 10, 2001, samples of the aqueous fractions were shipped on ice to the appropriate analytical laboratories for analysis of nitroaromatics (1-liter supplied), nitrate (100 mL supplied), and uranium (100 mL preserved with nitric acid).

On April 10, 2001, the permanganate-treated reaction flasks were prepared for each weathered bedrock sample by adding 300 grams of wet-weight processed material to 1,500 mL of distilled water. The slurries were then brought to a concentration of 20,000 mg/L of potassium permanganate. The contents of these reactors were periodically mixed at room temperature for 7 days. On April 17, 2001, the pH and ORP of each slurry were determined, and the slurry was centrifuged to produce distinct solid and aqueous fractions. The aqueous fractions were carefully removed, placed into appropriate sample bottles, and shipped on ice to the appropriate analytical laboratories for analysis of nitroaromatics (1-liter supplied), nitrate (100 mL supplied), and uranium (100 mL preserved with nitric acid).

The "Time Final" control flasks were also prepared for both samples on April 10, 2001. Each control flask was prepared by adding 300 grams of wet-weight processed bedrock to 1,500-mL of distilled water. The contents of these reactors were periodically mixed at room temperature for 7 days. On April 17, 2001, the pH and ORP of the slurry we determined, and the contents of each flask were then centrifuged to produce distinct solid and aqueous fractions. The aqueous fractions were carefully removed, placed into appropriate sample bottles, and shipped on ice to the appropriate analytical laboratories for analysis of nitroaromatics (1-liter supplied), nitrate (100 mL supplied), and uranium (100 mL preserved with nitric acid).

Data from the experiments are presented in Table 5-A and 5-B for bedrock samples BR3034 and BR3035, respectively.

Bedrock Sample BR3034 - No nitroaromatic compounds were detected above their PQLs in any of the samples tested (Time = 0, Time Final Control, and Permanganate-Treated).

With nitrate, the "Time = 0" and "Time Final Control" concentrations are essentially identical. The permanganate-treated sample, however, caused matrix interferences with the analytical test, and a final nitrate concentration could not be determined.

Lastly, uranium appears to slowly dissolve from the rock matrix into the surrounding distilled water as the contact time increases. For the "Time = 0" sample, the uranium concentration was 0.16 ± 0.02. This concentration increased to 0.82 ± 0.11 in the 7-day distilled water control. When the bedrock was treated with permanganate for 7 days, the dissolved uranium concentration increased to 2.16 ± 0.25.

Bedrock Sample BR3035 - No nitroaromatic compounds were detected above their PQLs in any of the samples tested (Time = 0, Time Final Control, and Permanganate-Treated).

With nitrate, the "Time = 0" and "Time Final Control" concentrations were essentially unchanged (7.68 and 8.7, respectively). The permanganate-treated sample, however, caused matrix interferences with the analytical test, and a final nitrate concentration could not be determined.

Lastly, uranium also appears to slowly dissolve from the rock matrix into the surrounding distilled water as the contact time increases with this bedrock. For the "Time = 0" sample, the uranium concentration was 0.19 ± 0.03. This concentration increased to 1.96 ± 0.26 in the 7-day distilled water control. When the bedrock was treated with permanganate for 7 days, the dissolved uranium concentration increased to 2.16 ± 0.30.

Persulfate Solubilization Test

Each processed weathered bedrock sample was individually tested in this experiment to determine whether reaction with persulfate would increase the concentration of dissolved secondary COC. The "Time = 0" and "Time Final" samples prepared for the analogous permanganate solubilization experiment described above served the same functions for this test.

On April 10, 2001, the persulfate-treated reaction flasks were prepared for both samples by adding 300 grams of wet-weight processed weathered bedrock to 1,500 mL of distilled water. The slurries were then brought to a concentration of 50,000 mg/L of sodium persulfate, and the contents of these reactors were periodically mixed at room temperature for 7 days. On April 17, 2001, the pH and ORP of the slurry were determined, and the slurry was then centrifuged to produce distinct solid and aqueous fractions. The aqueous fractions were carefully removed, placed into appropriate sample bottles, and shipped on ice to the appropriate analytical laboratories for analysis of nitroaromatics (1-liter supplied), nitrate (100 mL supplied), and uranium (100 mL preserved with nitric acid).

Data from the experiments are shown in Table 5-A and 5-B for bedrock samples BR3034 and BR3035, respectively.

Bedrock Sample BR3034 - No nitroaromatic compounds were detected above their PQLs in any of the samples tested (Time = 0, Time Final Control, and Permanganate-Treated).

With nitrate, the "Time = 0" and "Time Final Control" concentrations are essentially identical 19.2 mg/L and 20.4 mg/L, respectively). The nitrate concentration in the persulfate-treated sample was essentially the same: 23.3 mg/L.

Lastly, uranium appears to slowly dissolve from the rock matrix into the surrounding distilled water as the contact time increases. For the

"Time = 0" sample, the uranium concentration was 0.16 ± 0.02. This concentration increased to 0.82 ± 0.11 in the 7-day distilled water control. When the bedrock was treated with persulfate for 7 days, the dissolved uranium concentration was approximately six times higher than that of the 7-day control (6.23 ± 0.85 vs. 0.82 ± 0.11, respectively).

Bedrock Sample BR3035 - No nitroaromatic compounds were detected above their PQLs in any of the samples tested (Time = 0, Time Final Control, and Permanganate-Treated).

With nitrate, the "Time = 0" and "Time Final Control" concentrations were essentially unchanged (7.68 and 8.7, respectively). The persulfate-treated sample had a nitrate concentration of 8.75 mg/L.

Lastly, uranium also appears to slowly dissolve from the rock matrix into the surrounding distilled water as the contact time increases with this bedrock. For the "Time = 0" sample, the uranium concentration was 0.19 ± 0.03. This concentration increased to 1.96 ± 0.26 in the 7-day distilled water control. When the bedrock was treated with persulfate for 7 days, the dissolved uranium concentration increased to 3.43 ± 0.46.

RESULTS AND DISCUSSION

The bench scale study was performed to determine the following four factors:

1. The oxidation efficiency of permanganate and persulfate on TCE and daughter products;

2. The interaction of the bedrock with the oxidants (bedrock matrix demand and contaminant solubilization);

3. The oxidation efficiency of permanganate and persulfate on nitroaromatic compounds; and

4. The oxidation efficiency of permanganate and persulfate on dissolved uranium concentrations.

The initial characterization data, shown in Table 1, confirmed that the primary ground water contaminant was TCE. Traces levels of a number of other volatile organic compounds were also detected during the initial ground water characterization. However, many were also found in the method blanks. The only compounds not also found in the method blanks for the ground water sample were acetone, cis- and trans-1,2-dichloroethylene (DCE), chloroform and bromoform. No organic contaminants were found in the bedrock samples alone, however trace levels of acetone and 2-butanone were detected in the processed weathered bedrock sample as well as the method blanks for the samples.

Uranium was found at low levels in both the processed weathered bedrock and the ground water.

Oxidation of TCE

Ground water samples were treated with both permanganate and persulfate over a 7-day reaction period. Table 2 presents the results from these experiments. Both oxidants reduced TCE to concentrations to below 10 μg/L, the PQL achieved. Based on many other similar TCE oxidation experiments performed by the RTC, it is likely that the final TCE levels are below 1 μg/L. The corresponding "Time Final" control sample showed minimal loss (< 9%) of TCE. Therefore, it can be concluded that both persulfate and permanganate were effective in reducing the TCE levels through oxidation.

In addition to TCE, cis-1,2-DCE was also oxidized to low levels with both permanganate and persulfate.

In both oxidation studies, acetone appears to have been formed during the oxidation reactions. In the permanganate study, acetone was also detected in the method blank. Therefore, the presence of acetone in the

permanganate oxidation sample may be a laboratory artifact, and not a result of formation due to permanganate oxidation of the volatile organics.

The persulfate oxidation reaction resulted in a higher detected level of acetone (48 µg/L), which was not detected in the corresponding method blank. Previous experience at the RTC has shown that acetone may form during persulfate oxidation of some organic compounds. Experience has also shown that this formation is transient, and persulfate will degrade acetone as it forms.

Bedrock Matrix Demand

The total bedrock matrix demand test measures the amount of oxidant consumed by naturally-occurring materials in the soil matrix (organics and metals) as well as any oxidizable contaminants present. If the total matrix demand is high, the economics of insitu oxidation may be adversely affected as a large amount of oxidant would be needed to overcome the matrix demand. Except when contaminant concentrations are exceedingly high, the total matrix demand is generally driven by naturally-occurring organic and reduced metal species.

The bedrock matrix demand results for permanganate and persulfate are presented in Table 4. These results show that the bedrock samples have a relatively low demand. Therefore, it is not expected that the bedrock matrix will interfere with the efficient oxidation of the contaminants present by consuming large quantities of the oxidant added.

Oxidation of Nitroaromatics

Because the ground water from GW3034 did not contain concentrations of nitroaromatics, the ground water was spiked with low levels (10 µg/L) of a number of nitroaromatics, using a nitroaromatics standard

solution. The spiked ground water was then treated with permanganate and persulfate for seven days.

In general, both permanganate and persulfate appear to have oxidized several of the nitroaromatics present (see Table 3). Relative to the control sample, it appears that permanganate was effective in treating dinitrobenzene, and the nitro- and dinitrotoluenes. Persulfate appeared to oxidize the majority of nitroaromatics, present with the exception of trinitrobenzene and trinitrotoluene.

Based on these results, permanganate and persulfate oxidation appears to have some beneficial effect on dissolved nitroaromatics. However, because of the low concentrations of compounds used in this phase of the study, further testing needs to be performed in order to determine the extent of oxidation and analytical variability encountered.

The bedrock samples were also treated with excess permanganate or persulfate to see whether any nitroaromatics present in the rock matrix would be desorbed by the oxidants. As shown in Table 5, no nitroaromatics were detected in any of the treated or control samples.

Effect of Oxidation on Uranium

The effect of oxidation on uranium was examined for both weathered bedrock (solubilization) and ground water (oxidation efficiency).

Table 3 presents the ground water results. Permanganate oxidation appears to reduce the dissolved uranium levels. While, persulfate oxidation does not have any beneficial effect. Permanganate oxidation decreased the uranium levels from approximately 4 μg/L to less than 1 μg/L, a 75% reduction. Persulfate oxidation resulted in an apparent increase in uranium concentrations from approximately 4 μg/L to approximately 6 μg/L. This may be due to analytical variability because only aqueous samples were used and the treated samples had no source of additional uranium (e.g., leaching from the bedrock matrix).

The second phase of the study was designed to determine the effect of oxidation on the uranium in the bedrock matrix, in order to determine if the oxidants would solubilize uranium from the bedrock. The assumption was that the secondary COCs, specifically uranium, may be adsorbed onto the bedrock matrix and leached into the ground water as a result of the chemical oxidation process. The results are listed in Table 5.

From these results, it appears that the uranium present in the bedrock matrix may be available through leaching. This can be seen from the increase in the "Control" concentrations with respect to their "Time = 0" concentrations. This shows that uranium can be leached out of the bedrock using only distilled water.

It also appears that the adsorbed uranium is liberated during chemical oxidation. Permanganate has a relatively small effect on uranium solublization. The dissolved uranium concentration (vs. its control) increases by a factor of 2.5 for BR3034 and a factor of 1.12 for BR 3035. Persulfate increased uranium dissolution, relative to their respective controls, by a factor of 7.5 for BR3034 and by a factor of 4.5 for BR3035.

If uranium is present in a reduced state (U^{+4}) both oxidants are strong enough to oxidize it to the +6 state:

$$U^{+4} + 2H_2O \rightarrow UO_2^{++} + 4H^+ + 2e^- \quad E_o = -0.334V$$

With permanganate oxidation, the uranyl ion (UO_2^{+2}) would most likely form an insoluble hydroxide [$UO_2(OH)_2$]. Additionally, uranium concentrations may decrease when using permanganate through uranium binding to MnO_2 formed as a byproduct of permanganate oxidation. With persulfate a more soluble uranyl sulfate (UO_2SO_4) would be formed. Therefore, persulfate oxidation would have a greater effect on uranium solubility.

It should be noted that these bedrock solubilization experiments used a high dose of oxidants on crushed bedrock, resulting in extremely

conservative conditions not likely to be encountered in the field. Any effects seen are exacerbated due to the increased surface area of the crushed rock, as well as an over abundance of oxidant. Therefore, it is unlikely that this high degree of solubilization would occur under more typical field conditions.

In conclusion, permanganate appears to have a more beneficial effect than persulfate on uranium concentrations in the ground water as well as uranium desorption from the bedrock.

ANALYTICAL DATA QUALITY ASSURANCE/QUALITY CONTROL

All samples were stored, transported and analyzed using standard good laboratory practices (GLP) and appropriate analytical methodologies. Following each phase of the treatability study, all samples were refrigerated at 4°C prior to shipment to the analytical laboratories. Analytical samples were shipped via common carrier to the analytical laboratories in a cooler(s) under proper chain-of-custody procedures. The cooler(s) were filled with ice to maintain the sample temperature at or below 4°C.

Data Review

Analyses for volatile organics, nitroaromatics, and inorganic parameters (except uranium analyses) were performed by CompuChem. Uranium analyses were performed by Paragon. Both laboratories performed these analyses following the appropriate methodologies (Contract Lab Protocol [CLP] and/or USEPA SW-846), and quality control/quality assurance (QA/AC) procedures.

Due to the time limitations of this study, the data packages received were cursorily reviewed by ERM personnel. All data were reviewed for accuracy, completeness, and general adherence to methodology. ERM will perform a more detailed review of the data, and present an amendment if there are any changes to the analytical data. Data

validation was not performed on these data, and was not required under the Scope-of-Work for this treatability study.

Analytical Detection Limits

It should be noted that these experiments were constructed in order to provide the analytical laboratories with the proper sample volumes to reach the contract required detection limits (CRDL). The CRDL is effected by several factors, including sample volume, sample/extract dilution, and percent moisture of non-aqueous samples. In general, the CRDL for the VOAs analyzed by OLM04.2 is 10 µg/L. Elevated detection limits are seen in the "Time Final Control" samples for both the permanganate and persulfate oxidation efficiency tests due to the high level of TCE detected in these samples. The variability in detection limits for the nitroaromatic analyses (USEPA SW-846 8330) are due to the differences in useable sample volumes extracted by the analytical personnel.

CONCLUSIONS

The results of these experiments demonstrated that both permanganate and persulfate were effective in significantly reducing TCE levels from approximately 500 µ/L to less than 10 µ/L in seven days at room temperature. The oxidants were also effective in reducing the concentrations of several other volatile organics present.

While both oxidants appeared to effect a decrease in the concentration of some specific nitroaromatic compounds present, additional testing would be necessary to convincingly determine the variability and degree of treatment effectiveness that could be reproducibly obtained.

The two bedrock samples tested exhibited low total oxidant demands, indicating that the matrix material does not consume excessive quantities of either potassium permanganate or sodium persulfate.

Low total oxidant demand is typically a requirement for cost-effective use of insitu chemical oxidation on a large scale.

With respect to uranium: (1) uranium adsorbed to the processed bedrock samples appears to solubilize over time into the surrounding water matrix, (2) treating the bedrock samples with permanganate resulted in a low to moderate increase in the final dissolved uranium levels; and (3) treatment of the bedrock with persulfate, however, resulted in a significantly greater increase in the final dissolved uranium level, as compared to the permanganate treated samples. The complementary release of uranium from bedrock by permanganate followed by its corresponding decrease in aqueous concentration is encouraging from a technology implementation perspective, and likely justifies further investigation on a laboratory or field-pilot basis.

For uranium already dissolved in ground water, treatment with permanganate results in a significant decrease in soluble uranium, while persulfate treatment under similar conditions resulted in an increase in dissolved uranium levels.

- Potassium permanganate would be the preferred reagent recommended for use with an insitu chemical oxidation system for the following reasons:

- Permanganate effectively oxidizes TCE, the primary COC;

- Permanganate appears to oxidize trace levels of some nitroaromatic constituents;

- Permanganate appears to be able to reduce dissolved uranium levels, perhaps through the formation of insoluble uranium salts;

- Application of permanganate does not appear to cause the leaching of major amounts of secondary COCs (i.e., uranium) from the site bedrock; and

- Only low quantities of the oxidant are consumed by the bedrock matrix, offering the potential for cost-effective field remediation.

Based on the favorable results obtained from the treatability study, an insitu permanganate oxidation field pilot study at the WSSRAP using potassium permanganate would be justified as a means of confirming both treatment effectiveness and process economics.

Should you have any questions or require additional information concerning these results, please feel free to contact Alan J. Cork at 636/928-0300 or George J. Skladany at 609/895-0050.

Sincerely,

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TABLES

Table 1. Initial Characterization Results

Weldon Spring Site Remedial Action Project
Insitu Chemical Oxidation Treatment Bench Scale Testing
2-May-01

Analyte	Ground Water (GW3034)		Bedrock (BR3034)		Bedrock (BR3035)	
	Concentration	*Notes **	*Concentration*	*Notes **	*Concentration*	*Notes **
Volatiles (ug/L or ug/kg)						
Acetone	36		8	JB	4	JB
Methyl acetate	28	DJB	11	U	11	U
trans -1,2-Dichloroethene	1	J	11	U	11	U
cis -1,2-Dichloroethene	20		11	U	11	U
2-Butanone	10	U	11	U	2	JB
Chloroform	1	J	11	U	11	U
Trichloroethene	640	DB	11	U	11	U
4-Methyl-2-pentanone	12	DJ	11	U	11	U
2-Hexanone	14	DJB	11	U	11	U
Bromoform	6	DJ	11	U	11	U
1,1,2,2-Tetrachloroethane	13	DJB	11	U	11	U
1,2-Dibromo-3-chloropropane	35	DJB	11	U	11	U
Nitroaromatics (ug/L or ug/kg)						
HMX	3.2	U	0.25	U	0.25	U
1,3,5-Trinitrobenzene	1.6	U	0.25	U	0.25	U
RDX	4.0	U	0.25	U	0.25	U
1,3-Dinitrobenzene	1.6	U	0.25	U	0.25	U
2,4,6-Trinitrotoluene	3.2	U	0.25	U	0.25	U
Tetryl	3.2	U	0.50	U	0.50	U
Nitrobenzene	2.4	U	0.25	U	0.25	U
2,4-Dinitrotoluene	4.0	U	0.25	U	0.25	U
2,6-Dinitrotoluene	4.0	U	0.50	U	0.50	U
2-Amino-4,6-dinitrotoluene	4.8	U	0.50	U	0.50	U
4-Amino-2,6-dinitrotoluene	3.2	U	0.50	U	0.50	U
2-Nitrotoluene	4.0	U	0.50	U	0.50	U
4-Nitrotoluene	4.0	U	0.50	U	0.50	U
3-Nitrotoluene	3.2	U	0.50	U	0.50	U
Other Parameters						
Total Organic Carbon (mg/L or mg/kg)	69.6		110,500		113,000	
Nitrate (mg/L or mg/kg)	785		7.63		3.6	
Alkalinity (mg/L)	230		Not analyzed		Not analyzed	
Chemical Oxygen Demand (mg/L or mg/kg)	20.2		26.4		3.00	ND
pH (standard units)	7.46		Not analyzed		Not analyzed	
Uranium (ug/L or ug/g)	3.93 ± 0.53		0.72 ± 0.10		0.84 ± 0.11	

* Notes:

U: The compound was analyzed for, but not detected at the Practical Quantitation Limit (PQL)
J: Estimated value based on a detected concentration above MDL but less than the PQL
B: The compound was also detected in the method blank analyzed in association with the sample:
D: The quantitation is based on a dilution analysis of the sample or sample extract
P: There was a greater than 25% difference between the detected concentrations on the two HPLC columns. The lower of the two values is reported
ND: Not detected at the reported detection limit

Table 2. Oxidation Efficiency Results for Primary COC

Weldon Spring Site Remedial Action Project

Insitu Chemical Oxidation Treatment Bench Scale Testing

2-May-01

2-A. Treatment with Potassium Permanganate for Seven Days

Analyte	Time = 0		Time Final Control		Permanganate-Treated	
	Concentration	*Notes* *	*Concentration*	*Notes* *	*Concentration*	*Notes* *
Volatiles (ug/L)						
Acetone	4	JB	10	U	18	B
duplicate	5	JB	50	U	18	B
Methyl acetate	10	U	10	U	10	U
duplicate	10	U	50	U	10	U
trans -1,2-Dichloroethene	1	J	2	J	10	U
duplicate	1	J	50	U	10	U
cis -1,2-Dichloroethene	18		20		10	U
duplicate	16	J	16	J	10	U
Chloroform	1	J	1	J	3	JB
duplicate			50	U	10	U
Trichloroethene	510	DB	490	DB	10	U
duplicate	540	DB	500		10	U
Tetrachloroethene	10	U	10	U	10	U
duplicate	7	J	50	U	10	U
Xylene (total)	10	U	10	U	10	U
duplicate			5	JB	10	U
1,3-Dichlorobenzene	10	U	10	U	10	U
duplicate			5	JB	10	U
1,4-Dichlorobenzene	10	U	10	U	10	U
duplicate			6	JB	10	U
1,2-Dichlorobenzene	10	U	10	U	10	U
duplicate			7	JB	10	U
1,2-Dibromo-3-Chloropropane	10	U	10	U	10	U
duplicate			5	JB	10	U
1,2,4-Trichlorobenzene	10	U	10	U	10	U
duplicate			13	JB	10	U

* Notes:

U: The compound was analyzed for, but not detected at the Practical Quantitation Limit (PQL)

J: Estimated value based on a detected concentration above MDL but less than the PQL

B: The compound was also detected in the method blank analyzed in association with the sample:

D: The quantitation is based on a dilution analysis of the sample or sample extract

P: There was a greater than 25% difference between the detected concentrations on the two HPLC columns. The lower of the two values is reported

ND: Not detected at the reported detection limit

Table 2. Oxidation Efficiency Results for Primary COC

Weldon Spring Site Remedial Action Project

Insitu Chemical Oxidation Treatment Bench Scale Testing

2-May-01

2-B. Treatment with Sodium Persulfate for Seven Days

Analyte	Time = 0		Time Final Control		Persulfate-Treated	
	Concentration	*Notes* *	*Concentration*	*Notes* *	*Concentration*	*Notes* *
Volatiles (ug/L)						
Acetone	4	JB	10	U	48	
duplicate	5	JB	50	U	31	
Methyl acetate	10	U	10	U	10	U
duplicate	10	U	50	U	10	U
trans -1,2-Dichloroethene	1	J	2	J	10	U
duplicate	1	J	50	U	10	U
cis -1,2-Dichloroethene	18		20		10	U
duplicate	16	J	16	J	10	U
Chloroform	1	J	1	J	1	J
duplicate			50	U	1	J
Trichloroethene	510	DB	490	DB	2	J
duplicate	540	DB	500		10	U
Tetrachloroethene	10	U	10	U	10	U
duplicate	7	J	50	U	10	U
Xylene (total)	10	U	10	U	10	U
duplicate			5	JB	10	U
1,3-Dichlorobenzene	10	U	10	U	10	U
duplicate			5	JB	10	U
1,4-Dichlorobenzene	10	U	10	U	10	U
duplicate			6	JB	10	U
1,2-Dichlorobenzene	10	U	10	U	10	U
duplicate			7	JB	10	U
1,2-Dibromo-3-Chloropropane	10	U	10	U	10	U
duplicate			5	JB	10	U
1,2,4-Trichlorobenzene	10	U	10	U	10	U
duplicate			13	JB	2	JB

* Notes:

U: The compound was analyzed for, but not detected at the Practical Quantitation Limit (PQL)

J: Estimated value based on a detected concentration above MDL but less than the PQL

B: The compound was also detected in the method blank analyzed in association with the sample:

D: The quantitation is based on a dilution analysis of the sample or sample extract

P: There was a greater than 25% difference between the detected concentrations on the two HPLC columns. The lower of the two values is reported

ND: Not detected at the reported detection limit

Table 3. Oxidation Efficiency Results for Secondary COCs

Weldon Spring Site Remedial Action Project

Insitu Chemical Oxidation Treatment Bench Scale Testing

2-May-01

3-A. Treatment with Potassium Permanganate for Seven Days

Analyte	Time = 0		Time Final Control		Permanganate-Treated	
	Concentration	*Notes* *	*Concentration*	*Notes* *	*Concentration*	*Notes* *
Nitroaromatics (ug/L)						
HMX	9.1	J	4.8	U	3.8	U
1,3,5-Trinitrobenzene	7.1		2.4	U	1.9	U
RDX	0.4	JP	6.0	U	4.8	U
1,3-Dinitrobenzene	7.4		5.7		1.9	U
2,4,6-Trinitrotoluene	6.3	J	3.0		3.8	U
Tetryl	0.49	JP	4.8	U	3.8	U
Nitrobenzene	6.4	J	7.6		5.1	P
2,4-Dinitrotoluene	8.8	J	8.0		2.2	J
2,6-Dinitrotoluene	7.5	J	7.4		5.2	
2-Amino-4,6-dinitrotoluene	8.0	J	7.1	J	5.7	U
4-Amino-2,6-dinitrotoluene	8.6	J	4.8	U	3.8	U
2-Nitrotoluene	8.0	J	7.2		2.6	JP
4-Nitrotoluene	8.1	J	6.0	U	4.8	U
3-Nitrotoluene	6.8	JP	7.7		3.8	U
Other Parameters						
Nitrate (mg/L)	740		776		Not analyzed **	
Uranium (ug/L)	4.00 ± 0.54		4.16 ± 0.56		0.88 ± 0.12	

3-B. Treatment with Sodium Persulfate for Seven Days

Analyte	Time = 0		Time Final Control		Persulfate-Treated	
	Concentration	*Notes* *	*Concentration*	*Notes* *	*Concentration*	*Notes* *
Nitroaromatics (ug/L)						
HMX	9.1	J	4.8	U	3.8	U
1,3,5-Trinitrobenzene	7.1		2.4	U	7.7	
RDX	0.4	JP	6.0	U	4.8	U
1,3-Dinitrobenzene	7.4		5.7		1.9	U
2,4,6-Trinitrotoluene	6.3	J	3.0		3.7	JP
Tetryl	0.49	JP	4.8	U	3.8	U
Nitrobenzene	6.4	J	7.6		2.8	U
2,4-Dinitrotoluene	8.8	J	8.0		4.8	U
2,6-Dinitrotoluene	7.5	J	7.4		4.8	U
2-Amino-4,6-dinitrotoluene	8.0	J	7.1	J	5.7	U
4-Amino-2,6-dinitrotoluene	8.6	J	4.8	U	3.8	U
2-Nitrotoluene	8.0	J	7.2		4.8	U
4-Nitrotoluene	8.1	J	6.0	U	4.8	U
3-Nitrotoluene	6.8	JP	7.7		3.8	U
Other Parameters						
Nitrate (mg/L)	740		776		Not analyzed **	
Uranium (ug/L)	4.00 ± 0.54		4.16 ± 0.56		6.18 ± 0.84	

*Notes:

U: The compound was analyzed for, but not detected at the Practical Quantitation Limit (PQL)

J: Estimated value based on a detected concentration above MDL but less than the PQL

B: The compound was also detected in the method blank analyzed in association with the sample:

D: The quantitation is based on a dilution analysis of the sample or sample extract

P: There was a greater than 25% difference between the detected concentrations on the two HPLC columns. The lower of the two values is reported

ND: Not detected at the reported detection limit

** Not analyzed: Matrix interferences precluded proper analysis

Table 4. Bedrock Oxidant Demand Results

Weldon Spring Site Remedial Action Project
Insitu Chemical Oxidation Treatment Bench Scale Testing
2-May-01

4-A. Potassium Permanganate After 15 Days

Bedrock	Demand *(g/kg wet-weight bedrock)*
BR3034	0.15 to 0.31
BR3035	0.15 to 0.31

4-B. Sodium Persulfate After 15 Days

Bedrock	Demand *(g/kg wet-weight bedrock)*
BR3034	< 0.09
BR3035	< 0.09

1F
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

GW3034T0DL

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: V1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: V1971-1DA55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 5.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

Number TICs found: 0

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
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FORM I VOA-TIC OLM04.2

04/17/01 15:36 FAX 919 379 4070 COMPUCHEM 018

1B

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034T0DL

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: V1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: V1971-1DA55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 5.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	Q
79-01-6	Trichloroethene	510 DB
108-87-2	Methylcyclohexane	50 U
78-87-5	1,2-Dichloropropane	50 U
75-27-4	Bromodichloromethane	50 U
10061-01-5	cis-1,3-Dichloropropene	50 U
108-10-1	4-Methyl-2-Pentanone	50 U
108-88-3	Toluene	50 U
10061-02-6	trans-1,3-Dichloropropene	50 U
79-00-5	1,1,2-Trichloroethane	50 U
127-18-4	Tetrachloroethene	50 U
591-78-6	2-Hexanone	50 U
124-48-1	Dibromochloromethane	50 U
106-93-4	1,2-Dibromoethane	50 U
108-90-7	Chlorobenzene	50 U
100-41-4	Ethylbenzene	50 U
1330-20-7	Xylene (Total)	50 U
100-42-5	Styrene	50 U
75-25-2	Bromoform	50 U
98-82-8	Isopropylbenzene	50 U
79-34-5	1,1,2,2-Tetrachloroethane	50 U
541-73-1	1,3-Dichlorobenzene	50 U
106-46-7	1,4-Dichlorobenzene	50 U
95-50-1	1,2-Dichlorobenzene	50 U
96-12-8	1,2-Dibromo-3-Chloropropane	50 U
120-82-1	1,2,4-Trichlorobenzene	50 U

Table 5. Bedrock Solubilization Tests for Secondary COCs

Weldon Spring Site Remedial Action Project

Insitu Chemical Oxidation Treatment Bench Scale Testing

2-May-01

5-A. Treatment of Bedrock 3034 with Permanganate or Persulfate for Seven Days

Analyte	Time = 0		Time Final Control		Permanganate-Treated		Persulfate-Treated	
	Concentration	*Notes **	*Concentration*	*Notes **	*Concentration*	*Notes **	*Concentration*	*Notes **
Nitroaromatics (ug/L)								
HMX	9.7	U	3.2	U	6.4	U	1.6	U
1,3,5-Trinitrobenzene	4.9	U	1.6	U	3.2	U	0.8	U
RDX	12	U	4.0	U	8.0	U	2.0	U
1,3-Dinitrobenzene	4.9	U	1.6	U	3.2	U	0.8	U
2,4,6-Trinitrotoluene	9.7	U	3.2	U	6.4	U	1.6	U
Tetryl	9.7	U	3.2	U	6.4	U	1.6	U
Nitrobenzene	7.3	U	2.4	U	4.8	U	1.2	U
2,4-Dinitrotoluene	12	U	4.0	U	8.0	U	2.0	U
2,6-Dinitrotoluene	12	U	4.0	U	8.0	U	2.0	U
2-Amino-4,6-dinitrotoluene	14	U	4.8	U	9.6	U	2.4	U
4-Amino-2,6-dinitrotoluene	9.7	U	3.2	U	6.4	U	1.6	U
2-Nitrotoluene	12	U	4.0	U	8.0	U	2.0	U
4-Nitrotoluene	12	U	4.0	U	8.0	U	2.0	U
3-Nitrotoluene	9.7	U	3.2	U	6.4	U	1.6	U
Other Parameters								
Nitrate (mg/L)	19.2		20.4		Not analyzed **		23.3	
Uranium (ug/L)	0.16 ± 0.02		0.82 ± 0.11		2.16 ± 0.25		6.23 ± 0.85	

5-B. Treatment of Bedrock 3035 with Permanganate or Persulfate for Seven Days

Analyte	Time = 0		Time Final Control		Permanganate-Treated		Persulfate-Treated	
	Concentration	*Notes **	*Concentration*	*Notes **	*Concentration*	*Notes **	*Concentration*	*Notes **
Nitroaromatics (ug/L)								
HMX	10	U	1.8	U	2.6	U	2.0	U
1,3,5-Trinitrobenzene	5.1	U	0.9	U	1.3	U	1.0	U
RDX	13	U	2.2	U	3.2	U	2.5	U
1,3-Dinitrobenzene	5.1	U	0.9	U	1.3	U	1.0	U
2,4,6-Trinitrotoluene	10	U	1.8	U	2.6	U	2.0	U
Tetryl	10	U	1.8	U	2.6	U	2.0	U
Nitrobenzene	7.7	U	1.4	U	2	U	1.5	U
2,4-Dinitrotoluene	13	U	2.2	U	3.2	U	2.5	U
2,6-Dinitrotoluene	13	U	2.2	U	3.2	U	2.5	U
2-Amino-4,6-dinitrotoluene	15	U	2.7	U	3.9	U	3.0	U
4-Amino-2,6-dinitrotoluene	10	U	1.8	U	2.6	U	2.0	U
2-Nitrotoluene	13	U	2.2	U	3.2	U	2.5	U
4-Nitrotoluene	13	U	2.2	U	3.2	U	2.5	U
3-Nitrotoluene	10	U	1.8	U	2.6	U	2.0	U
Other Parameters								
Nitrate (mg/L)	7.68		8.7		Not analyzed **		8.75	
Uranium (ug/L)	0.19 ± 0.03		1.96 ± 0.26	J	2.16 ± 0.30		3.43 ± 0.46	

* Notes:

U: The compound was analyzed for, but not detected at the Practical Quantitation Limit (PQL)

J: Estimated value based on a detected concentration above MDL but less than the PQL

B: The compound was also detected in the method blank analyzed in association with the sample:

D: The quantitation is based on a dilution analysis of the sample or sample extract

P: There was a greater than 25% difference between the detected concentrations on the two HPLC columns. The lower of the two values is reported

ND: Not detected at the reported detection limit

** Not analyzed: Matrix interferences precluded proper analysis

FIGURES

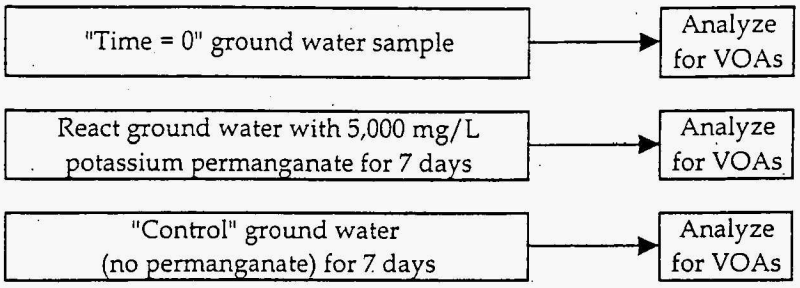
Figure 1. Oxidation Efficiency Tests for Primary COC

Weldon Spring Site Remedial Action Project

Insitu Chemical Oxidation Treatment Bench Scale Testing

2-May-01

Permanganate Efficiency Test



Persulfate Efficiency Test

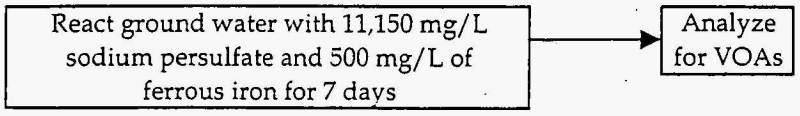


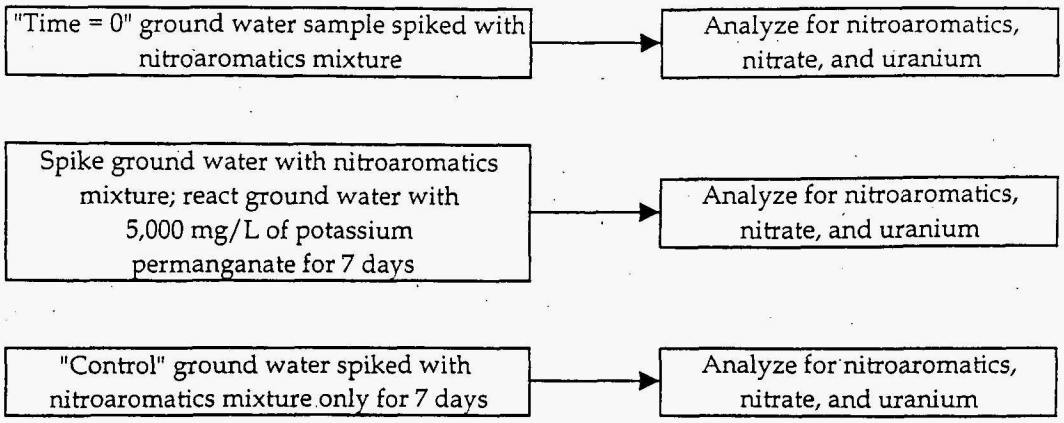
Figure 2. Oxidation Efficiency Tests for Secondary COCs

Weldon Spring Site Remedial Action Project

Insitu Chemical Oxidation Treatment Bench Scale Testing

2-May-01

Permanganate Efficiency Test



Persulfate Efficiency Test

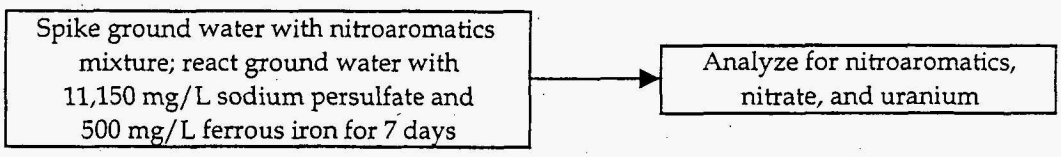


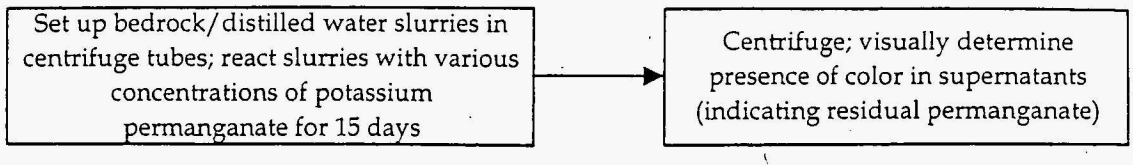
Figure 3. Bedrock Total Oxidant Demand Tests

Weldon Spring Site Remedial Action Project

Insitu Chemical Oxidation Treatment Bench Scale Testing

2-May-01

Permanganate Demand Test



Persulfate Demand Test

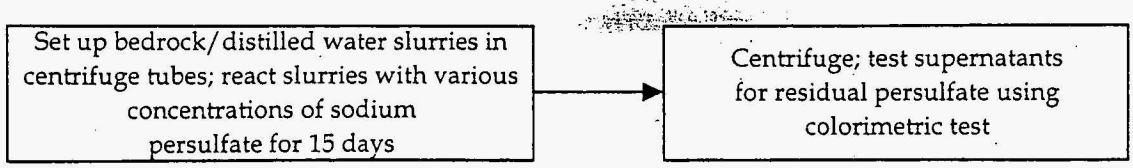
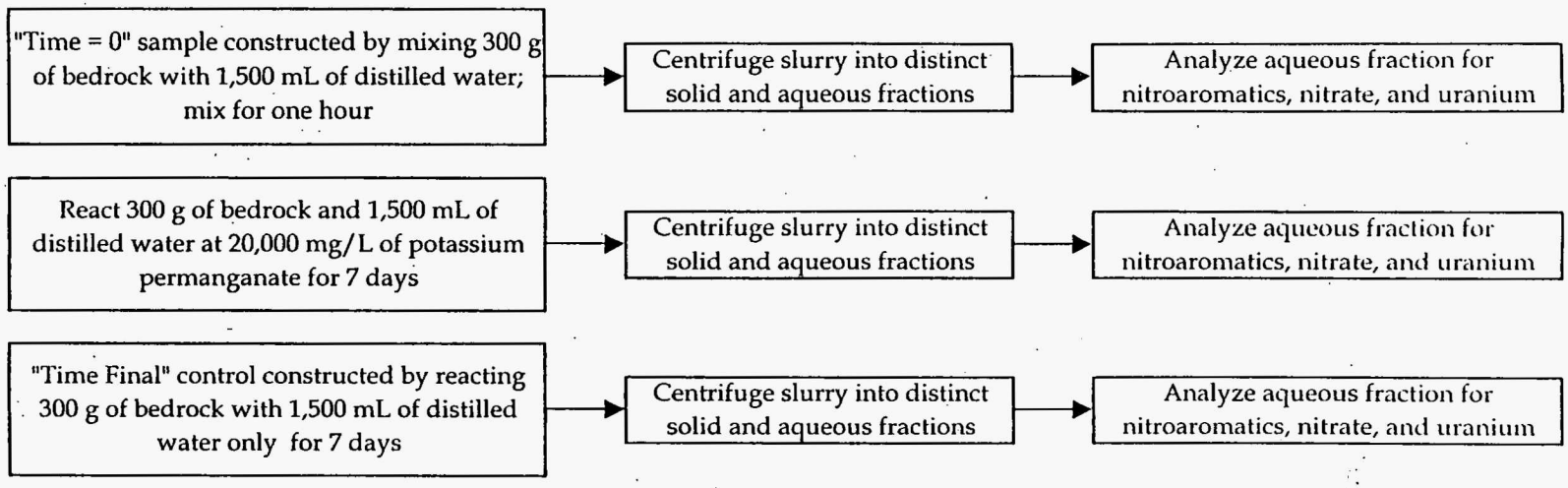
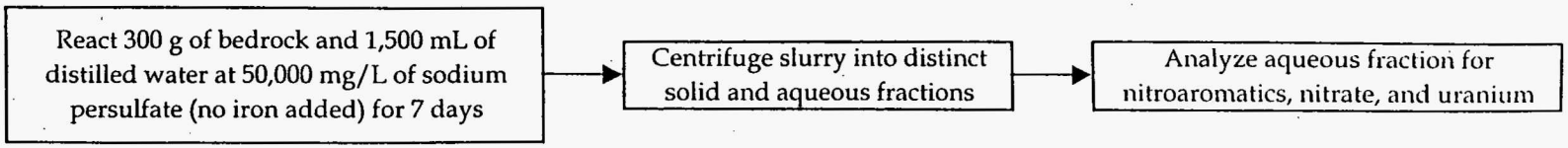


Figure 4. Bedrock Solubilization Tests for Secondary COCs
Weldon Spring Site Remedial Action Project
Insitu Chemical Oxidation Treatment Bench Scale Testing
2-May-01

Permanganate Solubilization Test



Persulfate Solubilization Test



APPENDIX A

LABORATORY ANALYTICAL REPORTS

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BR3034ERM

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: Q1971

Matrix: (soil/water) SOIL Lab Sample ID: Q1971-1

Sample wt/vol: 5.0 (g/mL) G Lab File ID: Q1971-1RB55

Level: (low/med) LOW Date Received: 04/02/01

% Moisture: not dec. 5 Date Analyzed: 04/05/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (ul) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or µg/Kg) UG/KG	Q
75-71-8	Dichlorodifluoromethane	11	U
74-87-3	Chloromethane	11	U
75-01-4	Vinyl Chloride	11	U
74-83-9	Bromomethane	11	U
75-00-3	Chloroethane	11	U
75-69-4	Trichlorofluoromethane	11	U
75-35-4	1,1-Dichloroethene	11	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	11	U
67-64-1	Acetone	8	JB
75-15-0	Carbon Disulfide	11	U
79-20-9	Methyl Acetate	11	U
75-09-2	Methylene Chloride	11	U
156-60-5	trans-1,2-Dichloroethene	11	U
1634-04-4	Methyl-tert-butyl ether	11	U
75-34-3	1,1-Dichloroethane	11	U
156-59-2	cis-1,2-Dichloroethene	11	U
78-93-3	2-Butanone	11	U
67-66-3	Chloroform	11	U
71-55-6	1,1,1-Trichloroethane	11	U
110-82-7	Cyclohexane	11	U
56-23-5	Carbon Tetrachloride	11	U
71-43-2	Benzene	11	U
107-06-2	1,2-Dichloroethane	11	U

04/05/01 16:23 FAX 919 379 4070 COMPUCHEM 002

1B

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BR3034ERM

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: Q1971

Matrix: (soil/water) SOIL Lab Sample ID: Q1971-1

Sample wt/vol: 5.0(g/mL) G Lab File ID: Q1971-1RB55

Level: (low/med) LOW Date Received: 04/02/01

% Moisture: not dec. 5 Date Analyzed: 04/05/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:_____(ul) Soil Aliquot Volume: _____(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or µg/Kg) UG/KG	Q
79-01-6	Trichloroethene	11	U
108-87-2	Methylcyclohexane	11	U
78-87-5	1,2-Dichloropropane	11	U
75-27-4	Bromodichloromethane	11	U
10061-01-5	cis-1,3-Dichloropropene	11	U
108-10-1	4-Methyl-2-Pentanone	11	U
108-88-3	Toluene	11	U
10061-02-6	trans-1,3-Dichloropropene	11	U
79-00-5	1,1,2-Trichloroethane	11	U
127-18-4	Tetrachloroethene	11	U
591-78-6	2-Hexanone	11	U
124-48-1	Dibromochloromethane	11	U
106-93-4	1,2-Dibromoethane	11	U
108-90-7	Chlorobenzene	11	U
100-41-4	Ethylbenzene	11	U
1330-20-7	Xylene (Total)	11	U
100-42-5	Styrene	11	U
75-25-2	Bromoform	11	U
98-82-8	Isopropylbenzene	11	U
79-34-5	1,1,2,2-Tetrachloroethane	11	U
541-73-1	1,3-Dichlorobenzene	11	U
106-46-7	1,4-Dichlorobenzene	11	U
95-50-1	1,2-Dichlorobenzene	11	U
96-12-8	1,2-Dibromo-3-Chloropropane	11	U
120-82-1	1,2,4-Trichlorobenzene	11	U

04/05/01 16:23 FAX 919 379 4070 COMPUCHEM 003

1D
GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BR3034ERM

Lab Name: COMPUCHEM Contract:

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: Q1971

Matrix: (soil/water) SOIL Lab Sample ID: Q1971-1

Sample wt/vol: 2.0 (g/mL) G Lab File ID: _____

% Moisture: 0 decanted: (Y/N) N Date Received: 04/02/01

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 04/02/01

Concentrated Extract Volume: 10000(ul) Date Analyzed: 04/04/01

Injection Volume: 25.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) MG/KG	Q
2691-41-0	HMX	0.25	U
99-35-4	1,3,5-Trinitrobenzene	0.25	U
121-82-4	RDX	0.25	U
99-65-0	1,3-Dinitrobenzene	0.25	U
118-96-7	2,4,6-Trinitrotoluene	0.25	U
479-45-8	Tetryl	0.50	U
98-95-3	Nitrobenzene	0.25	U
121-14-2	2,4-Dinitrotoluene	0.25	U
606-20-2	2,6-Dinitrotoluene	0.50	U
35572-78-2	2-Amino-4,6-dinitrotoluene	0.50	U
1946-51-0	4-Amino-2,6-dinitrotoluene	0.50	U
88-72-2	2-Nitrotoluene	0.50	U
99-99-0	4-Nitrotoluene	0.50	U
99-08-1	3-Nitrotoluene	0.50	U

FORM I PEST

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

5R3035ERM

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: Q1971

Matrix: (soil/water) SOIL Lab Sample ID: Q1971-2

Sample wt/vol: 5.0(g/mL) G Lab File ID: Q1971-2B55

Level: (low/med) LOW Date Received: 04/02/01

% Moisture: not dec. 10 Date Analyzed: 04/05/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:_____(ul) Soil Aliquot Volume: _____(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
75-71-8	Dichlorodifluoromethane	11	U
74-87-3	Chloromethane	11	U
75-01-4	Vinyl Chloride	11	U
74-83-9	Bromomethane	11	U
75-00-3	Chloroethane	11	U
75-69-4	Trichlorofluoromethane	11	U
75-35-4	1,1-Dichloroethene	11	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	11	U
67-64-1	Acetone	4	JB
75-15-0	Carbon Disulfide	11	U
79-20-9	Methyl Acetate	11	U
75-09-2	Methylene Chloride	11	U
156-60-5	trans-1,2-Dichloroethene	11	U
1634-04-4	Methyl-tert-butyl ether	11	U
75-34-3	1,1-Dichloroethane	11	U
156-59-2	cis-1,2-Dichloroethene	11	U
78-93-3	2-Butanone	2	JB
67-66-3	Chloroform	11	U
71-55-6	1,1,1-Trichloroethane	11	U
110-82-7	Cyclohexane	11	U
56-23-5	Carbon Tetrachloride	11	U
71-43-2	Benzene	11	U
107-06-2	1,2-Dichloroethane	11	U

04/05/01 16:23 FAX 919 379 4070 COMPUCHEM 004

1B

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BR3035ERM

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: Q1971

Matrix: (soil/water) SOIL Lab Sample ID: Q1971-2

Sample wt/vol: 5.0(g/mL) G Lab File ID: Q1971-2B55

Level: (low/med) LOW Date Received: 04/02/01

% Moisture: not dec. 10 Date Analyzed: 04/05/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:_____(ul) Soil Aliquot Volume:_____(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
79-01-6	Trichloroethene	11	U
108-87-2	Methylcyclohexane	11	U
78-87-5	1,2-Dichloropropane	11	U
75-27-4	Bromodichloromethane	11	U
10061-01-5	cis-1,3-Dichloropropene	11	U
108-10-1	4-Methyl-2-Pentanone	11	U
108-88-3	Toluene	11	U
10061-02-6	trans-1,3-Dichloropropene	11	U
79-00-5	1,1,2-Trichloroethane	11	U
127-18-4	Tetrachloroethene	11	U
591-78-6	2-Hexanone	11	U
124-48-1	Dibromochloromethane	11	U
106-93-4	1,2-Dibromoethane	11	U
108-90-7	Chlorobenzene	11	U
100-41-4	Ethylbenzene	11	U
1330-20-7	Xylene (Total)	11	U
100-42-5	Styrene	11	U
75-25-2	Bromoform	11	U
98-82-8	Isopropylbenzene	11	U
79-34-5	1,1,2,2-Tetrachloroethane	11	U
541-73-1	1,3-Dichlorobenzene	11	U
106-46-7	1,4-Dichlorobenzene	11	U
95-50-1	1,2-Dichlorobenzene	11	U
96-12-8	1,2-Dibromo-3-Chloropropane	11	U
120-82-1	1,2,4-Trichlorobenzene	11	U

04/05/01 16:23 FAX 818 379 4070 COMPUCHEM 005

1D

GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BR3035ERM

Lab Name: COMPUCHEM Contract:

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: Q1971

Matrix: (soil/water) SOIL Lab Sample ID: Q1971-2

Sample wt/vol: 2.0 (g/mL) G Lab File ID: _____

% Moisture: 0 decanted: (Y/N) N Date Received: 04/02/01

Extraction: (SepF/Cont/Sonc) SONC Date Extracted: 04/02/01

Concentrated Extract Volume: 10000 (ul) Date Analyzed: 04/04/01

Injection Volume: 25.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) MG/KG	Q
2691-41-0	HMX	0.25	U
99-35-4	1,3,5-Trinitrobenzene	0.25	U
121-82-4	RDX	0.25	U
99-65-0	1,3-Dinitrobenzene	0.25	U
118-96-7	2,4,6-Trinitrotoluene	0.25	U
479-45-8	Tetryl	0.50	U
98-95-3	Nitrobenzene	0.25	U
121-14-2	2,4-Dinitrotoluene	0.25	U
606-20-2	2,6-Dinitrotoluene	0.50	U
35572-78-2	2-Amino-4,6-dinitrotoluene	0.50	U
1946-51-0	4-Amino-2,6-dinitrotoluene	0.50	U
88-72-2	2-Nitrotoluene	0.50	U
99-99-0	4-Nitrotoluene	0.50	U
99-08-1	3-Nitrotoluene	0.50	U

FORM I PEST

TOTAL ORGANIC CARBON (QUAD) ANALYSIS

SUMMARY REPORT

ITEM NO.	SAMPLE IDENTIFIER	COMPUCHEM NUMBER	RESULT (mg/Kg)	REPORTING LIMIT (mg/Kg)
1.	BR3034ERM	T1971-1	110500	53
2.	BR3035ERM	T1971-2	113000	56

BRL = BELOW REPORTING LIMIT

Reviewed by/ID#: [signature] [2405] Date: 4/13/01

EX. 6

NITRATE/NITRITE ANALYSIS

SUMMARY REPORT

ITEM NO.	SAMPLE IDENTIFIER	COMPUCHEM NUMBER	RESULT (mg/Kg)	REPORTING LIMIT (mg/Kg)
1.	BR3034ERM	Q1971-1	7.63	1.1
2.	BR3035ERM	Q1971-2	3.6	1.1

BRL = BELOW REPORTING LIMIT

Reviewed by/ID#: [signature] [2405] Date: 4/5/01

EX. 6

1B
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034ERMDL

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: R1971

Matrix: (soil/water) WATER Lab Sample ID: R1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: R1971-1DA55

Level: (low/med) LOW Date Received: 04/02/01

% Moisture: not dec. _____ Date Analyzed: 04/03/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 6.2

Soil Extract Volume:_____(uL) Soil Aliquot Volume: _____(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
79-01-6	Trichloroethene	640	DB
108-87-2	Methylcyclohexane	63	U
78-87-5	1,2-Dichloropropane	63	U
75-27-4	Bromodichloromethane	63	U
10061-01-5	cis-1,3-Dichloropropene	63	U
108-10-1	4-Methyl-2-Pentanone	12	DJ
108-88-3	Toluene	63	U
10061-02-6	trans-1,3-Dichloropropene	63	U
79-00-5	1,1,2-Trichloroethane	63	U
127-18-4	Tetrachloroethene	63	U
591-78-6	2-Hexanone	14	DJB
124-48-1	Dibromochloromethane	63	U
106-93-4	1,2-Dibromoethane	63	U
108-90-7	Chlorobenzene	63	U
100-41-4	Ethylbenzene	63	U
1330-20-7	Xylene (Total)	63	U
100-42-5	Styrene	63	U
75-25-2	Bromoform	6	DJ
98-82-8	Isopropylbenzene	63	U
79-34-5	1,1,2,2-Tetrachloroethane	13	DJB
541-73-1	1,3-Dichlorobenzene	63	U
106-46-7	1,4-Dichlorobenzene	63	U
95-50-1	1,2-Dichlorobenzene	63	U
96-12-8	1,2-Dibromo-3-Chloropropane	35	DJB
120-82-1	1,2,4-Trichlorobenzene	63	U

FORM I VOA-2

OLM04.2

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034ERMDL

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: R1971

Matrix: (soil/water) WATER Lab Sample ID: R1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: R1971-1DA55

Level: (low/med) LOW Date Received: 04/02/01

% Moisture: not dec. _____ Date Analyzed: 04/03/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 6.2

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	63	U
74-87-3	Chloromethane	63	U
75-01-4	Vinyl Chloride	63	U
74-83-9	Bromomethane	63	U
75-00-3	Chloroethane	63	U
75-69-4	Trichlorofluoromethane	63	U
75-35-4	1,1-Dichloroethene	63	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	63	U
67-64-1	Acetone	70	D
75-15-0	Carbon Disulfide	63	U
79-20-9	Methyl Acetate	28	DJB
75-09-2	Methylene Chloride	63	U
156-60-5	trans-1,2-Dichloroethene	63	U
1634-04-4	Methyl tert-Butyl Ether	63	U
75-34-3	1,1-Dichloroethane	63	U
156-59-2	cis-1,2-Dichloroethene	22	DJ
78-93-3	2-Butanone	63	U
67-66-3	Chloroform	63	U
71-55-6	1,1,1-Trichloroethane	63	U
110-82-7	Cyclohexane	63	U
56-23-5	Carbon Tetrachloride	63	U
71-43-2	Benzene	63	U
107-06-2	1,2-Dichloroethane	63	U

1D
GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034ERM

Lab Name: COMPUCHEM Contract:

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: R1971

Matrix: (soil/water) WATER Lab Sample ID: R1971-1

Sample wt/vol: 770.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N) ___ Date Received: 04/02/01

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/03/01

Concentrated Extract Volume: 16000(ul) Date Analyzed: 04/04/01

Injection Volume: 25.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	3.2	U
99-35-4	1,3,5-Trinitrobenzene	1.6	U
121-82-4	RDX	4.0	U
99-65-0	1,3-Dinitrobenzene	1.6	U
118-96-7	2,4,6-Trinitrotoluene	3.2	U
479-45-8	Tetryl	3.2	U
98-95-3	Nitrobenzene	2.4	U
121-14-2	2,4-Dinitrotoluene	4.0	U
606-20-2	2,6-Dinitrotoluene	4.0	U
35572-78-2	2-Amino-4,6-dinitrotoluene	4.8	U
1946-51-0	4-Amino-2,6-dinitrotoluene	3.2	U
88-72-2	2-Nitrotoluene	4.0	U
99-99-0	4-Nitrotoluene	4.0	U
99-08-1	3-Nitrotoluene	3.2	U

FORM I PEST

1B
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034ERM

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: R1971

Matrix: (soil/water) WATER Lab Sample ID: R1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: R1971-1A55

Level: (low/med) LOW Date Received: 04/02/01

% Moisture: not dec. _____ Date Analyzed: 04/03/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
79-01-6	Trichloroethene	770	EB
108-87-2	Methylcyclohexane	10	U
78-87-5	1,2-Dichloropropane	10	U
75-27-4	Bromodichloromethane	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
108-10-1	4-Methyl-2-Pentanone	10	U
108-88-3	Toluene	10	U
10061-02-6	trans-1,3-Dichloropropene	10	U
79-00-5	1,1,2-Trichloroethane	10	U
127-18-4	Tetrachloroethene	10	U
591-78-6	2-Hexanone	10	U
124-48-1	Dibromochloromethane	10	U
106-93-4	1,2-Dibromoethane	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethylbenzene	10	U
1330-20-7	Xylene (Total)	10	U
100-42-5	Styrene	10	U
75-25-2	Bromoform	10	U
98-82-8	Isopropylbenzene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
541-73-1	1,3-Dichlorobenzene	10	U
106-46-7	1,4-Dichlorobenzene	10	U
95-50-1	1,2-Dichlorobenzene	10	U
96-12-8	1,2-Dibromo-3-Chloropropane	10	U
120-82-1	1,2,4-Trichlorobenzene	10	U

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034ERM

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: R1971

Matrix: (soil/water) WATER Lab Sample ID: R1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: R1971-1A55

Level: (low/med) LOW Date Received: 04/02/01

% Moisture: not dec. _____ Date Analyzed: 04/03/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	10	U
74-87-3	Chloromethane	10	U
75-01-4	Vinyl Chloride	10	U
74-83-9	Bromomethane	10	U
75-00-3	Chloroethane	10	U
75-69-4	Trichlorofluoromethane	10	U
75-35-4	1,1-Dichloroethene	10	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	10	U
67-64-1	Acetone	36	
75-15-0	Carbon Disulfide	10	U
79-20-9	Methyl Acetate	10	U
75-09-2	Methylene Chloride	10	U
156-60-5	trans-1,2-Dichloroethene	1	J
1634-04-4	Methyl tert-Butyl Ether	10	U
75-34-3	1,1-Dichloroethane	10	U
156-59-2	cis-1,2-Dichloroethene	20	
78-93-3	2-Butanone	10	U
67-66-3	Chloroform	1	J
71-55-6	1,1,1-Trichloroethane	10	U
110-82-7	Cyclohexane	10	U
56-23-5	Carbon Tetrachloride	10	U
71-43-2	Benzene	10	U
107-06-2	1,2-Dichloroethane	10	U

04/05/01 15:24 FAX 919 549 4070 COMPUCHEM 006

TOTAL URANIUM ANALYSIS RESULTS SUMMARY
By Laser-Induced Kinetic Phosphorimetry

Lab Name: Paragon Analytics, Inc. Date Collected: 03/30/2001

Client Name: CompuChem Date Analyzed : 04/03/2001

Client Project ID: Weldon Springs

Lab Sample ID Series: 01-04-001 Sample Matrix : SOIL

Client Sample ID	Lab Sample ID	Total Uranium (ug/g)	Reporting Limit	Flag
BR3034ERM	04-001-01	0.72 ± 0.10	0.10	
BR3035ERM	04-001-02	0.84 ± 0.11	0.10	
Blank	04-001-B1	BDL	0.10	U
BR3034ERM	04-001-D1	0.79 ± 0.11	0.10	

Reported Uncertainties are the Estimated Total Propagated Uncertainties (2σ).
See PAI SOP 743R3 for details of TPU determinations.

FLAGS = J - 'Estimated Value' - result between Method Detection Limit and Reporting Limit.
U - 'Not Detected' - result less than Method Detection Limit.

BDL = Below Detection Limit; see method for DL determination.

Remarks:

Sample 01-04-001-D1 is a duplicate of 01-04-001-01.

PRELIMINARY RESULTS

BP

ALKALINITY ANALYSIS

SUMMARY REPORT

ITEM NO.	SAMPLE IDENTIFIER	COMPUCHEM NUMBER	RESULT (mg/L)	REPORTING LIMIT (mg/L)
1.	GW3034ERM	U1971-1	230	10

BRL = BELOW REPORTING LIMIT

Reviewed by/ID#: [signature] [2405] Date: 4/13/01 EK.6

NITRATE/NITRITE ANALYSIS

SUMMARY REPORT

ITEM NO.	SAMPLE IDENTIFIER	COMPUCHEM NUMBER	RESULT (mg/L)	REPORTING LIMIT (mg/L)
1.	GW3034ERM	R1971-1	785	25

BRL = BELOW REPORTING LIMIT

Reviewed by/ID#: [signature] [2405] Date: 4/5/01

EX-6

CORROSIVITY BY PH ANALYSIS

SUMMARY REPORT

ITEM NO.	SAMPLE IDENTIFIER	COMPUCHEM NUMBER	RESULT (Standard pH units)	REPORTING LIMIT (Standard pH units)
1.	GW3034ERM	U1971-1	7.46	N/A

BRL = BELOW REPORTING LIMIT

Reviewed by/ID#: RWerge / [2405] Date: 4/13/01 EX-6

TOTAL ORGANIC CARBON ANALYSIS

SUMMARY REPORT

ITEM NO.	SAMPLE IDENTIFIER	COMPUCHEM NUMBER	RESULT (mg/L)	REPORTING LIMIT (mg/L)
1.	GW3034ERM	U1971-1	69.6	1

BRL = BELOW REPORTING LIMIT

Reviewed by/ID#: [signature] / [2405] Date: 4/13/01

EX. 6

TOTAL URANIUM ANALYSIS RESULTS SUMMARY

By Laser-Induced Kinetic Phosphorimetry

Lab Name: Paragon Analytics, Inc. Date Collected: 03/30/2001

Client Name: CompuChem Date Analyzed : 04/03/2001

Client Project ID: Weldon Springs

Lab Sample ID Series: 01-04-001 Sample Matrix : WATER

Client Sample ID	Lab Sample ID	Total Uranium (ug/L)	Reporting Limit	Flag
GW3034ERM	04-001-03	3.93 ± 0.53	0.20	
Blank	04-001-B2	0.02 ± 0.00	0.20	J
GW3034ERM	04-001-D2	3.89 ± 0.52	0.20	

Reported Uncertainties are the Estimated Total Propagated Uncertainties (2σ).
See PAI SOP 743R3 for details of TPU determinations.

FLAGS - J - 'Estimated Value' - result between Method Detection Limit and Reporting Limit.
U - 'Not Detected' - result less than Method Detection Limit.

BDL = Below Detection Limit; see method for DL determination.

Remarks:

Sample 01-04-001-D2 is a duplicate of 01-04-001-03.

PRELIMINARY RESULTS

S 10662

233167

SUBCONTRACT CHAIN-OF-CUSTODY RECORD

COMPUCHEM
a division of Liberty Analytical Corp.

501 Madison Avenue
Cary, NC 27513
1-800-833-5097

Project Name: Weldon Springs	Samples shipped to: Test America	CompuChem point-of-contact: (4) Diane Byrd
TAT: 7 calendar days	Contact:	Phone: (919) 379-4100 X 4009
Report style: CLP	Address:	Fax: (919) 379- 4050
	Phone: ( )	Sampling complete? Y or N (see Note 1)
Disk requirement:	Project Locale (state)	Project-specific (PS) or Batch (B) QC? PS

BOX #1: 1. Surface Water, 2. Ground Water, 3. Leachate, 4. Rinsate, 5. Soil / Sediment / Sludge, 6. Trip Blank, 7. Oil, 8. Waste, 9. Other _____

BOX #2: A. HCl + Ice, B. HNO_3 + Ice, C. NaOH + Ice, D. H_2SO_4 + Ice, E. Unpreserved, F. Ice Only, G. Other _____, H. $NaHSO_4$ + Ice, I. ZnAc+NaOH + Ice, J. Methanol

BOX #3: F- Filtered, U- Unfiltered ✓

BOX #4: H- High, M- Medium, L- Low

BOX #5: C- CLP, T- TCLP, S- SW-846, W- CWA 600-series, O- Other _____

Sample ID	Date / Year 2001	Time	Box #1 Matrix	Box #2 Preservative	Box #3 Filtered / Unfiltered	Box #4 Expected Conc.	Box #5 Method	# of Bottles	Use for Lab QC (MS or DUP)	PARAMETERS: ADD				CCN	Remarks / Comments (see Notes 2 & 3)
BR3034ERM	3/30	0000		47181				1		✓				S1971-1	Limited volumes
BR3035ERM	↓	↓		182				1		✓				-2	↓
GW3034ERM	↓	↓		47183				1		✓				-3	↓
					Fax To										
				Raleigh Office											
				(919) 785-1672											

01-0428
RALEIGH, NC

Clients Special Instructions: Temperature _____ °C

Lab: Received in good condition? Y or N Describe any problems:

#1 Relinquished by:(sig) Diane Byrd Date: 4/16/01	#2 Relinquished by:(sig) Samuel Lee Hayes Date: 4/16/01	Relinquished by:(sig) Date:
Company Name: CompuChem Time: 15:05	Company Name: Test America Time: 17:00	Company Name: Time:
#1 Received by:(sig) Samuel Lee Hayes Date: 15:05	#2 Received by:(sig) M. Beasley Date: 4/16/01	#2 Received by:(sig) Date:
Company Name: Test America Time:	Company Name: 15.0 Time: 4:00	Company Name: Time:

FROM

Note (1) If "N" lab should batch samples to await remainder of project - maximizing batch size and minimizing QC ratio; if "Y" lab should begin processing batches now.
Note (2) Samples should be stored 60 days after date report mailed at no extra charge.
Note (3) All lab copies of data should be retained for a minimum of 3 years.
Note (4) Please call point-of-contact to verify receipt of samples.

TESTAMERICA, INC.

COOLER RECEIPT FORM

Client: Compuchem BC# 233107

Cooler Received On: 4/16/01 And Opened On: 4/16/01 By: Mark Beasley

(Signature)

1. Temperature of Cooler when opened 15.0 DEGREES CELSIUS
2. Were custody seals on outside of cooler and intact?.....YES NO
   a. If yes, what kind and where: TAPE
   b. Were the signature and date correct?.....YES NO
3. Were custody seals on containers intact?.....YES NO
4. Were custody papers inside cooler?.....YES NO
5. Were custody papers properly filled out (ink,signed,etc)?.....YES NO
6. Did you sign the custody papers in the appropriate place?.....YES NO
7. What kind of packing material was used? Bubblewrap Peanuts Other None
8. Was sufficient ice used (if appropriate)?.....YES NO
9. Did all bottles arrive in good condition(unbroken)?.....YES NO
10. Were all bottle labels complete (#,date,signed,pres,etc)?.....YES NO
11. Did all bottle labels and tags agree with custody papers?.....YES NO
12. Were correct bottles used for the analysis requested?.....YES NO
13. If present, was any observable VOA headspace present?.....YES NO
14. If present, were VOA vials checked for absence of air bubbles and noted if found?.....YES NO
15. Was sufficient amount of sample sent in each bottle?.....YES NO
16. Were correct preservatives used?.....YES NO
17. Was residual chlorine present (if appropriate?).....YES NO
18. Corrective action taken, if necessary:
    a. Name of person contacted: SEE ATTACHED FOR RESOLUTION IF NEEDED
    b. Date:

FROM

SAMPLE NONCONFORMANCE/COC REVISION FORM

TestAmerica
Nashville Division

ACCT NO. 2303

DATE RECEIVED _____

COMPANY Compuchem

Relinquished by:	Date/Time:	Received by:	Date/Time
MB	4-9-01 8:40	JH	4-9-01 0900
Relinquished by:	**Date/Time:**	**Received by:**	**Date/Time:**
Jennifer Neckelba	4-9-01 1230	MB	4/9/01 12:30
Relinquished by:	**Date/Time:**	**Received by:**	**Date/Time:**

PROBLEM(S):

FOC/TOC?

TPH METHOD?

EDB METHOD?

NEED LIST OF COMPOUNDS:

TEMPERATURE UPON RECEIPT 15.0

ICE -- OR-- NO ICE??

NO COC - PLEASE FAX

DOCUMENTATION LEVEL?

METALS LIST?

TCLP WHAT?

HERB LIST- LONG OR SHORT?

8260 INSTEAD OF 8021?

SATURDAY DELIVERY MARKED? NO

FIELD TEST-- OUT OF HOLD

NO ANALYSIS REQUESTED

OUT OF HOLDING TIME-- TEST

OTHER: _____

RESOLUTION: Go ahead & run anyway

CONTACTED	DATE/TIME	EMAIL	LEFT MESSAGE
Sam	4-9-01 1050		Sam checking

Revised 8/9/00

Sample Nonconformance/COC Revision Form CSF-12

TestAmerica
INCORPORATED

ANALYTICAL REPORT

COMPUCHEM 2303
DIANE BYRD
501 MADISON AVENUE
CARY, NC 27513

Lab Number: 01-A47181
Sample ID: S1971-1
Sample Type: Ground water
Site ID:

Project:
Project Name: WELDON SPRINGS
Sampler:

Date Collected: 3/30/01
Time Collected:
Date Received: 4/ 9/01
Time Received: 9:00

Analyte	Result	Units	Report Limit	Quan Limit	Dil Factor	Analysis Date	Analysis Time	Analyst	Method	Batch
MISCELLANEOUS CHEMISTRY										
Chemical Oxygen Demand	26.4	mg/l	3.00	3.00	1	4/11/01	15:19	S. Overton	410.4 Mod	7937

Sample was received at 15.0 degrees celsius, client notified.

ND - Not detected at the report limit.
- Recovery outside Laboratory historical limits.

COD method modified for HACH Method 8000.

These results relate only to the items tested.
This report shall not be reproduced except in full and with permission of the laboratory.

Report Approved By: [signature] Report Date: 4/16/01

Paul E. Lane, Jr., Lab Director
Michael H. Dunn, M.S., Technical Director
Johnny A. Mitchell, Dir. Technical Serv.
Eric S. Smith, Assistant Technical Director
Gail A. Lage, Technical Serv.
Glenn L. Norton, Technical Serv.
Kelly S. Comstock, Technical Serv.
Pamela A. Langford, Technical Serv.

Laboratory Certification Number: 387

End of Sample Report.

2960 Foster Creighton Drive / Nashville, TN 37204 / 615-726-0177 / Fax: 615-726-0954 / 800-765-0980

FROM

TestAmerica
INCORPORATED

ANALYTICAL REPORT

COMPUCHEM 2303
DIANE BYRD
501 MADISON AVENUE
CARY, NC 27513

Lab Number: 01-A47182
Sample ID: S1971-2
Sample Type: Ground water
Site ID:

Project:
Project Name: WELDON SPRINGS
Sampler:

Date Collected: 3/30/01
Time Collected:
Date Received: 4/ 9/01
Time Received: 9:00

Analyte	Result	Units	Report Limit	Quan Limit	Dil Factor	Analysis Date	Analysis Time	Analyst	Method	Batch
MISCELLANEOUS CHEMISTRY										
Chemical Oxygen Demand	ND	mg/l	3.00	3.00	1	4/11/01	15:19	S. Overton	410.4 Mod	7937

Sample was received at 15.0 degrees celsius. client notified.

ND - Not detected at the report limit.
- Recovery outside Laboratory historical limits.

COD method modified for HACH Method 8000.

These results relate only to the items tested.
This report shall not be reproduced except in full and with permission of the laboratory.

Report Approved By: [signature] Report Date: 4/16/01

Paul E. Lane, Jr., Lab Director
Michael H. Dunn, M.S., Technical Director
Johnny A. Mitchell, Dir. Technical Serv.
Eric S. Smith, Assistant Technical Director
Gail A. Lage, Technical Serv.
Glenn L. Norton, Technical Serv.
Kelly S. Comstock, Technical Serv.
Pamela A. Langford, Technical Serv.

Laboratory Certification Number: 387

End of Sample Report.

2960 Foster Creighton Drive / Nashville, TN 37204 / 615-726-0177 / Fax: 615-726-0954 / 800-765-0980

TestAmerica
INCORPORATED

ANALYTICAL REPORT

COMPUCHEM 2303
DIANE BYRD
501 MADISON AVENUE
CARY, NC 27513

Lab Number: 01-A47183
Sample ID: S1971-3
Sample Type: Ground water
Site ID:

Date Collected: 3/30/01
Time Collected:
Date Received: 4/ 9/01
Time Received: 9:00

Project:
Project Name: WELDON SPRINGS
Sampler:

Analyte	Result	Units	Report Limit	Quan Limit	Dil Factor	Analysis Date	Analysis Time	Analyst	Method	Batch
MISCELLANEOUS CHEMISTRY										
Chemical Oxygen Demand	20.2	mg/l	3.00	3.00	1	4/11/01	15:19	S. Overton	410.4 Mod	7937

Sample was received at 15.0 degrees celsius, client notified.

ND = Not detected at the report limit.
# = Recovery outside Laboratory historical limits.

COD method modified for HACH Method 8000.

These results relate only to the items tested.
This report shall not be reproduced except in full and with permission of the laboratory.

Report Approved By: [signature] Report Date: 4/16/01

Paul E. Lane, Jr., Lab Director
Michael H. Dunn, M.S., Technical Director
Johnny A. Mitchell, Dir. Technical Serv.
Eric S. Smith, Assistant Technical Director
Gail A. Lage, Technical Serv.
Glenn L. Norton, Technical Serv.
Kelly S. Comstock, Technical Serv.
Pamela A. Langford, Technical Serv.

Laboratory Certification Number: 387

End of Sample Report.

2960 Foster Creighton Drive / Nashville, TN 37204 / 615-726-0177 / Fax: 615-726-0954 / 800-765-0980

TestAmerica
INCORPORATED

PROJECT QUALITY CONTROL DATA
Project Number:

Matrix Spike Recovery

Analyte	units	Orig. Val.	MS Val	Spike Conc	Recovery	Target Range	Q.C. Batch	Spike Sample
MISC PARAMETERS								
Chemical Oxygen Demand	mg/l	26.4	73.9	50.0	95	80 - 120	7937	01-A47181

Laboratory Control Data

Analyte	units	Known Val.	Analyzed Val	% Recovery	Target Range	Q.C. Batch
MISC PARAMETERS						
Chemical Oxygen Demand	mg/l	50.0	50.6	101	90 - 110	7937

Duplicates

Analyte	units	Orig. Val.	Duplicate	RPD	Limit	Q.C. Batch	Sample Dup'd
Chemical Oxygen Demand	mg/l	20.2	20.7	2.44	15.	7937	01-A47183

Blank Data

Analyte	Blank Value	Units	Q.C. Batch	Date Analyzed	Time Analyzed
MISC PARAMETERS					
Chemical Oxygen Demand	< 3.00	mg/l	7937	4/11/01	15:19

- Value outside Laboratory historical QC limits.

End of Report for Project 233107

2960 Foster Creighton Drive / Nashville, TN 37204 / 615-726-0177 / Fax: 615-726-0954 / 800-765-0980

T20 Effluent Test

CHAIN-OF-CUSTODY RECORD

No. 059459

CompuChem
a division of Liberty Analytical Corp.
501 Madison Avenue
Cary, NC 27513
1-800-833-5097

Project Name : Willow Springs	Client Address : 500 Pennsylvania Ave, West Chester, PA 19380	Point-of-Contact : Luke Pacione / Chris Smith
Carrier : FedEx		Telephone No. : 1-800-443-1511
Airbill No. :		Sampling complete? Y or N (see Note 1)
Sampler Name : Tony Kwan	Sampler Signature :	Project-specific (PS) or Batch (B) QC ? ____

BOX #1	BOX #2	BOX #3	Box #4	Box #5
1. Surface Water	A. HCl + Ice	F. Filtered	H. High	C. CLP 3/90
2. Ground Water	B. HNO3 + Ice	U. Unfiltered	M. Medium	T. TCLP
3. Leachate	C. NaOH + Ice		L. Low	S. SW-846
4. Rinsate	D. H2SO4 + Ice			W. CWA 600-series
5. Soil / Sediment / Sludge	E. Unpreserved			O. Other_____
6. Trip Blank	F. Ice Only			
7. Oil	G. Other_____			
8. Waste	H. NaHSO4 + Ice			
9. Other_____	I. ZnAc+NaOH + Ice			

Sample ID (9 characters maximum)	Date:Year: 99	Time	Box #1 Matrix	Box #2 Preservative	Box #3 Filtered / Unfiltered	Box #4 Expected Conc.	Box #5 Method	No. of Bottles	Use for Lab QC (MS or DUP)	VOA	SVOC	Pesticide	PCB	Herbicide	Metals / Mercury	Cyanide	TOC / TOX	O&G / TPH	URANIUM				Remarks / Comments (see Notes 2 & 3)
6U3C34T0	4/9	:	2	B	U	M		1											X				3 day TAT
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Clients Special Instructions: Temperature _____ °C

Lab: Received in Good Condition? Y or N Describe Problems, If any:

#1 Relinquished By: (Sig) [signature] Date: 4/9/99	#2 Relinquished By: (Sig) Date:	#3 Relinquished By: (Sig) Date:
Company Name: Time:	Company Name: Time:	Company Name: Time:
#1 Received By: (Sig) Date:	#2 Received By: (Sig) Date:	#3 Received By: (Sig) Date:
Company Name: Time:	Company Name: Time:	Company Name: Time:

Note (1): If "N" lab will hold samples to await remainder of project-maximizing batch size and minimizing QC ratio; if "Y" lab will begin processing batches now.
Note (2): Samples held 60 days after date report mailed at no extra charge. Note (3): All lab copies of data destroyed after three years.

TOTAL URANIUM ANALYSIS RESULTS SUMMARY

By Laser-Induced Kinetic Phosphorimetry

Lab Name: Paragon Analytics, Inc. Date Collected: 04/06/2001

Client Name: CompuChem Date Analyzed : 04/11/2001

Client Project ID: Weldon Springs

Lab Sample ID Series: 01-04-092 Sample Matrix : WATER

Client Sample ID	Lab Sample ID	Total Uranium (ug/L)	Reporting Limit	Flag
GW3034T0	04-092-01	4.00 ± 0.54	0.20	
Blank	04-092-B1	BDL	0.20	U
GW3034T0	04-092-D1	3.96 ± 0.53	0.20	

Reported Uncertainties are the Estimated Total Propagated Uncertainties (2σ).
See PAI SOP 743R3 for details of TPU determinations.

FLAGS = J - 'Estimated Value' - result between Method Detection Limit and Reporting Limit.
U - 'Not Detected' - result less than Method Detection Limit.

BDL = Below Detection Limit; see method for DL determination.

Remarks:

Sample 01-04-092-D1 is a duplicate of 01-04-092-01.

BP

00001

T20 Effluent Test

CompuChem
a division of Liberty Analytical Corp.

501 Madison Avenue
Cary, NC 27513
1-800-833-5097

CHAIN-OF-CUSTODY RECORD

No. 059458

Project Name :	Client Address :	Point-of-Contact :
Carrier :		Telephone No. :
Airbill No. :		Sampling complete? Y or N (see Note 1)
Sampler Name :	Sampler Signature :	Project-specific (PS) or Batch (B) QC ? ____

BOX #1	BOX #2	BOX #3	Box #4	Box #5
1. Surface Water	A. HCl + Ice	F. Filtered	H. High	C. CLP 3/90
2. Ground Water	B. HNO3 + Ice	U. Unfiltered	M. Medium	S. SW-846
3. Leachate	C. NaOH + Ice		L. Low	W. CWA 600-series
4. Rinsate	D. H2SO4 + Ice			O. Other____
5. Soil / Sediment / Sludge	E. Unpreserved			T. TCLP
6. Trip Blank	F. Ice Only			
7. Oil	G. Other____			
8. Waste	H. NaHSO4 + Ice			
9. Other____	I. ZnAc+NaOH + Ice			

Sample ID (9 characters maximum)	Date:Year:	Time	Box #1 Matrix	Box #2 Preservative	Box #3 Filtered / Unfiltered	Box #4 Expected Conc.	Box #5 Method	No. of Bottles	Use for Lab QC (MS or DUP)	VOA	SVOC	Pesticide	PCB	Herbicide	Metals/Mercury	Cyanide	TOC/TOX	O&G/TPH	Nitroaromatics	Nitrates			Remarks / Comments (see Notes 2 & 3)
GW502470	4/4	:	GW	F	U	M		5		X									X	X			5 day TAT
	/	:								X													
	/	:								X													
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Clients Special Instructions: Temperature ____ °C

Lab: Received in Good Condition? Y or N Describe Problems, If any:

#1 Relinquished By: (Sig) Date:	#2 Relinquished By: (Sig) Date:	#3 Relinquished By: (Sig) Date:
Company Name: Time:	Company Name: Time:	Company Name: Time:
#1 Received By: (Sig) Date:	#2 Received By: (Sig) Date:	#3 Received By: (Sig) Date:
Company Name: Time:	Company Name: Time:	Company Name: Time:

Note (1): If "N" lab will hold samples to await remainder of project-maximizing batch size and minimizing QC ratio; if "Y" lab will begin processing batches now.
Note (2): Samples stored 60 days after date report mailed at no extra charge. Note (3): All lab ...

TEO Soil Test

CHAIN-OF-CUSTODY RECORD

No. 059460

CompuChem
a division of Liberty Analytical Corp.
501 Madison Avenue
Cary, NC 27513
1-800-833-5097

Project Name : Weldon Springs	Client Address : 303 Brandywine Pkwy West Chester, PA 19380	Point-of-Contact : Chuck Small
Carrier :		Telephone No. : 919-379-4021
Airbill No. :		Sampling complete? Y or N (see Note 1)
Sampler Name :	Sampler Signature :	Project-specific (PS) or Batch (B) QC ? ____

BOX #1	1. Surface Water	6. Trip Blank	BOX #2	A. HCl + Ice	F. Ice Only	BOX #3	F. Filtered	Box #4	H. High	Box #5	C. CLP 3/90 T. TCLP
	2. Ground Water	7. Oil		B. HNO3 + Ice	G. Other_____		U. Unfiltered		M. Medium		S. SW-846
	3. Leachate	8. Waste		C. NaOH + Ice	H. NaHSO4 + Ice				L. Low		W. CWA 600-series
	4. Rinsate	9. Other_____		D. H2SO4 + Ice	I. ZnAc+NaOH + Ice				✓ ✓		O. Other_____
	5. Soil / Sediment / Sludge			E. Unpreserved							

Sample ID (9 characters maximum)	Date:Year: 2001	Time	Box #1 Matrix	Box #2 Preservative	Box #3 Filtered / Unfiltered	Box #4 Expected Conc.	Box #5 Method	No. of Bottles	Use for Lab QC (MS or DUP)	VOA	SVOC	Pesticide	PCB	Herbicide	Metals / Mercury	Cyanide	TOC / TOX	O&G / TPH	Nitrate	Nitrogen			Remarks / Comments (see Notes 2 & 3)
✓ BR3034TO	4/9	:	2	F	U	M		2											1	1			30day TAT
✓ BR3035TO	4/9	:	2	F	U	M		2											1	1			
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Clients Special Instructions: Temperature _____ °C

Lab: Received in Good Condition? Y or N **Describe Problems, If any:**

#1 Relinquished By: (Sig) [signature] Date: 4/10/01	#2 Relinquished By: (Sig) Date:	#3 Relinquished By: (Sig) Date:
Company Name: TPM Time: / /	Company Name: Time:	Company Name: Time:
#1 Received By: (Sig) Date:	#2 Received By: (Sig) Date:	#3 Received By: (Sig) Date:
Company Name: Time:	Company Name: Time:	Company Name: Time:

Note (1): If "N" lab will hold samples to await remainder of project-maximizing batch size and minimizing QC ratio; if "Y" lab will begin processing batches now.
Note (2): Samples stored 60 days after date report mailed at no extra charge. Note (3): All lab copies of data destroyed after three years.

VOLATILE ORGANICS ANALYSIS DATA SHEET

GW3034T0

Lab Name: COMPUCHEM | Contract: OLM04-REVS

Lab Code: LIBRTY | Case No.: | SAS No.: | SDG No.: V1971

Matrix: (soil/water) WATER | Lab Sample ID: V1971-1

Sample wt/vol: 5 (g/mL) ML | Lab File ID: V1971-1A55

Level: (low/med) LOW | Date Received: 04/10/01

% Moisture: not dec. _____ | Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) | Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) | Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	10	U
74-87-3	Chloromethane	10	U
75-01-4	Vinyl Chloride	10	U
74-83-9	Bromomethane	10	U
75-00-3	Chloroethane	10	U
75-69-4	Trichlorofluoromethane	10	U
75-35-4	1,1-Dichloroethene	10	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	10	U
67-64-1	Acetone	4	JB
75-15-0	Carbon Disulfide	10	U
79-20-9	Methyl Acetate	10	U
75-09-2	Methylene Chloride	10	J
156-60-5	trans-1,2-Dichloroethene	1	J
1634-04-4	Methyl tert-Butyl Ether	10	U
75-34-3	1,1-Dichloroethane	10	U
156-59-2	cis-1,2-Dichloroethene	18	
78-93-3	2-Butanone	10	U
67-66-3	Chloroform	1	J
71-55-6	1,1,1-Trichloroethane	10	U
110-82-7	Cyclohexane	10	U
56-23-5	Carbon Tetrachloride	10	U
71-43-2	Benzene	10	U
107-06-2	1,2-Dichloroethane	10	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

GW3034T0

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: V1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: V1971-1A55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	Q
79-01-6	Trichloroethene	570	EB
108-87-2	Methylcyclohexane	10	U
78-87-5	1,2-Dichloropropane	10	U
75-27-4	Bromodichloromethane	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
108-10-1	4-Methyl-2-Pentanone	10	U
108-88-3	Toluene	1	J
10061-02-6	trans-1,3-Dichloropropene	10	U
79-00-5	1,1,2-Trichloroethane	10	U
127-18-4	Tetrachloroethene	10	U
591-78-6	2-Hexanone	10	U
124-48-1	Dibromochloromethane	10	U
106-93-4	1,2-Dibromoethane	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethylbenzene	10	U
1330-20-7	Xylene (Total)	10	U
100-42-5	Styrene	10	U
75-25-2	Bromoform	10	U
98-82-8	Isopropylbenzene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
541-73-1	1,3-Dichlorobenzene	10	U
106-46-7	1,4-Dichlorobenzene	10	U
95-50-1	1,2-Dichlorobenzene	10	U
96-12-8	1,2-Dibromo-3-Chloropropane	10	U
120-82-1	1,2,4-Trichlorobenzene	10	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

GW3034T0

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: V1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: V1971-1A55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

Number TICs found: 0 CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-TIC OLM04.2

04/17/01 15:34 FAX 919 379 4070 COMPUCHEM 009

VOLATILE ORGANICS ANALYSIS DATA SHEET

GW3034T0D

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: V1971-2

Sample wt/vol: 5 (g/mL) ML Lab File ID: V1971-2A55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____(uL) Soil Aliquot Volume: _____(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	10	U
74-87-3	Chloromethane	10	U
75-01-4	Vinyl Chloride	10	U
74-83-9	Bromomethane	10	U
75-00-3	Chloroethane	10	U
75-69-4	Trichlorofluoromethane	10	U
75-35-4	1,1-Dichloroethene	10	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	10	U
67-64-1	Acetone	5	JB
75-15-0	Carbon Disulfide	10	U
79-20-9	Methyl Acetate	10	U
75-09-2	Methylene Chloride	9	J
156-60-5	trans-1,2-Dichloroethene	1	J
1634-04-4	Methyl tert-Butyl Ether	10	U
75-34-3	1,1-Dichloroethane	10	U
156-59-2	cis-1,2-Dichloroethene	16	
78-93-3	2-Butanone	10	U
67-66-3	Chloroform	10	U
71-55-6	1,1,1-Trichloroethane	10	U
110-82-7	Cyclohexane	10	U
56-23-5	Carbon Tetrachloride	10	U
71-43-2	Benzene	10	U
107-06-2	1,2-Dichloroethane	10	U

04/17/01 15:34 FAX 919 379 4070 COMPUCHEM 010

VOLATILE ORGANICS ANALYSIS DATA SHEET

GW3034T0D

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: V1971-2

Sample wt/vol: 5 (g/mL) ML Lab File ID: V1971-2A55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
79-01-6	Trichloroethene	540	EB
108-87-2	Methylcyclohexane	10	U
78-87-5	1,2-Dichloropropane	10	U
75-27-4	Bromodichloromethane	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
108-10-1	4-Methyl-2-Pentanone	10	U
108-88-3	Toluene	1	J
10061-02-6	trans-1,3-Dichloropropene	10	U
79-00-5	1,1,2-Trichloroethane	10	U
127-18-4	Tetrachloroethene	7	J
591-78-6	2-Hexanone	10	U
124-48-1	Dibromochloromethane	10	U
106-93-4	1,2-Dibromoethane	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethylbenzene	10	U
1330-20-7	Xylene (Total)	10	U
100-42-5	Styrene	10	U
75-25-2	Bromoform	10	U
98-82-8	Isopropylbenzene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
541-73-1	1,3-Dichlorobenzene	10	U
106-46-7	1,4-Dichlorobenzene	10	U
95-50-1	1,2-Dichlorobenzene	10	U
96-12-8	1,2-Dibromo-3-Chloropropane	10	U
120-82-1	1,2,4-Trichlorobenzene	10	U

1F

VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

GW3034T0D

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: V1971-2

Sample wt/vol: 5 (g/mL) ML Lab File ID: V1971-2A55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____(uL) Soil Aliquot Volume: _____(uL)

Number TICs found: 0 CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-TIC OLM04.2

04/17/01 15:35 FAX 919 379 4070 COMPUCHEM 012

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034T0DDL

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: V1971-2

Sample wt/vol: 5 (g/mL) ML Lab File ID: V1971-2DA55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 5.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	50	U
74-87-3	Chloromethane	50	U
75-01-4	Vinyl Chloride	50	U
74-83-9	Bromomethane	50	U
75-00-3	Chloroethane	50	U
75-69-4	Trichlorofluoromethane	50	U
75-35-4	1,1-Dichloroethene	50	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	50	U
67-64-1	Acetone	18	DJB
75-15-0	Carbon Disulfide	50	U
79-20-9	Methyl Acetate	50	U
75-09-2	Methylene Chloride	13	DJ
156-60-5	trans-1,2-Dichloroethene	50	U
1634-04-4	Methyl tert-Butyl Ether	50	U
75-34-3	1,1-Dichloroethane	50	U
156-59-2	cis-1,2-Dichloroethene	15	DJ
78-93-3	2-Butanone	50	U
67-66-3	Chloroform	50	U
71-55-6	1,1,1-Trichloroethane	50	U
110-82-7	Cyclohexane	50	U
56-23-5	Carbon Tetrachloride	50	U
71-43-2	Benzene	50	U
107-06-2	1,2-Dichloroethane	50	U

FORM I VOA-1 OLM04.2

04/17/01 15:35 FAX 919 379 4070 COMPUCHEM 013

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034T0DDL

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: V1971-2

Sample wt/vol: 5 (g/mL) ML Lab File ID: V1971-2DA55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 5.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	Q
79-01-6	Trichloroethene	540	DB
108-87-2	Methylcyclohexane	50	U
78-87-5	1,2-Dichloropropane	50	U
75-27-4	Bromodichloromethane	50	U
10061-01-5	cis-1,3-Dichloropropene	50	U
108-10-1	4-Methyl-2-Pentanone	50	U
108-88-3	Toluene	50	U
10061-02-6	trans-1,3-Dichloropropene	50	U
79-00-5	1,1,2-Trichloroethane	50	U
127-18-4	Tetrachloroethene	8	DJ
591-78-6	2-Hexanone	50	U
124-48-1	Dibromochloromethane	50	U
106-93-4	1,2-Dibromoethane	50	U
108-90-7	Chlorobenzene	50	U
100-41-4	Ethylbenzene	50	U
1330-20-7	Xylene (Total)	50	U
100-42-5	Styrene	50	U
75-25-2	Bromoform	50	U
98-82-8	Isopropylbenzene	50	U
79-34-5	1,1,2,2-Tetrachloroethane	50	U
541-73-1	1,3-Dichlorobenzene	50	U
106-46-7	1,4-Dichlorobenzene	50	U
95-50-1	1,2-Dichlorobenzene	50	U
96-12-8	1,2-Dibromo-3-Chloropropane	50	U
120-82-1	1,2,4-Trichlorobenzene	50	U

1F

VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

GW3034T0DDL

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: V1971-2

Sample wt/vol: 5 (g/mL) ML Lab File ID: V1971-2DA55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 5.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

Number TICs found: 0

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-TIC OLM04.2

04/17/01 15:36 FAX 919 379 4070 COMPUCHEM 015

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034T0DL

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: V1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: V1971-1DA55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 5.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	50	U
74-87-3	Chloromethane	50	U
75-01-4	Vinyl Chloride	50	U
74-83-9	Bromomethane	50	U
75-00-3	Chloroethane	50	U
75-69-4	Trichlorofluoromethane	50	U
75-35-4	1,1-Dichloroethene	50	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	50	U
67-64-1	Acetone	18	DJB
75-15-0	Carbon Disulfide	50	U
79-20-9	Methyl Acetate	50	U
75-09-2	Methylene Chloride	12	DJ
156-60-5	trans-1,2-Dichloroethene	50	U
1634-04-4	Methyl tert-Butyl Ether	50	U
75-34-3	1,1-Dichloroethane	50	U
156-59-2	cis-1,2-Dichloroethene	16	DJ
78-93-3	2-Butanone	11	DJB
67-66-3	Chloroform	50	U
71-55-6	1,1,1-Trichloroethane	50	U
110-82-7	Cyclohexane	50	U
56-23-5	Carbon Tetrachloride	50	U
71-43-2	Benzene	50	U
107-06-2	1,2-Dichloroethane	50	U

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034T0DLMS

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: WG9546-4

Sample wt/vol: 5 (g/mL) ML Lab File ID: WG9546-4A55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 5.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	50	U
74-87-3	Chloromethane	50	U
75-01-4	Vinyl Chloride	50	U
74-83-9	Bromomethane	50	U
75-00-3	Chloroethane	50	U
75-69-4	Trichlorofluoromethane	50	U
75-35-4	1,1-Dichloroethene	170	D
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	13	DJ
67-64-1	Acetone	21	DJB
75-15-0	Carbon Disulfide	50	U
79-20-9	Methyl Acetate	50	U
75-09-2	Methylene Chloride	17	DJ
156-60-5	trans-1,2-Dichloroethene	50	U
1634-04-4	Methyl tert-Butyl Ether	50	U
75-34-3	1,1-Dichloroethane	50	U
156-59-2	cis-1,2-Dichloroethene	16	DJ
78-93-3	2-Butanone	50	U
67-66-3	Chloroform	50	U
71-55-6	1,1,1-Trichloroethane	50	U
110-82-7	Cyclohexane	50	U
56-23-5	Carbon Tetrachloride	50	U
71-43-2	Benzene	230	D
107-06-2	1,2-Dichloroethane	50	U

FORM I VOA-1 OLM04.2

04/17/01 15:37 FAX 919 379 4070 COMPUCHEM 019

1B
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034T0DLMS

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: WG9546-4

Sample wt/vol: 5 (g/mL) ML Lab File ID: WG9546-4A55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 5.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	UG/L	Q
79-01-6	Trichloroethene	740	DB
108-87-2	Methylcyclohexane	50	U
78-87-5	1,2-Dichloropropane	50	U
75-27-4	Bromodichloromethane	50	U
10061-01-5	cis-1,3-Dichloropropene	50	U
108-10-1	4-Methyl-2-Pentanone	50	U
108-88-3	Toluene	240	D
10061-02-6	trans-1,3-Dichloropropene	50	U
79-00-5	1,1,2-Trichloroethane	50	U
127-18-4	Tetrachloroethene	50	U
591-78-6	2-Hexanone	50	U
124-48-1	Dibromochloromethane	50	U
106-93-4	1,2-Dibromoethane	50	U
108-90-7	Chlorobenzene	250	D
100-41-4	Ethylbenzene	50	U
1330-20-7	Xylene (Total)	50	U
100-42-5	Styrene	50	U
75-25-2	Bromoform	50	U
98-82-8	Isopropylbenzene	50	U
79-34-5	1,1,2,2-Tetrachloroethane	50	U
541-73-1	1,3-Dichlorobenzene	50	U
106-46-7	1,4-Dichlorobenzene	50	U
95-50-1	1,2-Dichlorobenzene	50	U
96-12-8	1,2-Dibromo-3-Chloropropane	50	U
120-82-1	1,2,4-Trichlorobenzene	50	U

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034T0DLMSD

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: WG9546-5

Sample wt/vol: 5 (g/mL) ML Lab File ID: WG9546-5A55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 5.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	50	U
74-87-3	Chloromethane	50	U
75-01-4	Vinyl Chloride	50	U
74-83-9	Bromomethane	50	U
75-00-3	Chloroethane	50	U
75-69-4	Trichlorofluoromethane	50	U
75-35-4	1,1-Dichloroethene	170	D
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	50	U
67-64-1	Acetone	26	DJB
75-15-0	Carbon Disulfide	50	U
79-20-9	Methyl Acetate	15	DJ
75-09-2	Methylene Chloride	12	DJ
156-60-5	trans-1,2-Dichloroethene	50	U
1634-04-4	Methyl tert-Butyl Ether	50	U
75-34-3	1,1-Dichloroethane	50	U
156-59-2	cis-1,2-Dichloroethene	15	DJ
78-93-3	2-Butanone	17	DJB
67-66-3	Chloroform	50	U
71-55-6	1,1,1-Trichloroethane	50	U
110-82-7	Cyclohexane	50	U
56-23-5	Carbon Tetrachloride	50	U
71-43-2	Benzene	240	D
107-06-2	1,2-Dichloroethane	50	U

FORM I VOA-1 OLM04.2

04/17/01 15:37 FAX 919 379 4070 COMPUCHEM 021

1B

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034T0DLMSD

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: WG9546-5

Sample wt/vol: 5 (g/mL) ML Lab File ID: WG9546-5A55

Level: (low/med) LOW Date Received: 04/10/01

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 5.0

Soil Extract Volume: _____(uL) Soil Aliquot Volume: _____(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
79-01-6	Trichloroethene	750	DB
108-87-2	Methylcyclohexane	50	U
78-87-5	1,2-Dichloropropane	50	U
75-27-4	Bromodichloromethane	50	U
10061-01-5	cis-1,3-Dichloropropene	50	U
108-10-1	4-Methyl-2-Pentanone	9	DJ
108-88-3	Toluene	240	D
10061-02-6	trans-1,3-Dichloropropene	50	U
79-00-5	1,1,2-Trichloroethane	6	DJB
127-18-4	Tetrachloroethene	50	U
591-78-6	2-Hexanone	7	DJB
124-48-1	Dibromochloromethane	50	U
106-93-4	1,2-Dibromoethane	6	DJ
108-90-7	Chlorobenzene	260	D
100-41-4	Ethylbenzene	50	U
1330-20-7	Xylene (Total)	50	U
100-42-5	Styrene	50	U
75-25-2	Bromoform	8	DJ
98-82-8	Isopropylbenzene	50	U
79-34-5	1,1,2,2-Tetrachloroethane	16	DJB
541-73-1	1,3-Dichlorobenzene	50	U
106-46-7	1,4-Dichlorobenzene	50	U
95-50-1	1,2-Dichlorobenzene	50	U
96-12-8	1,2-Dibromo-3-Chloropropane	39	DJB
120-82-1	1,2,4-Trichlorobenzene	14	DJB

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

VHBLKVT

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: WG9546-6

Sample wt/vol: 5 (g/mL) ML Lab File ID: WG9546-6A55

Level: (low/med) LOW Date Received: _____

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____(uL) Soil Aliquot Volume: _____(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	10	U
74-87-3	Chloromethane	10	U
75-01-4	Vinyl Chloride	10	U
74-83-9	Bromomethane	10	U
75-00-3	Chloroethane	10	U
75-69-4	Trichlorofluoromethane	10	U
75-35-4	1,1-Dichloroethene	10	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	10	U
67-64-1	Acetone	3	JB
75-15-0	Carbon Disulfide	10	U
79-20-9	Methyl Acetate	10	U
75-09-2	Methylene Chloride	10	U
156-60-5	trans-1,2-Dichloroethene	10	U
1634-04-4	Methyl tert-Butyl Ether	10	U
75-34-3	1,1-Dichloroethane	10	U
156-59-2	cis-1,2-Dichloroethene	10	U
78-93-3	2-Butanone	10	U
67-66-3	Chloroform	10	U
71-55-6	1,1,1-Trichloroethane	10	U
110-82-7	Cyclohexane	10	U
56-23-5	Carbon Tetrachloride	10	U
71-43-2	Benzene	10	U
107-06-2	1,2-Dichloroethane	10	U

1B

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

VHBLKVT

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: WG9546-6

Sample wt/vol: 5 (g/mL) ML Lab File ID: WG9546-6A55

Level: (low/med) LOW Date Received: _____

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	UG/L	Q
79-01-6	Trichloroethene	10	U
108-87-2	Methylcyclohexane	10	U
78-87-5	1,2-Dichloropropane	10	U
75-27-4	Bromodichloromethane	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
108-10-1	4-Methyl-2-Pentanone	10	U
108-88-3	Toluene	10	U
10061-02-6	trans-1,3-Dichloropropene	10	U
79-00-5	1,1,2-Trichloroethane	10	U
127-18-4	Tetrachloroethene	10	U
591-78-6	2-Hexanone	10	U
124-48-1	Dibromochloromethane	10	U
106-93-4	1,2-Dibromoethane	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethylbenzene	10	U
1330-20-7	Xylene (Total)	10	U
100-42-5	Styrene	10	U
75-25-2	Bromoform	10	U
98-82-8	Isopropylbenzene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
541-73-1	1,3-Dichlorobenzene	10	U
106-46-7	1,4-Dichlorobenzene	10	U
95-50-1	1,2-Dichlorobenzene	10	U
96-12-8	1,2-Dibromo-3-Chloropropane	10	U
120-82-1	1,2,4-Trichlorobenzene	10	U

1F

VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

VHBLKVT

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: WG9546-6

Sample wt/vol: 5 (g/mL) ML Lab File ID: WG9546-6A55

Level: (low/med) LOW Date Received: _____

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

Number TICs found: 0 CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-TIC OLM04.2

04/17/01 15:39 FAX 919 379 4070 COMPUCHEM 025

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

VIBLKSD

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: VIBLKSD

Sample wt/vol: 5 (g/mL) ML Lab File ID: CC010413A55

Level: (low/med) LOW Date Received: _____

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	10	U
74-87-3	Chloromethane	10	U
75-01-4	Vinyl Chloride	10	U
74-83-9	Bromomethane	10	U
75-00-3	Chloroethane	10	U
75-69-4	Trichlorofluoromethane	10	U
75-35-4	1,1-Dichloroethene	10	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	10	U
67-64-1	Acetone	2	JB
75-15-0	Carbon Disulfide	10	U
79-20-9	Methyl Acetate	10	U
75-09-2	Methylene Chloride	10	U
156-60-5	trans-1,2-Dichloroethene	10	U
1634-04-4	Methyl tert-Butyl Ether	10	U
75-34-3	1,1-Dichloroethane	10	U
156-59-2	cis-1,2-Dichloroethene	10	U
78-93-3	2-Butanone	2	JB
67-66-3	Chloroform	10	U
71-55-6	1,1,1-Trichloroethane	10	U
110-82-7	Cyclohexane	10	U
56-23-5	Carbon Tetrachloride	10	U
71-43-2	Benzene	10	U
107-06-2	1,2-Dichloroethane	10	U

1B

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

VIBLKSD

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: VIBLKSD

Sample wt/vol: 5 (g/mL) ML Lab File ID: CC010413A55

Level: (low/med) LOW Date Received: _____

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
79-01-6	Trichloroethene	10	U
108-87-2	Methylcyclohexane	10	U
78-87-5	1,2-Dichloropropane	10	U
75-27-4	Bromodichloromethane	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
108-10-1	4-Methyl-2-Pentanone	10	U
108-88-3	Toluene	10	U
10061-02-6	trans-1,3-Dichloropropene	10	U
79-00-5	1,1,2-Trichloroethane	10	U
127-18-4	Tetrachloroethene	10	U
591-78-6	2-Hexanone	10	U
124-48-1	Dibromochloromethane	10	U
106-93-4	1,2-Dibromoethane	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethylbenzene	10	U
1330-20-7	Xylene (Total)	10	U
100-42-5	Styrene	10	U
75-25-2	Bromoform	10	U
98-82-8	Isopropylbenzene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
541-73-1	1,3-Dichlorobenzene	10	U
106-46-7	1,4-Dichlorobenzene	10	U
95-50-1	1,2-Dichlorobenzene	10	U
96-12-8	1,2-Dibromo-3-Chloropropane	10	U
120-82-1	1,2,4-Trichlorobenzene	10	U

1F

VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

VIBLKSD

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: VIBLKSD

Sample wt/vol: 5 (g/mL) ML Lab File ID: CC010413A55

Level: (low/med) LOW Date Received: _____

% Moisture: not dec. _____ Date Analyzed: 04/13/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

Number TICs found: 0 CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-TIC OLM04.2

04/17/01 15:39 FAX 919 379 4070 COMPUCHEM 028

GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

BR3034T0

Lab Name: COMPUCHEM Contract:

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: V1971-3

Sample wt/vol: 190.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N) ___ Date Received: 04/11/01

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/13/01

Concentrated Extract Volume: 12000(ul) Date Analyzed: 04/13/01

Injection Volume: 25.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	9.7	U
99-35-4	1,3,5-Trinitrobenzene	4.9	U
121-82-4	RDX	12	U
99-65-0	1,3-Dinitrobenzene	4.9	U
118-96-7	2,4,6-Trinitrotoluene	9.7	U
479-45-8	Tetryl	9.7	U
98-95-3	Nitrobenzene	7.3	U
121-14-2	2,4-Dinitrotoluene	12	U
606-20-2	2,6-Dinitrotoluene	12	U
35572-78-2	2-Amino-4,6-dinitrotoluene	14	U
1946-51-0	4-Amino-2,6-dinitrotoluene	9.7	U
88-72-2	2-Nitrotoluene	12	U
99-99-0	4-Nitrotoluene	12	U
99-08-1	3-Nitrotoluene	9.7	U

FORM I PEST

04/17/01 15:32 FAX 919 379 4070 COMPUCHEM 002

GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

BR3035T0

Lab Name: COMPUCHEM Contract:

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: V1971-4

Sample wt/vol: 210.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N) ___ Date Received: 04/11/01

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/13/01

Concentrated Extract Volume: 14000 (ul) Date Analyzed: 04/13/01

Injection Volume: 25.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	10	U
99-35-4	1,3,5-Trinitrobenzene	5.1	U
121-82-4	RDX	13	U
99-65-0	1,3-Dinitrobenzene	5.1	U
118-96-7	2,4,6-Trinitrotoluene	10	U
479-45-8	Tetryl	10	U
98-95-3	Nitrobenzene	7.7	U
121-14-2	2,4-Dinitrotoluene	13	U
606-20-2	2,6-Dinitrotoluene	13	U
35572-78-2	2-Amino-4,6-dinitrotoluene	15	U
1946-51-0	4-Amino-2,6-dinitrotoluene	10	U
88-72-2	2-Nitrotoluene	13	U
99-99-0	4-Nitrotoluene	13	U
99-08-1	3-Nitrotoluene	10	U

FORM I PEST

04/17/01 15:32 FAX 919 379 4070 COMPUCHEM 003

1D
GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034T0

Lab Name: COMPUCHEM Contract:

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: V1971-1

Sample wt/vol: 260.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N) ___ Date Received: 04/10/01

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/13/01

Concentrated Extract Volume: 20000 (ul) Date Analyzed: 04/13/01

Injection Volume: 25.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	9.1	J
99-35-4	1,3,5-Trinitrobenzene	7.1	
121-82-4	RDX	0.35	JP
99-65-0	1,3-Dinitrobenzene	7.4	
118-96-7	2,4,6-Trinitrotoluene	6.3	J
479-45-8	Tetryl	0.49	JP
98-95-3	Nitrobenzene	6.4	J
121-14-2	2,4-Dinitrotoluene	8.8	J
606-20-2	2,6-Dinitrotoluene	7.5	J
35572-78-2	2-Amino-4,6-dinitrotoluene	8.0	J
1946-51-0	4-Amino-2,6-dinitrotoluene	8.6	J
88-72-2	2-Nitrotoluene	8.0	J
99-99-0	4-Nitrotoluene	8.1	J
99-08-1	3-Nitrotoluene	6.8	JP

FORM I PEST

04/17/01 15:33 FAX 919 379 4070 COMPUCHEM 004

GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

PZNLCS

Lab Name: COMPUCHEM Contract:

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: V1971

Matrix: (soil/water) WATER Lab Sample ID: WG9612-2

Sample wt/vol: 770.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N) ___ Date Received: _____

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/13/01

Concentrated Extract Volume: 12000(ul) Date Analyzed: 04/13/01

Injection Volume: 25.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	6.4	
99-35-4	1,3,5-Trinitrobenzene	4.5	
121-82-4	RDX	2.7	J
99-65-0	1,3-Dinitrobenzene	4.1	
118-96-7	2,4,6-Trinitrotoluene	3.6	
479-45-8	Tetryl	7.2	
98-95-3	Nitrobenzene	3.5	
121-14-2	2,4-Dinitrotoluene	4.6	
606-20-2	2,6-Dinitrotoluene	6.5	
35572-78-2	2-Amino-4,6-dinitrotoluene	6.1	
1946-51-0	4-Amino-2,6-dinitrotoluene	6.1	
88-72-2	2-Nitrotoluene	6.6	
99-99-0	4-Nitrotoluene	6.5	
99-08-1	3-Nitrotoluene	6.6	

FORM I PEST

04/17/01 15:33 FAX 818 379 4070 COMPUCHEM 005

NITRATE ANALYSIS

SUMMARY REPORT

ITEM NO.	SAMPLE IDENTIFIER	COMPUCHEM NUMBER	RESULT (mg/L)	REPORTING LIMIT (mg/L)
1.	GW3034T0	V1971-1	740	20
2.	BR3034T0	V1971-3	19.2	0.5
3.	BR3035T0	V1971-4	7.68	0.2

BRL = BELOW REPORTING LIMIT

Reviewed by/ID#: [illegible] [12405] Date: 4/16/01 EX. 6

3

TO Sol Test

CHAIN-OF-CUSTODY RECORD

No. 059455

CompuChem
a division of Liberty Analytical Corp.
501 Madison Avenue
Cary, NC 27513
1-800-833-5097

Project Name : Weldon Springs	Client Address : [illegible] Blandyville Pkwy West Chester, PA 19380	Point-of-Contact : Lori Pacheco / Chris Ball
Carrier :		Telephone No. : 1-800-443-7711
Airbill No. :		Sampling complete? Y or N (see Note 1)
Sampler Name :	Sampler Signature :	Project-specific (PS) or Batch (B) QC ? ____

BOX #1	1. Surface Water	6. Trip Blank	BOX #2	A. HCl + Ice	F. Ice Only	BOX #3	F. Filtered	Box #4	H. High
	2. Ground Water	7. Oil		B. HNO3 + Ice	G. Other_____		U. Unfiltered		M. Medium
	3. Leachate	8. Waste		C. NaOH + Ice	H. NaHSO4 + Ice				L. Low
	4. Rinsate	9. Other_____		D. H2SO4 + Ice	I. ZnAc+NaOH + Ice				
	5. Soil / Sediment / Sludge			E. Unpreserved					

Box #5		
	C. CLP 3/90	T. TCLP
	S. SW-846	
	W. CWA 600-series	
	O. Other_____	

Sample ID (9 characters maximum)	Date:Year	Time	Box #1 Matrix	Box #2 Preservative	Box #3 Filtered / Unfiltered	Box #4 Expected Conc.	Box #5 Method	No. of Bottles	Use for Lab QC (MS or DUP)	VOA	SVOC	Pesticide	PCB	Herbicide	Metals / Mercury	Cyanide	TOC / TOX	O&G / TPH	URANIUM				Remarks / Comments (see Notes 2 & 3)
BR30347C	4/9	:	2	B	U	M		1											1				30d TAT
BR30355T	4/9	:	2	B	U	M		1											1				
	/	:																					
	/	:																					
	/	:																					
	/	:																					
	/	:																					
	/	:																					
	/	:																					
	/	:																					

Clients Special Instructions: Temperature _____ °C

Lab: Received in Good Condition? Y or N **Describe Problems, If any:**

#1 Relinquished By: (Sig) Tony Kamm	Date: 4/10/01	#2 Relinquished By: (Sig)	Date:	#3 Relinquished By: (Sig)	Date:
Company Name: EPM II	Time: / /	Company Name:	Time:	Company Name:	Time:
#1 Received By: (Sig)	Date:	#2 Received By: (Sig)	Date:	#3 Received By: (Sig)	Date:
Company Name:	Time:	Company Name:	Time:	Company Name:	Time:

Note (1): If "N" lab will hold samples to await remainder of project-maximizing batch size and minimizing QC ratio; if "Y" lab will begin processing batches now.
Note (2): Samples stored 60 days after date report mailed at no extra charge. Note (3): All lab copies of data destroyed after three years

TOTAL URANIUM ANALYSIS RESULTS SUMMARY

By Laser-Induced Kinetic Phosphorimetry

Lab Name: Paragon Analytics, Inc. Date Collected: 04/09/2001

Client Name: CompuChem Date Analyzed : 04/13/2001

Client Project ID: Weldon Springs

Lab Sample ID Series: 01-04-110 Sample Matrix : WATER

Client Sample ID	Lab Sample ID	Total Uranium (ug/L)	Reporting Limit	Flag
BR3034TO	04-110-01	0.16 ± 0.02	0.20	J
BR3035TO	04-110-02	0.19 ± 0.03	0.20	J
Blank	04-110-B1	0.02 ± 0.00	0.20	J
BR3034TO	04-110-D1	0.16 ± 0.02	0.20	J

Reported Uncertainties are the Estimated Total Propagated Uncertainties (2σ).
See PAI SOP 743R3 for details of TPU determinations.

FLAGS - J - 'Estimated Value' - result between Method Detection Limit and Reporting Limit.
U - 'Not Detected' - result less than Method Detection Limit.

Remarks:

Sample 01-04-110-D1 is a duplicate of 01-04-110-01.

BP

SDG: ☐ Incomplete ☐ Complete EGS Test T=7 ✓✓✓

Sample Chain of Custody

W.O. Number: Project Name: WS

Sampler: JL

ERM T.R. Number	Date	Time	COMP	GRAB	Sample Location	Number of Containers	VOCs	Nitrogen as TKN	Nitrates				Remarks
✓	4/16/01	10:00			GW3034-CUTL-7	5	X	X	X				
✓	4/16/01	10:00			GW3034-KMnO4-7	5	X	X	X				
✓	4/16/01	10:00			GW3034-PONS-7	5	X	X	X				

Sample Relinquished	Date	Time	Sample Received by:	Date	Time	Reason for Transfer
[illegible]	4/16/01	12:00	FedEx	4/16/01	12:00	

Copies: **White** and **Yellow** copies accompany sample shipments to laboratory. **Yellow** copy retained by laboratory. **White** copy to be returned to ERM for files. **Pink** copy retained by sampler. **Gold** copy extra as needed (warehouse)

8 94

ANALYTICAL REPORT OF DATA - CASE # W1971

SUBMITTED TO:
Mr. David Robinson
ERM
250 Phillips Blvd., Suite 280
Princeton Crossroads
Ewing, NJ 08618

LABORATORY CHRONICLE - NITRATE ANALYSIS

ITEM NO.	SAMPLE IDENTIFIER	COMPUCHEM NUMBER	DATE SAMPLE RECEIVED	DATE ANALYSIS COMPLETED
1.	GW3034CNTL7	W1971-1	04/17/01	04/18/01
2.	GW3034KMNO47	W1971-2	04/17/01	*
3.	GW3034PERS7	W1971-3	04/17/01	*

* Analysis could not be completed due to sample matrix.

04/23/01 13:57 FAX 919 379 4070 COMPUCHEM 002/027

NITRATE ANALYSIS

SUMMARY REPORT

ITEM NO.	SAMPLE IDENTIFIER	COMPUCHEM NUMBER	RESULT (mg/L)	REPORTING LIMIT (mg/L)
1.	GW3034CNTL7	W1971-1	776	0.05

BRL = BELOW REPORTING LIMIT

Reviewed by/ID#: R. Seroge [2405] Date: 4/19/01 Ex-6

04/23/01 13:57 FAX 919 379 4070 COMPUCHEM 003/027

1D
GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034CNTL7

Lab Name: COMPUCHEM Contract: 8330

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: W1971-1

Sample wt/vol: 770.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N) ___ Date Received: 04/17/01

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/18/01

Concentrated Extract Volume: 24000 (ul) Date Analyzed: 04/19/01

Injection Volume: 25.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	4.8	U
99-35-4	1,3,5-Trinitrobenzene	2.4	U
121-82-4	RDX	6.0	U
99-65-0	1,3-Dinitrobenzene	5.7	
118-96-7	2,4,6-Trinitrotoluene	3.0	J
479-45-8	Tetryl	4.8	U
98-95-3	Nitrobenzene	7.6	
121-14-2	2,4-Dinitrotoluene	8.0	
606-20-2	2,6-Dinitrotoluene	7.4	
35572-78-2	2-Amino-4,6-dinitrotoluene	7.1	J
1946-51-0	4-Amino-2,6-dinitrotoluene	4.8	U
88-72-2	2-Nitrotoluene	7.2	
99-99-0	4-Nitrotoluene	6.0	U
99-08-1	3-Nitrotoluene	7.7	

FORM I PEST

04/23/01 13:57 FAX 818 378 4070 COMPUCHEM 004/027

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034PERS7

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: W1971-3

Sample wt/vol: 5 (g/mL) ML Lab File ID: W1971-3RA59

Level: (low/med) LOW Date Received: 04/17/01

% Moisture: not dec. _____ Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	10	U
74-87-3	Chloromethane	10	U
75-01-4	Vinyl Chloride	10	U
74-83-9	Bromomethane	10	U
75-00-3	Chloroethane	10	U
75-69-4	Trichlorofluoromethane	10	U
75-35-4	1,1-Dichloroethene	10	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	10	U
67-64-1	Acetone	48	
75-15-0	Carbon Disulfide	10	U
79-20-9	Methyl Acetate	10	U
75-09-2	Methylene Chloride	7	JB
156-60-5	trans-1,2-Dichloroethene	10	U
1634-04-4	Methyl tert-Butyl Ether	10	U
75-34-3	1,1-Dichloroethane	10	U
156-59-2	cis-1,2-Dichloroethene	10	U
78-93-3	2-Butanone	10	U
67-66-3	Chloroform	1	J
71-55-6	1,1,1-Trichloroethane	10	U
110-82-7	Cyclohexane	10	U
56-23-5	Carbon Tetrachloride	10	U
71-43-2	Benzene	10	U
107-06-2	1,2-Dichloroethane	10	U

04/23/01 14:02 FAX 919 379 4070 COMPUCHEM 018/027

1B
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034KMN047

Lab Name: COMPUCHEM Contract:

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: X1971-2

Sample wt/vol: 5 (g/mL) ML Lab File ID: X1971-2RA51

Level: (low/med) LOW Date Received: _____

% Moisture: not dec. _____ Date Analyzed: 04/25/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
79-01-6	Trichloroethene	10	U
108-87-2	Methylcyclohexane	10	U
78-87-5	1,2-Dichloropropane	10	U
75-27-4	Bromodichloromethane	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
108-10-1	4-Methyl-2-Pentanone	10	U
108-88-3	Toluene	1	JB
10061-02-6	trans-1,3-Dichloropropene	10	U
79-00-5	1,1,2-Trichloroethane	10	U
127-18-4	Tetrachloroethene	10	U
591-78-6	2-Hexanone	10	U
124-48-1	Dibromochloromethane	10	U
106-93-4	1,2-Dibromoethane	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethylbenzene	10	U
1330-20-7	Xylene (Total)	10	U
100-42-5	Styrene	10	U
75-25-2	Bromoform	10	U
98-82-8	Isopropylbenzene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
541-73-1	1,3-Dichlorobenzene	10	U
106-46-7	1,4-Dichlorobenzene	10	U
95-50-1	1,2-Dichlorobenzene	10	U
96-12-8	1,2-Dibromo-3-Chloropropane	10	U
120-82-1	1,2,4-Trichlorobenzene	10	U

04/26/01 14:14 FAX 919 379 4070 COMPUCHEM 003/003

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034KMN047

Lab Name: COMPUCHEM Contract:

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: X1971-2

Sample wt/vol: 5 (g/mL) ML Lab File ID: X1971-2RA51

Level: (low/med) LOW Date Received: _____

% Moisture: not dec. _____ Date Analyzed: 04/25/01

GC Column: EQUITY624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	10	U
74-87-3	Chloromethane	10	U
75-01-4	Vinyl Chloride	10	U
74-83-9	Bromomethane	10	U
75-00-3	Chloroethane	10	U
75-69-4	Trichlorofluoromethane	10	U
75-35-4	1,1-Dichloroethene	10	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	10	U
67-64-1	Acetone	18	B
75-15-0	Carbon Disulfide	10	U
79-20-9	Methyl Acetate	10	U
75-09-2	Methylene Chloride	16	B
156-60-5	trans-1,2-Dichloroethene	10	U
1634-04-4	Methyl tert-Butyl Ether	10	U
75-34-3	1,1-Dichloroethane	10	U
156-59-2	cis-1,2-Dichloroethene	10	U
78-93-3	2-Butanone	10	U
67-66-3	Chloroform	3	JB
71-55-6	1,1,1-Trichloroethane	10	U
110-82-7	Cyclohexane	10	U
56-23-5	Carbon Tetrachloride	10	U
71-43-2	Benzene	10	U
107-06-2	1,2-Dichloroethane	10	U

04/26/01 14:14 FAX 919 379 4070 COMPUCHEM 002/003

1F

VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

GW3034KMN047

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: W1971-2

Sample wt/vol: 5 (g/mL) ML Lab File ID: W1971-2B59

Level: (low/med) LOW Date Received: 04/17/01

% Moisture: not dec. _____ Date Analyzed: 04/19/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 100.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

Number TICs found: 1 CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	14.79	720	JB
2.				
3.				
4.				
5.				
6.				
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28.				
29.				
30.				

FORM I VOA-TIC OLM04.2

1B

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034KMN047

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: W1971-2

Sample wt/vol: 5 (g/mL) ML Lab File ID: W1971-2B59

Level: (low/med) LOW Date Received: 04/17/01

% Moisture: not dec. _____ Date Analyzed: 04/19/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 100.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	UG/L	Q
79-01-6	Trichloroethene	1000	U
108-87-2	Methylcyclohexane	1000	U
78-87-5	1,2-Dichloropropane	1000	U
75-27-4	Bromodichloromethane	1000	U
10061-01-5	cis-1,3-Dichloropropene	1000	U
108-10-1	4-Methyl-2-Pentanone	1000	U
108-88-3	Toluene	1000	U
10061-02-6	trans-1,3-Dichloropropene	1000	U
79-00-5	1,1,2-Trichloroethane	1000	U
127-18-4	Tetrachloroethene	1000	U
591-78-6	2-Hexanone	1000	U
124-48-1	Dibromochloromethane	1000	U
106-93-4	1,2-Dibromoethane	1000	U
108-90-7	Chlorobenzene	1000	U
100-41-4	Ethylbenzene	1000	U
1330-20-7	Xylene (Total)	1000	U
100-42-5	Styrene	1000	U
75-25-2	Bromoform	1000	U
98-82-8	Isopropylbenzene	1000	U
79-34-5	1,1,2,2-Tetrachloroethane	1000	U
541-73-1	1,3-Dichlorobenzene	1000	U
106-46-7	1,4-Dichlorobenzene	1000	U
95-50-1	1,2-Dichlorobenzene	1000	U
96-12-8	1,2-Dibromo-3-Chloropropane	1000	U
120-82-1	1,2,4-Trichlorobenzene	1000	U

04/23/01 14:01 FAX 919 379 4070 COMPUCHEM 016/027

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034KMN047

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: W1971-2

Sample wt/vol: 5 (g/mL) ML Lab File ID: W1971-2B59

Level: (low/med) LOW Date Received: 04/17/01

% Moisture: not dec. _____ Date Analyzed: 04/19/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 100.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	1000	U
74-87-3	Chloromethane	1000	U
75-01-4	Vinyl Chloride	1000	U
74-83-9	Bromomethane	1000	U
75-00-3	Chloroethane	1000	U
75-69-4	Trichlorofluoromethane	1000	U
75-35-4	1,1-Dichloroethene	1000	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	1000	U
67-64-1	Acetone	1000	U
75-15-0	Carbon Disulfide	1000	U
79-20-9	Methyl Acetate	1000	U
75-09-2	Methylene Chloride	1000	U
156-60-5	trans-1,2-Dichloroethene	1000	U
1634-04-4	Methyl tert-Butyl Ether	1000	U
75-34-3	1,1-Dichloroethane	1000	U
156-59-2	cis-1,2-Dichloroethene	1000	U
78-93-3	2-Butanone	1000	U
67-66-3	Chloroform	1000	U
71-55-6	1,1,1-Trichloroethane	1000	U
110-82-7	Cyclohexane	1000	U
56-23-5	Carbon Tetrachloride	1000	U
71-43-2	Benzene	1000	U
107-06-2	1,2-Dichloroethane	1000.	U

04/23/01 14:01 FAX 919 379 4070 COMPUCHEM 015/027

1F

EPA SAMPLE NO.

VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

GW3034CNTL7DL

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: W1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: W1971-1D2A59

Level: (low/med) LOW Date Received: 04/17/01

% Moisture: not dec. _____ Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 5.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

Number TICs found: 4

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	11.83	42	JD
2.	LABORATORY ARTIFACT	13.50	70	JBD
3.	LABORATORY ARTIFACT	14.78	270	JBD
4.	LABORATORY ARTIFACT	16.20	600	JBD
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FORM I VOA-TIC OLM04.2

-1B

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034CNTL7DL

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: W1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: W1971-1D2A59

Level: (low/med) LOW Date Received: 04/17/01

% Moisture: not dec. _____ Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 5.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
79-01-6	Trichloroethene	490	D
108-87-2	Methylcyclohexane	50	U
78-87-5	1,2-Dichloropropane	50	U
75-27-4	Bromodichloromethane	50	U
10061-01-5	cis-1,3-Dichloropropene	50	U
108-10-1	4-Methyl-2-Pentanone	50	U
108-88-3	Toluene	50	U
10061-02-6	trans-1,3-Dichloropropene	50	U
79-00-5	1,1,2-Trichloroethane	50	U
127-18-4	Tetrachloroethene	50	U
591-78-6	2-Hexanone	50	U
124-48-1	Dibromochloromethane	50	U
106-93-4	1,2-Dibromoethane	50	U
108-90-7	Chlorobenzene	50	U
100-41-4	Ethylbenzene	50	U
1330-20-7	Xylene (Total)	50	U
100-42-5	Styrene	50	U
75-25-2	Bromoform	50	U
98-82-8	Isopropylbenzene	50	U
79-34-5	1,1,2,2-Tetrachloroethane	50	U
541-73-1	1,3-Dichlorobenzene	50	U
106-46-7	1,4-Dichlorobenzene	50	U
95-50-1	1,2-Dichlorobenzene	50	U
96-12-8	1,2-Dibromo-3-Chloropropane	50	U
120-82-1	1,2,4-Trichlorobenzene	50	U

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1A
VOLATILE ORGANICS-ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034CNTL7DL

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: W1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: W1971-1D2A59

Level: (low/med) LOW Date Received: 04/17/01

% Moisture: not dec. _____ Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 5.0

Soil Extract Volume: _____(uL) Soil Aliquot Volume: _____(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	50	U
74-87-3	Chloromethane	50	U
75-01-4	Vinyl Chloride	50	U
74-83-9	Bromomethane	50	U
75-00-3	Chloroethane	50	U
75-69-4	Trichlorofluoromethane	50	U
75-35-4	1,1-Dichloroethene	50	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	50	U
67-64-1	Acetone	99	D
75-15-0	Carbon Disulfide	50	U
79-20-9	Methyl Acetate	50	U
75-09-2	Methylene Chloride	22	DJB
156-60-5	trans-1,2-Dichloroethene	50	U
1634-04-4	Methyl tert-Butyl Ether	50	U
75-34-3	1,1-Dichloroethane	50	U
156-59-2	cis-1,2-Dichloroethene	19	DJ
78-93-3	2-Butanone	50	U
67-66-3	Chloroform	50	U
71-55-6	1,1,1-Trichloroethane	50	U
110-82-7	Cyclohexane	50	U
56-23-5	Carbon Tetrachloride	50	U
71-43-2	Benzene	50	U
107-06-2	1,2-Dichloroethane	50	U

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1F

EPA SAMPLE NO.

VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

GW3034CNTL7

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: W1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: W1971-1RA59

Level: (low/med) LOW Date Received: 04/17/01

% Moisture: not dec. _____ Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

Number TICs found: 3

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	13.49	11	JB
2.	LABORATORY ARTIFACT	14.77	44	JB
3.	LABORATORY ARTIFACT	16.20	100	JB
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FORM I VOA-TIC OLM04.2

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VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034CNTL7

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: W1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: W1971-1RA59

Level: (low/med) LOW Date Received: 04/17/01

% Moisture: not dec. _____ Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
79-01-6	Trichloroethene	620	E
108-87-2	Methylcyclohexane	10	U
78-87-5	1,2-Dichloropropane	10	U
75-27-4	Bromodichloromethane	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
108-10-1	4-Methyl-2-Pentanone	10	U
108-88-3	Toluene	2	J
10061-02-6	trans-1,3-Dichloropropene	10	U
79-00-5	1,1,2-Trichloroethane	10	U
127-18-4	Tetrachloroethene	10	U
591-78-6	2-Hexanone	10	U
124-48-1	Dibromochloromethane	10	U
106-93-4	1,2-Dibromoethane	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethylbenzene	10	U
1330-20-7	Xylene (Total)	10	U
100-42-5	Styrene	10	U
75-25-2	Bromoform	10	U
98-82-8	Isopropylbenzene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
541-73-1	1,3-Dichlorobenzene	10	U
106-46-7	1,4-Dichlorobenzene	10	U
95-50-1	1,2-Dichlorobenzene	10	U
96-12-8	1,2-Dibromo-3-Chloropropane	10	U
120-82-1	1,2,4-Trichlorobenzene	10	U

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1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034CNTL7

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: W1971-1

Sample wt/vol: 5 (g/mL) ML Lab File ID: W1971-1RA59

Level: (low/med) LOW Date Received: 04/17/01

% Moisture: not dec. _____ Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	10	U
74-87-3	Chloromethane	10	U
75-01-4	Vinyl Chloride	10	U
74-83-9	Bromomethane	10	U
75-00-3	Chloroethane	10	U
75-69-4	Trichlorofluoromethane	10	U
75-35-4	1,1-Dichloroethene	10	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	10	U
67-64-1	Acetone	10	U
75-15-0	Carbon Disulfide	10	U
79-20-9	Methyl Acetate	10	U
75-09-2	Methylene Chloride	13	B
156-60-5	trans-1,2-Dichloroethene	2	J
1634-04-4	Methyl tert-Butyl Ether	10	U
75-34-3	1,1-Dichloroethane	10	U
156-59-2	cis-1,2-Dichloroethene	20	
78-93-3	2-Butanone	10	U
67-66-3	Chloroform	1	J
71-55-6	1,1,1-Trichloroethane	10	U
110-82-7	Cyclohexane	10	U
56-23-5	Carbon Tetrachloride	10	U
71-43-2	Benzene	10	U
107-06-2	1,2-Dichloroethane	10	U

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CompuChem

a division of Liberty Analytical Corporation
501 Madison Avenue
Cary, N.C. 27513
Tel: 919/379-4100 Fax: 919/379-4050

SDG NARRATIVE
SDG #W1971
CONTRACT # OLM04-REVS

SAMPLE IDENTIFICATIONS: GW3034CNTL7 GW3034KMNO47 GW3034PERS7

The three water samples listed above were received intact, at 6, degrees C, in sealed shipping containers, on April 17, 2001. All samples were submitted for volatile, nitrate, and explosives analysis.

The volatile samples were prepared and analyzed following Contract Laboratory Protocol(CLP) Statement of Work(SOW), document OLM04.2, and this portion of the SDG narrative deals with the volatile fractions only. All pertinent Quality Assurance Notices are included in the narrative section, and all pertinent Laboratory Notices for SDG # W1971 are included in the sample data sections.

Analysis holding time requirements were met for all samples, and sample pH values were less than 2.0 for all samples. No pH could be measured for sample GW3034KMNO47, as the color inherent to the sample stained the pH paper so that no reading could be obtained.

The Target Compound List(TCL) analyte trichloroethene was identified above the Contract Required Quantitation Limit(CRQL), and outside of calibration limits in the neat analysis of GW3034CNTL7. One SMC compound failed high for recovery in this analysis, and the sample was diluted and brought trichloroethene into calibration limits. An SMC compound again failed high for recoevry, and we have reported both neat and diluted analyses.

Sample GW3034KMNO47 was initially analyzed at a 100X dilution and did not contain any reportable levels of TCL analytes. The sample was not reanalyzed at a lesser dilution as the reactive nature of the sample may have caused instrument downtime.

No instrument blank was analyzed between sample GW3034CNTL7(with exceeding levels of trichloroethene), and GW3034PERS7. Due to the fact that no trichloroethene was identified in GW3034PERS7 above the CRQL, we are reporting the data with reference to this qualifier.

Other than laboratory artifact and siloxane peaks, no reportable Tentatively Identified Compounds(TICs) were present in the submitted samples.

All Bromofluorobenzene (BFB) abundance criteria were met for tunes associated to this SDG. Overall QC criteria were met for all initial and continuing calibration standards associated to this SDG.

The system monitoring compounds(SMCs) met recovery criteria in the analyses of these samples(except as noted above), and all of the internal standards met retention time and response criteria in the analyses of these samples.

The associated method blanks met all quality control criteria, and did not contain any target analytes above the CRQL.
The asssociated storage blank met all QC criteria, and also did not contain any TCL analytes above the CRQL.

Duplicate matrix spikes were generated from the original GW3034PERS7, and met all QC precision and accuracy criteria without exception. The associated Laboratory Control Sample(LCS) met all accuracy requirements.

Manual quantitations were performed on the process files in some of the the associated initial, and continuing calibration(s). The reasons have been coded with explanations provided in the notice included in the narrative section of this SDG.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the Laboratory Manager or his/her designee, as verified by the following signature.

1D

GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

PACLCS

Lab Name: COMPUCHEM Contract: 8330

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: WG9680-2

Sample wt/vol: 770.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N)___ Date Received: _____

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/18/01

Concentrated Extract Volume: 19000(ul) Date Analyzed: 04/19/01

Injection Volume: 25.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	6.8	P
99-35-4	1,3,5-Trinitrobenzene	4.8	P
121-82-4	RDX	2.7	JP
99-65-0	1,3-Dinitrobenzene	4.5	P
118-96-7	2,4,6-Trinitrotoluene	3.9	P
479-45-8	Tetryl	8.2	P
98-95-3	Nitrobenzene	3.6	P
121-14-2	2,4-Dinitrotoluene	4.8	P
606-20-2	2,6-Dinitrotoluene	7.0	P
35572-78-2	2-Amino-4,6-dinitrotoluene	6.3	P
1946-51-0	4-Amino-2,6-dinitrotoluene	6.5	P
88-72-2	2-Nitrotoluene	7.4	P
99-99-0	4-Nitrotoluene	6.8	P
99-08-1	3-Nitrotoluene	7.3	P

FORM I PEST

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GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

GW3034PERS7

Lab Name: COMPUCHEM Contract: 8330

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: W1971-3

Sample wt/vol: 770.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N) ___ Date Received: 04/17/01

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/18/01

Concentrated Extract Volume: 19000(ul) Date Analyzed: 04/19/01

Injection Volume: 25.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	3.8	U
99-35-4	1,3,5-Trinitrobenzene	7.7	
121-82-4	RDX	4.8	U
99-65-0	1,3-Dinitrobenzene	1.9	U
118-96-7	2,4,6-Trinitrotoluene	3.7	JP
479-45-8	Tetryl	3.8	U
98-95-3	Nitrobenzene	2.8	U
121-14-2	2,4-Dinitrotoluene	4.8	U
606-20-2	2,6-Dinitrotoluene	4.8	U
35572-78-2	2-Amino-4,6-dinitrotoluene	5.7	U
1946-51-0	4-Amino-2,6-dinitrotoluene	3.8	U
88-72-2	2-Nitrotoluene	4.8	U
99-99-0	4-Nitrotoluene	4.8	U
99-08-1	3-Nitrotoluene	3.8	U

FORM I PEST

GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

GW3034KMNO47

Lab Name: COMPUCHEM Contract: 8330

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: W1971-2

Sample wt/vol: 770.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N) ___ Date Received: 04/17/01

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/18/01

Concentrated Extract Volume: 19000(ul) Date Analyzed: 04/19/01

Injection Volume: 25.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	3.8	U
99-35-4	1,3,5-Trinitrobenzene	1.9	U
121-82-4	RDX	4.8	U
99-65-0	1,3-Dinitrobenzene	1.9	U
118-96-7	2,4,6-Trinitrotoluene	3.8	U
479-45-8	Tetryl	3.8	U
98-95-3	Nitrobenzene	5.1	P
121-14-2	2,4-Dinitrotoluene	2.2	J
606-20-2	2,6-Dinitrotoluene	5.2	
35572-78-2	2-Amino-4,6-dinitrotoluene	5.7	U
1946-51-0	4-Amino-2,6-dinitrotoluene	3.8	U
88-72-2	2-Nitrotoluene	2.6	JP
99-99-0	4-Nitrotoluene	4.8	U
99-08-1	3-Nitrotoluene	3.8	U

FORM I PEST

1B

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034PERS7

Lab Name: COMPUCHEM

Contract: OLM04-REVS

Lab Code: LIBRTY Case No.:

SAS No.:

SDG No.: W1971

Matrix: (soil/water) WATER

Lab Sample ID: W1971-3

Sample wt/vol: 5 (g/mL) ML

Lab File ID: W1971-3RA59

Level: (low/med) LOW

Date Received: 04/17/01

% Moisture: not dec. _____

Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm)

Dilution Factor: 1.0

Soil Extract Volume: _____ (uL)

Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
79-01-6	Trichloroethene	2	J
108-87-2	Methylcyclohexane	10	U
78-87-5	1,2-Dichloropropane	10	U
75-27-4	Bromodichloromethane	1	J
10061-01-5	cis-1,3-Dichloropropene	10	U
108-10-1	4-Methyl-2-Pentanone	10	U
108-88-3	Toluene	10	U
10061-02-6	trans-1,3-Dichloropropene	10	U
79-00-5	1,1,2-Trichloroethane	10	U
127-18-4	Tetrachloroethene	10	U
591-78-6	2-Hexanone	10	U
124-48-1	Dibromochloromethane	10	U
106-93-4	1,2-Dibromoethane	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethylbenzene	10	U
1330-20-7	Xylene (Total)	10	U
100-42-5	Styrene	10	U
75-25-2	Bromoform	10	U
98-82-8	Isopropylbenzene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
541-73-1	1,3-Dichlorobenzene	10	U
106-46-7	1,4-Dichlorobenzene	10	U
95-50-1	1,2-Dichlorobenzene	10	U
96-12-8	1,2-Dibromo-3-Chloropropane	10	U
120-82-1	1,2,4-Trichlorobenzene	10	U

04/23/01 14:02 FAX 919 379 4070 COMPUCHEM 019/027

1F

VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

GW3034PERS7

Lab Name: COMPUCHEM | Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: | SAS No.: | SDG No.: W1971

Matrix: (soil/water) WATER | Lab Sample ID: W1971-3

Sample wt/vol: 5 (g/mL) ML | Lab File ID: W1971-3RA59

Level: (low/med) LOW | Date Received: 04/17/01

% Moisture: not dec. _____ | Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) | Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) | Soil Aliquot Volume: _____ (uL)

Number TICs found: 4 | CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	11.83	6	J
2.	LABORATORY ARTIFACT	13.49	10	JB
3.	LABORATORY ARTIFACT	14.78	25	JB
4.	LABORATORY ARTIFACT	16.21	15	JB
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FORM I VOA-TIC OLM04.2

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034PERS7MS

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: WG9683-4

Sample wt/vol: 5 (g/mL) ML Lab File ID: WG9683-4A59

Level: (low/med) LOW Date Received: 04/17/01

% Moisture: not dec. _____ Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	10	U
74-87-3	Chloromethane	10	U
75-01-4	Vinyl Chloride	10	U
74-83-9	Bromomethane	10	U
75-00-3	Chloroethane	10	U
75-69-4	Trichlorofluoromethane	10	U
75-35-4	1,1-Dichloroethene	58	
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	10	U
67-64-1	Acetone	43	
75-15-0	Carbon Disulfide	10	U
79-20-9	Methyl Acetate	10	U
75-09-2	Methylene Chloride	6	JB
156-60-5	trans-1,2-Dichloroethene	10	U
1634-04-4	Methyl tert-Butyl Ether	10	U
75-34-3	1,1-Dichloroethane	10	U
156-59-2	cis-1,2-Dichloroethene	10	U
78-93-3	2-Butanone	10	U
67-66-3	Chloroform	1	J
71-55-6	1,1,1-Trichloroethane	10	U
110-82-7	Cyclohexane	10	U
56-23-5	Carbon Tetrachloride	10	U
71-43-2	Benzene	50	
107-06-2	1,2-Dichloroethane	10	U

04/23/01 14:02 FAX 919 379 4070 COMPUCHEM 021/027

1B

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034PERS7MS

Lab Name: COMPUCHEM — Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: — SAS No.: — SDG No.: W1971

Matrix: (soil/water) WATER — Lab Sample ID: WG9683-4

Sample wt/vol: 5 (g/mL) ML — Lab File ID: WG9683-4A59

Level: (low/med) LOW — Date Received: 04/17/01

% Moisture: not dec. _____ — Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) — Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) — Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
79-01-6	Trichloroethene	48	
108-87-2	Methylcyclohexane	10	U
78-87-5	1,2-Dichloropropane	10	U
75-27-4	Bromodichloromethane	1	J
10061-01-5	cis-1,3-Dichloropropene	10	U
108-10-1	4-Methyl-2-Pentanone	10	U
108-88-3	Toluene	49	
10061-02-6	trans-1,3-Dichloropropene	10	U
79-00-5	1,1,2-Trichloroethane	10	U
127-18-4	Tetrachloroethene	10	U
591-78-6	2-Hexanone	10	U
124-48-1	Dibromochloromethane	10	U
106-93-4	1,2-Dibromoethane	10	U
108-90-7	Chlorobenzene	51	
100-41-4	Ethylbenzene	10	U
1330-20-7	Xylene (Total)	10	U
100-42-5	Styrene	10	U
75-25-2	Bromoform	10	U
98-82-8	Isopropylbenzene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
541-73-1	1,3-Dichlorobenzene	10	U
106-46-7	1,4-Dichlorobenzene	10	U
95-50-1	1,2-Dichlorobenzene	10	U
96-12-8	1,2-Dibromo-3-Chloropropane	10	U
120-82-1	1,2,4-Trichlorobenzene	10	U

04/23/01 14:03 FAX 919 379 4070 COMPUCHEM 022/027

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034PERS7MSD

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: WG9683-5

Sample wt/vol: 5 (g/mL) ML Lab File ID: WG9683-5A59

Level: (low/med) LOW Date Received: 04/17/01

% Moisture: not dec. _____ Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	10	U
74-87-3	Chloromethane	1	J
75-01-4	Vinyl Chloride	10	U
74-83-9	Bromomethane	10	U
75-00-3	Chloroethane	10	U
75-69-4	Trichlorofluoromethane	10	U
75-35-4	1,1-Dichloroethene	62	
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	10	U
67-64-1	Acetone	32	
75-15-0	Carbon Disulfide	10	U
79-20-9	Methyl Acetate	10	U
75-09-2	Methylene Chloride	8	JB
156-60-5	trans-1,2-Dichloroethene	10	U
1634-04-4	Methyl tert-Butyl Ether	10	U
75-34-3	1,1-Dichloroethane	10	U
156-59-2	cis-1,2-Dichloroethene	10	U
78-93-3	2-Butanone	10	U
67-66-3	Chloroform	2	J
71-55-6	1,1,1-Trichloroethane	10	U
110-82-7	Cyclohexane	10	U
56-23-5	Carbon Tetrachloride	10	U
71-43-2	Benzene	52	
107-06-2	1,2-Dichloroethane	10	U

04/23/01 14:03 FAX 919 379 4070 COMPUCHEM 023/027

1B

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

GW3034PERS7MSD

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: WG9683-5

Sample wt/vol: 5 (g/mL) ML Lab File ID: WG9683-5A59

Level: (low/med) LOW Date Received: 04/17/01

% Moisture: not dec. _____ Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
79-01-6	Trichloroethene	49	
108-87-2	Methylcyclohexane	10	U
78-87-5	1,2-Dichloropropane	10	U
75-27-4	Bromodichloromethane	1	J
10061-01-5	cis-1,3-Dichloropropene	10	U
108-10-1	4-Methyl-2-Pentanone	10	U
108-88-3	Toluene	47	
10061-02-6	trans-1,3-Dichloropropene	10	U
79-00-5	1,1,2-Trichloroethane	10	U
127-18-4	Tetrachloroethene	10	U
591-78-6	2-Hexanone	10	U
124-48-1	Dibromochloromethane	10	U
106-93-4	1,2-Dibromoethane	10	U
108-90-7	Chlorobenzene	49	
100-41-4	Ethylbenzene	10	U
1330-20-7	Xylene (Total)	10	U
100-42-5	Styrene	10	U
75-25-2	Bromoform	10	U
98-82-8	Isopropylbenzene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
541-73-1	1,3-Dichlorobenzene	10	U
106-46-7	1,4-Dichlorobenzene	10	U
95-50-1	1,2-Dichlorobenzene	10	U
96-12-8	1,2-Dibromo-3-Chloropropane	10	U
120-82-1	1,2,4-Trichlorobenzene	10	U

04/23/01 14:03 FAX 818 379 4070 COMPUCHEM 024/027

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

VHBLKXD

Lab Name: COMPUCHEM | Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: | SAS No.: | SDG No.: W1971

Matrix: (soil/water) WATER | Lab Sample ID: WG9620-8

Sample wt/vol: 5 (g/mL) ML | Lab File ID: WG9620-8A59

Level: (low/med) LOW | Date Received: _____

% Moisture: not dec. _____ | Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) | Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) | Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	10	U
74-87-3	Chloromethane	10	U
75-01-4	Vinyl Chloride	10	U
74-83-9	Bromomethane	10	U
75-00-3	Chloroethane	10	U
75-69-4	Trichlorofluoromethane	10	U
75-35-4	1,1-Dichloroethene	10	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	10	U
67-64-1	Acetone	10	U
75-15-0	Carbon Disulfide	10	U
79-20-9	Methyl Acetate	10	U
75-09-2	Methylene Chloride	2	JB
156-60-5	trans-1,2-Dichloroethene	10	U
1634-04-4	Methyl tert-Butyl Ether	10	U
75-34-3	1,1-Dichloroethane	10	U
156-59-2	cis-1,2-Dichloroethene	10	U
78-93-3	2-Butanone	10	U
67-66-3	Chloroform	10	U
71-55-6	1,1,1-Trichloroethane	10	U
110-82-7	Cyclohexane	10	U
56-23-5	Carbon Tetrachloride	10	U
71-43-2	Benzene	10	U
107-06-2	1,2-Dichloroethane	10	U

04/23/01 14:04 FAX 919 379 4070 COMPUCHEM 025/027

1B

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

VHBLKXD

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: WG9620-8

Sample wt/vol: 5 (g/mL) ML Lab File ID: WG9620-8A59

Level: (low/med) LOW Date Received: _____

% Moisture: not dec. _____ Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
79-01-6	Trichloroethene	10	U
108-87-2	Methylcyclohexane	10	U
78-87-5	1,2-Dichloropropane	10	U
75-27-4	Bromodichloromethane	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
108-10-1	4-Methyl-2-Pentanone	10	U
108-88-3	Toluene	10	U
10061-02-6	trans-1,3-Dichloropropene	10	U
79-00-5	1,1,2-Trichloroethane	10	U
127-18-4	Tetrachloroethene	10	U
591-78-6	2-Hexanone	10	U
124-48-1	Dibromochloromethane	10	U
106-93-4	1,2-Dibromoethane	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethylbenzene	10	U
1330-20-7	Xylene (Total)	10	U
100-42-5	Styrene	10	U
75-25-2	Bromoform	10	U
98-82-8	Isopropylbenzene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
541-73-1	1,3-Dichlorobenzene	10	U
106-46-7	1,4-Dichlorobenzene	10	U
95-50-1	1,2-Dichlorobenzene	10	U
96-12-8	1,2-Dibromo-3-Chloropropane	10	U
120-82-1	1,2,4-Trichlorobenzene	10	U

04/23/01 14:04 FAX 919 379 4070 COMPUCHEM 026/027

1F

VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

VHBLKXD

Lab Name: COMPUCHEM Contract: OLM04-REVS

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: W1971

Matrix: (soil/water) WATER Lab Sample ID: WG9620-8

Sample wt/vol: 5 (g/mL) ML Lab File ID: WG9620-8A59

Level: (low/med) LOW Date Received: _____

% Moisture: not dec. _____ Date Analyzed: 04/20/01

GC Column: RTX-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

Number TICs found: 4 CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1. 541-05-9	CYCLOTRISILOXANE, HEXAMETHYL	11.83	10	NJ
2.	LABORATORY ARTIFACT	13.50	9	JB
3.	LABORATORY ARTIFACT	14.78	24	JB
4.	LABORATORY ARTIFACT	16.20	76	JB
5.				
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04/23/01 14:04 FAX 919 379 4070 COMPUCHEM 027/027

☐ Incomplete ☐ Complete

T=7 efficiency

Sample Chain of Custody

W.O. Number: Project Name: WS

Sampler: JL

ERM T.R. Number	Date	Time	COMP	GRAB	Sample Location	Number of Containers	Urgent						Remarks
✓	4/16/01	1000 AM			GW3034-CNT2-7	1	X						
✓	4/16/01	1			GW3034-KMOD4-7	1	X						
✓	4/16/01	1			GW3034-PERS-7	1	X						

Sample Relinquished	Date	Time	Sample Received by:	Date	Time	Reason for Transfer
[illegible]	4/16/01	12:00	Fed Ex	4/16/01	12:00	

Copies: **White** and **Yellow** copies accompany sample shipments to laboratory. **Yellow** copy retained by laboratory. **White** copy to be returned to ERM for files. **Pink** copy retained by sampler. **Gold** copy extra as needed (warehouse). 8.94

TOTAL URANIUM ANALYSIS RESULTS SUMMARY

By Laser-Induced Kinetic Phosphorimetry

Lab Name: Paragon Analytics, Inc. Date Collected: 04/16/2001

Client Name: CompuChem Date Analyzed : 04/19/2001

Client Project ID: Weldon Springs

Lab Sample ID Series: 01-04-133 Sample Matrix : WATER

Client Sample ID	Lab Sample ID	Total Uranium (ug/L)	Reporting Limit	Flag
GW3034-CNTL-7	04-133-01	4.16 ± 0.56	0.20	
GW3034-KMN04-7	04-133-02	0.88 ± 0.12	0.20	
GW3034-PERS-7	04-133-03	6.18 ± 0.84	2.00	
Blank	04-133-B1	0.08 ± 0.01	0.20	J
GW3034-CNTL-7	04-133-D1	4.17 ± 0.56	0.20	

Reported Uncertainties are the Estimated Total Propagated Uncertainties (2σ).
See PAI SOP 743R3 for details of TPU determinations.

FLAGS - J - 'Estimated Value' - result between Method Detection Limit and Reporting Limit.
U - 'Not Detected' - result less than Method Detection Limit.

Remarks:

Sample 01-04-133-D1 is a duplicate of 01-04-133-01.

BP

Solubilization test

CHAIN-OF-CUSTODY RECORD

No. 059213

CompuChem
a division of Liberty Analytical Corp.
501 Madison Avenue
Cary, NC 27513
1-800-833-5097

Project Name : Weldon Springs	Client Address : 305 Brandywine Pkwy West Chester PA 19380	Point-of-Contact : Chuck Scott
Carrier :		Telephone No. : 919 387 4014
Airbill No. :		Sampling complete? Y or N (see Note 1)
Sampler Name : Tony Rymar	Sampler Signature :	Project-specific (PS) or Batch (B) QC ? ____

BOX #1	BOX #2	BOX #3	Box #4	Box #5
1. Surface Water	A. HCl + Ice	F. Filtered	H. High	C. CLP 3/90
2. Ground Water	B. HNO3 + Ice	U. Unfiltered	M. Medium	T. TCLP
3. Leachate	C. NaOH + Ice		L. Low	S. SW-846
4. Rinsate	D. H2SO4 + Ice			W. CWA 600-series
5. Soil / Sediment / Sludge	E. Unpreserved			O. Other____
6. Trip Blank	F. Ice Only			
7. Oil	G. Other____			
8. Waste	H. NaHSO4 + Ice			
9. Other____	I. ZnAc+NaOH + Ice			

Sample ID (9 characters maximum)	Date:Year: 2001	Time	Box #1 Matrix	Box #2 Preservative	Box #3 Filtered / Unfiltered	Box #4 Expected Conc.	Box #5 Method	No. of Bottles	Use for Lab QC (MS or DUP)	VOA	SVOC	Pesticide	PCB	Herbicide	Metals / Mercury	Cyanide	TOC / TOX	O&G / TPH				Remarks / Comments (see Notes 2 & 3)
BR3035PERM	4/1/7	:	2	F	U	M		2														2 DAY TAT
BR3034PERM	4/1/7	:																				
BR3035PERS	4/1/7	:																				
BR3034PERS	4/1/7	:																				
BR3035CNTL	4/1/7	:																				
BR3034CNTL	4/1/7	:																				
	/	:																				
	/	:																				
	/	:																				
	/	:																				

Clients Special Instructions: Temperature ____ °C

Lab: Received in Good Condition? Y or N **Describe Problems, If any:**

#1 Relinquished By: (Sig)	Date: 4/17/01	#2 Relinquished By: (Sig)	Date:	#3 Relinquished By: (Sig)	Date:
Company Name:	Time:	Company Name:	Time:	Company Name:	Time:
#1 Received By: (Sig)	Date:	#2 Received By: (Sig)	Date:	#3 Received By: (Sig)	Date:
Company Name:	Time:	Company Name:	Time:	Company Name:	Time:

Note (1): If "N" lab will hold samples to await remainder of project-maximizing batch size and minimizing QC ratio; if "Y" lab will begin processing batches now.
Note (2): Samples stored 60 days after date report mailed at no extra charge. Note (3): All lab copies of data destroyed after three years.

ANALYTICAL REPORT OF DATA - CASE # Y1971

SUBMITTED TO:
Mr. David Robinson
ERM
250 Phillips Blvd., Suite 280
Princeton Crossroads
Ewing, NJ 08618

LABORATORY CHRONICLE - NITRATE ANALYSIS

ITEM NO.	SAMPLE IDENTIFIER	COMPUCHEM NUMBER	DATE SAMPLE RECEIVED	DATE ANALYSIS COMPLETED
1.	BR3035PERM	Y1971-1	04/18/01	*
2.	BR3034PERM	Y1971-2	04/18/01	*
3.	BR3035PERS	Y1971-3	04/18/01	04/19/01
4.	BR3034PERS	Y1971-4	04/18/01	04/19/01
5.	BR3035CNTL	Y1971-5	04/18/01	04/19/01
6.	BR3034CNTL	Y1971-6	04/18/01	04/19/01

* Analysis not completed due to matrix interference.

FILE No.304 05/02 '01 11:39 ID:E.R.M. FAX:609 895 0111 PAGE 3/ 11
04/24/01 08:42 FAX 919 379 4070 COMPUCHEM 002/010

NITRATE ANALYSIS

SUMMARY REPORT

ITEM NO.	SAMPLE IDENTIFIER	COMPUCHEM NUMBER	RESULT (mg/L)	REPORTING LIMIT (mg/L)
1.	BR3035PERS	Y1971-3	8.75	0.05
2.	BR3034PERS	Y1971-4	23.3	0.05
3.	BR3035CNTL	Y1971-5	8.7	0.05
4.	BR3034CNTL	Y1971-6	20.4	0.05

BRL = BELOW REPORTING LIMIT

Reviewed by/ID#: R. George [2405] Date: 4/20/01 Ex. 6

3 -

1D

GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BR3034CNTL

Lab Name: COMPUCHEM Contract: 8330

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: Y1971

Matrix: (soil/water) WATER Lab Sample ID: Y1971-6

Sample wt/vol: 770.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N) ___ Date Received: 04/18/01

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/19/01

Concentrated Extract Volume: 16000 (ul) Date Analyzed: 04/21/01

Injection Volume: 25.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	3.2	U
99-35-4	1,3,5-Trinitrobenzene	1.6	U
121-82-4	RDX	4.0	U
99-65-0	1,3-Dinitrobenzene	1.6	U
118-96-7	2,4,6-Trinitrotoluene	3.2	U
479-45-8	Tetryl	3.2	U
98-95-3	Nitrobenzene	2.4	U
121-14-2	2,4-Dinitrotoluene	4.0	U
606-20-2	2,6-Dinitrotoluene	4.0	U
35572-78-2	2-Amino-4,6-dinitrotoluene	4.8	U
1946-51-0	4-Amino-2,6-dinitrotoluene	3.2	U
88-72-2	2-Nitrotoluene	4.0	U
99-99-0	4-Nitrotoluene	4.0	U
99-08-1	3-Nitrotoluene	3.2	U

FORM I PEST

FILE No.304 05/02 '01 11:39 ID:E.R.M. FAX:609 895 0111 PAGE 5/ 11
04/24/01 08:42 FAX 919 379 4070 COMPUCHEM 004/010

NITRATE ANALYSIS

SUMMARY REPORT

ITEM NO.	SAMPLE IDENTIFIER	COMPUCHEM NUMBER	RESULT (mg/L)	REPORTING LIMIT (mg/L)
1.	BR3035PERS	Y1971-3	8.75	0.05
2.	BR3034PERS	Y1971-4	23.3	0.05
3.	BR3035CNTL	Y1971-5	8.7	0.05
4.	BR3034CNTL	Y1971-6	20.4	0.05

BRL = BELOW REPORTING LIMIT

Reviewed by/ID#: R. George [2405] Date: 4/20/01 EX-6

04/24/01 08:42 FAX 919 379 4070 COMPUCHEM 003/010

1D

GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BR3034PERM

Lab Name: COMPUCHEM Contract: 8330

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: Y1971

Matrix: (soil/water) WATER Lab Sample ID: Y1971-2

Sample wt/vol: 385.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N)___ Date Received: 04/18/01

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/19/01

Concentrated Extract Volume: 16000 (ul) Date Analyzed: 04/21/01

Injection Volume: 25.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	6.4	U
99-35-4	1,3,5-Trinitrobenzene	3.2	U
121-82-4	RDX	8.0	U
99-65-0	1,3-Dinitrobenzene	3.2	U
118-96-7	2,4,6-Trinitrotoluene	6.4	U
479-45-8	Tetryl	6.4	U
98-95-3	Nitrobenzene	4.8	U
121-14-2	2,4-Dinitrotoluene	8.0	U
606-20-2	2,6-Dinitrotoluene	8.0	U
35572-78-2	2-Amino-4,6-dinitrotoluene	9.6	U
1946-51-0	4-Amino-2,6-dinitrotoluene	6.4	U
88-72-2	2-Nitrotoluene	8.0	U
99-99-0	4-Nitrotoluene	8.0	U
99-08-1	3-Nitrotoluene	6.4	U

FORM I PEST

FILE No.304 05/02 '01 11:40 ID:E.R.M. FAX:609 895 0111 PAGE 6/ 11
04/24/01 08:42 FAX 919 379 4070 COMPUCHEM 005/010

1D
GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BR3034PERS

Lab Name: COMPUCHEM Contract: 8330

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: Y1971

Matrix: (soil/water) WATER Lab Sample ID: Y1971-4

Sample wt/vol: 770.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N) ___ Date Received: 04/18/01

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/19/01

Concentrated Extract Volume: 8000 (ul) Date Analyzed: 04/21/01

Injection Volume: 25.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	1.6	U
99-35-4	1,3,5-Trinitrobenzene	0.80	U
121-82-4	RDX	2.0	U
99-65-0	1,3-Dinitrobenzene	0.80	U
118-96-7	2,4,6-Trinitrotoluene	1.6	U
479-45-8	Tetryl	1.6	U
98-95-3	Nitrobenzene	1.2	U
121-14-2	2,4-Dinitrotoluene	2.0	U
606-20-2	2,6-Dinitrotoluene	2.0	U
35572-78-2	2-Amino-4,6-dinitrotoluene	2.4	U
1946-51-0	4-Amino-2,6-dinitrotoluene	1.6	U
88-72-2	2-Nitrotoluene	2.0	U
99-99-0	4-Nitrotoluene	2.0	U
99-08-1	3-Nitrotoluene	1.6	U

FORM I PEST

1D
GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BR3035CNTL

Lab Name: COMPUCHEM Contract: 8330

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: Y1971

Matrix: (soil/water) WATER Lab Sample ID: Y1971-5

Sample wt/vol: 770.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N)___ Date Received: 04/18/01

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/19/01

Concentrated Extract Volume: 9000(ul) Date Analyzed: 04/21/01

Injection Volume: 25.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	1.8	U
99-35-4	1,3,5-Trinitrobenzene	0.90	U
121-82-4	RDX	2.2	U
99-65-0	1,3-Dinitrobenzene	0.90	U
118-96-7	2,4,6-Trinitrotoluene	1.8	U
479-45-8	Tetryl	1.8	U
98-95-3	Nitrobenzene	1.4	U
121-14-2	2,4-Dinitrotoluene	2.2	U
606-20-2	2,6-Dinitrotoluene	2.2	U
35572-78-2	2-Amino-4,6-dinitrotoluene	2.7	U
1946-51-0	4-Amino-2,6-dinitrotoluene	1.8	U
88-72-2	2-Nitrotoluene	2.2	U
99-99-0	4-Nitrotoluene	2.2	U
99-08-1	3-Nitrotoluene	1.8	U

FORM I PEST

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1D

GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BR3035PERM

Lab Name: COMPUCHEM Contract: 8330

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: Y1971

Matrix: (soil/water) WATER Lab Sample ID: Y1971-1

Sample wt/vol: 770.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N) ___ Date Received: 04/18/01

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/19/01

Concentrated Extract Volume: 13000 (ul) Date Analyzed: 04/20/01

Injection Volume: 25.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	2.6	U
99-35-4	1,3,5-Trinitrobenzene	1.3	U
121-82-4	RDX	3.2	U
99-65-0	1,3-Dinitrobenzene	1.3	U
118-96-7	2,4,6-Trinitrotoluene	2.6	U
479-45-8	Tetryl	2.6	U
98-95-3	Nitrobenzene	2.0	U
121-14-2	2,4-Dinitrotoluene	3.2	U
606-20-2	2,6-Dinitrotoluene	3.2	U
35572-78-2	2-Amino-4,6-dinitrotoluene	3.9	U
1946-51-0	4-Amino-2,6-dinitrotoluene	2.6	U
88-72-2	2-Nitrotoluene	3.2	U
99-99-0	4-Nitrotoluene	3.2	U
99-08-1	3-Nitrotoluene	2.6	U

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1D

GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BR3035PERS

Lab Name: COMPUCHEM Contract: 8330

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: Y1971

Matrix: (soil/water) WATER Lab Sample ID: Y1971-3

Sample wt/vol: 770.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N) ___ Date Received: 04/18/01

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/19/01

Concentrated Extract Volume: 10000(ul) Date Analyzed: 04/21/01

Injection Volume: 25.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	2.0	U
99-35-4	1,3,5-Trinitrobenzene	1.0	U
121-82-4	RDX	2.5	U
99-65-0	1,3-Dinitrobenzene	1.0	U
118-96-7	2,4,6-Trinitrotoluene	2.0	U
479-45-8	Tetryl	2.0	U
98-95-3	Nitrobenzene	1.5	U
121-14-2	2,4-Dinitrotoluene	2.5	U
606-20-2	2,6-Dinitrotoluene	2.5	U
35572-78-2	2-Amino-4,6-dinitrotoluene	3.0	U
1946-51-0	4-Amino-2,6-dinitrotoluene	2.0	U
88-72-2	2-Nitrotoluene	2.5	U
99-99-0	4-Nitrotoluene	2.5	U
99-08-1	3-Nitrotoluene	2.0	U

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1D
GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

PANLCS

Lab Name: COMPUCHEM Contract: 8330

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: Y1971

Matrix: (soil/water) WATER Lab Sample ID: WG9718-2

Sample wt/vol: 770.0 (g/ml) ML Lab File ID: _____

% Moisture: _____ decanted: (Y/N)___ Date Received: _____

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted: 04/19/01

Concentrated Extract Volume: 8000(ul) Date Analyzed: 04/20/01

Injection Volume: 25.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
2691-41-0	HMX	1.6	
99-35-4	1,3,5-Trinitrobenzene	1.0	
121-82-4	RDX	0.36	J
99-65-0	1,3-Dinitrobenzene	0.94	
118-96-7	2,4,6-Trinitrotoluene	0.86	J
479-45-8	Tetryl	1.0	J
98-95-3	Nitrobenzene	0.77	J
121-14-2	2,4-Dinitrotoluene	1.0	J
606-20-2	2,6-Dinitrotoluene	1.5	J
35572-78-2	2-Amino-4,6-dinitrotoluene	1.4	J
1946-51-0	4-Amino-2,6-dinitrotoluene	1.4	J
88-72-2	2-Nitrotoluene	1.4	J
99-99-0	4-Nitrotoluene	1.6	J
99-08-1	3-Nitrotoluene	1.6	

FORM I PEST

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Solubilization Test

CHAIN-OF-CUSTODY RECORD

No. 059212

CompuChem
a division of Liberty Analytical Corp.
501 Madison Avenue
Cary, NC 27513
1-800-833-5097

Project Name: Weldon Spring	Client Address: 508 Drapy Wine Pkwy West Chester, PA 19380	Point-of-Contact: Lori Tachera / Chuck Sa.
Carrier:		Telephone No.: 1-800-413-1511
Airbill No. Courier Custom		Sampling complete? Y or N (see Note 1)
Sampler Name: Tony Kymar	Sampler Signature:	Project-specific (PS) or Batch (B) QC ? ____

BOX #1	BOX #2	BOX #3	Box #4	Box #5
1. Surface Water	A. HCl + Ice	F. Filtered	H. High	C. CLP 3/90
2. Ground Water	B. HNO3 + Ice	U. Unfiltered	M. Medium	S. SW-846
3. Leachate	C. NaOH + Ice		L. Low	W. CWA 600-series
4. Rinsate	D. H2SO4 + Ice			O. Other____
5. Soil / Sediment / Sludge	E. Unpreserved			T. TCLP
6. Trip Blank	F. Ice Only			
7. Oil	G. Other____			
8. Waste	H. NaHSO4 + Ice			
9. Other____	I. ZnAc+NaOH + Ice			

Sample ID (9 characters maximum)	Date:Year	Time	Box #1 Matrix	Box #2 Preservative	Box #3 Filtered / Unfiltered	Box #4 Expected Conc.	Box #5 Method	No. of Bottles	Use for Lab QC (MS or DUP)	VOA	SVOC	Pesticide	PCB	Herbicide	Metals / Mercury	Cyanide	TOC / TOX	O&G / TPH	Uranium				Remarks / Comments (see Notes 2 & 3)
BP3035PERM	4/17	:	L	B	U	M		1											1				30 DAY TAT
BP3034PERM	4/17	:	↓	↓	↓	↓		↓											↓				
BP3035PERS	4/17	:	↓	↓	↓	↓		↓											↓				
BR3034PERS	4/17	:	↓	↓	↓	↓		↓											↓				
BR3035CNTL	4/17	:	↓	↓	↓	↓		↓											↓				
BR3034CNTL	4/17	:	↓	↓	↓	↓		↓											↓				
	/	:																					
	/	:																					
	/	:																					
	/	:																					

Clients Special Instructions: Temperature ____ °C

Lab: Received in Good Condition? Y or N Describe Problems, If any:

#1 Relinquished By: (Sig) [signature] Date: 4/17	#2 Relinquished By: (Sig) Date:	#3 Relinquished By: (Sig) Date:
Company Name: Time:	Company Name: Time:	Company Name: Time:
#1 Received By: (Sig) Date:	#2 Received By: (Sig) Date:	#3 Received By: (Sig) Date:
Company Name: Time:	Company Name: Time:	Company Name: Time:

Note (1): If "N" lab will hold samples to await remainder of project-maximizing batch size and minimizing QC ratio; if "Y" lab will begin processing batches now.

PRELIMINARY RESULTS

TOTAL URANIUM ANALYSIS RESULTS SUMMARY

By Laser-Induced Kinetic Phosphorimetry

Lab Name: Paragon Analytics, Inc. Date Collected: 04/17/2001

Client Name: CompuChem Date Analyzed : 04/19/2001

Client Project ID: Weldon Springs

Lab Sample ID Series: 01-04-142 Sample Matrix : WATER

Client Sample ID	Lab Sample ID	Total Uranium (ug/L)	Reporting Limit	Flag
BR3035PERM	04-142-01	2.16 ± 0.30	0.20	
BR3034PERM	04-142-02	1.30 ± 0.18	0.20	
BR3035PERS	04-142-03	3.43 ± 0.46	2.00	
BR3034PERS	04-142-04	6.23 ± 0.85	2.00	
BR3035CNTL	04-142-05	1.96 ± 0.26	2.00	J
BR3034CNTL	04-142-06	0.82 ± 0.11	0.20	
Blank	04-142-B1	0.03 ± 0.00	0.20	J
BR3035PERM	04-142-D1	1.85 ± 0.25	0.20	

Reported Uncertainties are the Estimated Total Propagated Uncertainties (2σ).
See PAI SOP 743R3 for details of TPU determinations.

FLAGS - J - 'Estimated Value' - result between Method Detection Limit and Reporting Limit.
U - 'Not Detected' - result less than Method Detection Limit.

Remarks:

Sample 01-04-142-D1 is a duplicate of 01-04-142-01.

APPENDIX B

WEATHERED BEDROCK OXIDATION DEMAND TEST RAW DATA

Bedrock BR3034 Total Permanganate Demand (15 days)

Weldon Spring Site Remedial Action Project
Insitu Chemical Oxidation Treatment Bench Scale Testing
2-May-01

Sample ID	Theoretical Permanganate Load, mg/kg wet wt bedrock	Observation	Permanganate Demand, g/kg wet wt bedrock	Permanganate Demand, lb/cu. yd bedrock	Observed ORP (mV)
1	20,000	Purple	< 20	< 54	712
2	10,000	Purple	< 10	< 27	703
3	5,000	Purple	< 5	< 14	694
4	2,500	Purple	< 2.5	< 6.8	664
5	1,250	Purple	< 1.3	< 3.4	682
6	630	Purple	< 0.63	< 1.7	668
7	310	Purple	< 0.31	< 0.84	659
8	150	Clear	> 0.15	> 0.41	648
9	80	Clear	> 0.08	> 0.22	641
10	40	Clear	> 0.04	> 0.11	632

Source: ERM's Remediation Technology Center

Bedrock BR3035 Total Permanganate Demand (15 days)

Weldon Spring Site Remedial Action Project
Insitu Chemical Oxidation Treatment Bench Scale Testing
2-May-01

Sample ID	Theoretical Permanganate Load, mg/kg wet wt bedrock	Observation	Permanganate Demand, g/kg wet wt bedrock	Permanganate Demand, lb/cu. yd bedrock	Observed ORP (mV)
1	20,000	Purple	< 20	< 54	669
2	10,000	Purple	< 10	< 27	672
3	5,000	Purple	< 5	< 14	653
4	2,500	Purple	< 2.5	< 6.8	646
5	1,250	Purple	< 1.3	< 3.4	636
6	630	Purple	< 0.63	< 1.7	623
7	310	Purple	< 0.31	< 0.84	615
8	150	Clear	> 0.15	> 0.41	611
9	80	Clear	> 0.08	> 0.22	608
10	40	Clear	> 0.04	> 0.11	603

Source: ERM's Remediation Technology Center

Bedrock BR3034 Total Persulfate Demand (15 days)

Weldon Spring Site Remedial Action Project
Insitu Chemical Oxidation Treatment Bench Scale Testing
2-May-01

Sample ID	Theoretical Persulfate Load, mg/kg wet wt bedrock	Observation	Persulfate Demand, g/kg wet wt bedrock	Persulfate Demand, lb/cu. yd bedrock	Observed ORP (mV)
1	45,200	blue	< 45	< 122	439
2	22,600	blue	< 23	< 61	435
3	11,300	blue	< 11.3	< 31	474
4	5,650	blue	< 5.7	< 15.3	466
5	2,825	blue	< 2.8	< 7.6	463
6	1,413	blue	< 1.41	< 3.8	459
7	706	blue	< 0.71	< 1.91	457
8	353	blue	< 0.35	< 0.95	450
9	177	blue	< 0.18	< 0.48	451
10	88	blue	< 0.09	< 0.24	454

Source: ERM's Remediation Technology Center

Bedrock BR3035 Total Persulfate Demand (15 days)

Weldon Spring Site Remedial Action Project
Insitu Chemical Oxidation Treatment Bench Scale Testing
2-May-01

Sample ID	Theoretical Persulfate Load, mg/kg wet wt bedrock	Observation	Persulfate Demand, g/kg wet wt bedrock	Persulfate Demand, lb/cu. yd bedrock	Observed ORP (mV)
1	45,200	blue	< 45	< 122	530
2	22,600	blue	< 23	< 61	513
3	11,300	blue	< 11.3	< 31	506
4	5,650	blue	< 5.7	< 15.3	490
5	2,825	blue	< 2.8	< 7.6	486
6	1,413	blue	< 1.41	< 3.8	477
7	706	blue	< 0.71	< 1.91	466
8	353	blue	< 0.35	< 0.95	463
9	177	blue	< 0.18	< 0.48	453
10	88	blue	< 0.09	< 0.24	450

Source: ERM's Remediation Technology Center

COPY

LABORATORY TREATABILITY STUDY REPORT

WELDON SPRING CHEMICAL PLANT SITE
ST. CHARLES, MISSOURI

MAY 1, 2001

PREPARED FOR

MORRISON KNUDSEN – FERGUSON COMPANY
7295 HIGHWAY 94 SOUTH
ST. CHARLES, MISSOURI 63304

PREPARED BY

IN-SITU OXIDATIVE TECHNOLOGIES, INC.
51 EVERETT DRIVE, SUITE A-10
WEST WINDSOR, NEW JERSEY 08550

ISOTEC CASE NO. 800346

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Section 1 Executive Summary

In-Situ Oxidative Technologies, Inc. (ISOTEC^{SM}) was retained by Morrison Knudsen - Ferguson Company (MK) to conduct a laboratory treatability study (study) on soil and groundwater samples collected at the Weldon Spring Chemical Plant site in St. Charles, Missouri. The purpose of the study was to determine the potential effectiveness of ISOTEC's in situ chemical oxidation process to oxidize soil and dissolved phase contaminants of concern at the site.

The ISOTEC process is based on Fenton's chemistry using a proprietary catalyst to produce hydroxyl radicals that oxidize chemical bonds. The contaminants of concern for the study are chlorinated volatile organic compounds (VOCs) primarily consisting of trichloroethene (TCE).

Experiments were conducted on samples of site groundwater and on a mixture of site groundwater and site soil (soil-slurry) that were prepared by ISOTEC at their facility. Results of the study indicated over a 99%* destruction of targeted VOCs in the groundwater test (GW-Test) and over 77%* destruction of targeted VOCs in the soil-slurry test (SL-Test) using ISOTEC process. Target VOCs were reduced to below the analytical method detection limits in both the GW-Test and SL-Test. The study results can be used to design a pilot scale application of the ISOTEC process for the site from which the study samples were collected.

*Percent reduction was calculated based on summation of analytical method detection limit values.

Section 2 Study Objectives

The objectives of the study were as follows:

- For each ISOTEC catalyst under evaluation, determine the amount of catalyst/oxidant mix (reagent) required to oxidize the measured contaminants at the site (i.e. the site-specific stoichiometry per catalyst);
- Evaluate the effectiveness of ISOTEC's Fenton-based chemical oxidation on site groundwater samples;
- Evaluate the effectiveness of ISOTEC's Fenton-based chemical oxidation in the presence of site aquifer solids (i.e. soil); and
- Determine the most effective reagent for a potential pilot scale application at the site.

Section 3 Sample Collection

Site soil and groundwater samples were collected by MK personnel and shipped to ISOTEC facility for the treatability study. The groundwater sample (hereinafter referred to as GW-3034-032801-ISO) was collected on March 28, 2001. The sample location was selected based on high contaminant concentrations detected in groundwater during previous sampling events. The groundwater was collected in five (5) 1-liter glass containers with no preservative and stored in ice-packed coolers for transportation. In addition, two (2) 40-mL vials of groundwater preserved in hydrochloric acid (HCl) were collected and submitted to the laboratory for VOC analysis. A 250-mL sample of the unpreserved groundwater sample was also provided for iron and manganese analysis.

Site soil identified as "SO-4033-ISO Soil" was collected on March 27, 2001 and sent to ISOTEC facility for the treatability study. The soil was stored at 4 degrees Celsius (°C) until mixed at the laboratory with the site groundwater sample to form the soil-slurry mix used during the study. A portion of the field soil was analyzed for iron (Fe), manganese (Mn), and total organic carbon (TOC).

Section 4 Laboratory Treatability Study

The study consisted of the experimental setup, establishing initial conditions and experimental controls, conducting the experiments through application of various catalysts and oxidants, and then submitting the treated samples for chemical analysis.

4.1 Experimental Setup

Two sets of laboratory experiments were performed: one set on the groundwater sample and two sets on a soil-slurry mix. The groundwater experiments are hereinafter referred to as Groundwater Test (GW-test) and consisted of the following:

- One experiment to determine the optimum catalyst/oxidant mix (reagent) and reagent volume, as evidenced by VOC oxidation in groundwater.

The soil-slurry experiments are hereinafter referred to as Soil-Slurry Test (SL-test) and consisted of the following:

- One experiment to determine the optimum reagent and reagent volume as evidenced by VOC oxidation in the soil-slurry.

4.1.1 GW-test Experimental Setup

The GW-test VOC experiment was performed in five (5) pairs of 140 ml sealed batch reactors (reactors). Groundwater was introduced into each reactor, leaving enough headspace for predetermined reagent volumes to be injected. The reactors were sealed with aluminum caps fitted with Teflon®-lined rubber septa to facilitate reagent injections.

Each pair received either a different reagent, or a different volume of a particular reagent. One reactor of each pair served as the "treatment reactor" while the other served as the "monitoring reactor". Both reactors of each pair received identical reagent doses. The treatment reactor was not opened or sampled until the end of the experiment. The monitoring reactor was used to monitor the extent of the oxidation reaction of the pair, by periodically extracting small samples for hydrogen peroxide analysis. Additional reactors were set up for control purposes. Control reactors are discussed later in Section 4.3.

4.1.2 SL-test Experimental Setup

The SL-test VOC experiment was performed in five (5) pairs of 120 ml sealed batch reactors (reactors). The soil-slurry mix was prepared from a one to one ratio by weight (1:1 w/w) of soil and groundwater. The soil-slurry was introduced into each reactor, leaving enough headspace for predetermined reagent volumes to be injected. The reactors were sealed with screw-top caps fitted with Teflon®-lined rubber septa to facilitate reagent injections. One additional reactor was setup and stored at 4^0C to represent initial conditions (Section 4.2).

Each pair received either a different reagent, or a different volume of a particular reagent, with one reactor serving as the "treatment reactor" and the other as the "monitoring

reactor". Both reactors of each pair received identical reagent doses. The treatment reactor was not opened or sampled until the end of the experiment. The monitoring reactor was used to monitor the extent of the oxidation reaction of the pair, by periodically extracting small samples for hydrogen peroxide analysis. Additional reactors were set up for control purposes. Control reactors are discussed later in Section 4.3.

4.2 Initial Conditions

The initial conditions of each matrix (soil, groundwater and soil-slurry) were established prior to initiating the experiments.

Soil was analyzed for iron and manganese by EPA method 6010 and total organic carbon (TOC) by EPA method 9060.

The results of the initial condition analyses are presented in Table 4-1. The analytical laboratory reports, including chains of custody, are presented in Appendix 2.

4.3 Experimental Control

Experimental control samples (Control) were set up during the study to document the following:

- Reduction in contaminant concentrations due to sample dilution by reagent volumes injected, and
- Reduction in contaminant concentrations due to volatilization caused by room temperature test conditions.

The control sample was set up in a treatment reactor but was injected with distilled water instead of catalyst and oxidant. The volume of distilled water injected was identical to the volumes of reagent injected into treatment reactors. The control sample remained at and was subject to the same conditions as the treatment and monitoring reactors.

Control samples were used during the following experiments:

- GW-test VOC experiment
- SL-test VOC experiment

4.4 Application of Reagents

The study experiments were performed on each matrix. Where multiple pairs of reactors were prepared for a given matrix, a series of different reagents or different volumes of the same reagent were injected into each pair of reactors (treatment and monitoring). Each monitoring reactor received an identical dose as its paired treatment reactor. Samples were periodically withdrawn from the monitoring reactors for hydrogen peroxide analysis, the results of which may have led to additional treatment dosages of the reagent

under study, for its paired treatment reactor. Distilled water was used to equalize the total volume of reagent used between reactor pair.

Following the last application of reagent, all reactors remained undisturbed at room temperature for a minimum of 24 hours or until the oxidizer was completely consumed as determined by Hach H_2O_2 testing equipment. The reaction was quenched using catalase, which is an organic enzyme catalyst naturally present in most soils that decomposes hydrogen peroxide directly to oxygen without generating hydroxyl radicals as shown below.

$$H_2O_2 \rightarrow H_2O + \frac{1}{2} O_2$$

After the resting period, excess catalase was injected into each reactor to decompose residual hydrogen peroxide and terminate the study. The use of catalase for quenching purposes is a standard practice in Fenton's chemistry and does not interfere with laboratory analysis. However, for control purposes, the exact volume of excess catalase injected into each treatment reactor was also injected into control reactors. The treatment effectiveness was evaluated by calculating the percent VOC reduction in each treatment reactor relative to the control reactors.

The type of catalyst tested, and the number of treatment dosages evaluated is discussed below.

4.4.1 ISOTEC Catalyst 4260

ISOTEC's patented Catalyst 4260 is a circum-neutral pH (e.g. 5-8) organometallic complex with high mobility within the subsurface. Based on historical contaminant levels noted at the site and previous experience with treatment of the compounds of concern, ISOTEC selected this catalyst for most of the experiments. The stoichiometric molar ratio of Catalyst 4260 to measured site contaminants was determined and then used to prepare the Catalyst 4260 reagent. One, two, and three treatment dosages of the Catalyst 4260 reagent were evaluated on the soil-slurry matrix for VOC oxidation. One, two, and three treatment dosages were evaluated on the groundwater matrix for VOC oxidation.

4.4.2 ISOTEC Catalyst 6260

ISOTEC's proprietary Catalyst 6260 is an organometallic complex that was also evaluated during this study. This catalyst is similar to Catalyst 4260 except for a slight variation in the formula components. The stoichiometric molar ratio of Catalyst 6260 to measured site contaminants was determined and then used to prepare the Catalyst 6260 reagent. One and two treatment dosages of the Catalyst 6260 reagent were evaluated on the soil-slurry matrix for VOC oxidation. One and two treatment dosages were evaluated on the groundwater matrix for VOC oxidation.

4.5 Sample Collection and Analysis

After the study was terminated by injecting excess catalase into the reactors, water from each of the GW-test VOC experiment treatment and control reactors was decanted into 40-ml glass vials preserved in HCl for VOC analysis by EPA method 624 + 10. Final values of pH were determined from the monitoring reactor. Likewise, a sample of slurry from each SL-test VOC experiment treatment and control reactor was homogenized in the 120-ml reactor vessels and analyzed for VOCs by EPA method 8260B+10.

All study samples were submitted to a New Jersey certified analytical laboratory for analysis.

Table 4-1: Initial Conditions

Sample Matrix		GW-3034-032801 Aqueous	SO-4033-ISO Soil	SL/INITIAL Slurry
Volatile Organic Compound	**UNITS**			
Trichloroethene	µg/L or µg/Kg	1,070	NA	42.2
Tetrachloroethene	µg/L or µg/Kg	ND(<7.6)	NA	19.6
Cis-1,2-Dichloroethene	µg/L or µg/Kg	26.2	NA	2.48 J
Total target VOCs	**µg/L or µg/Kg**	**1,096.2**	**NA**	**64.28 J**
Total TIC's	µg/L or µg/Kg	ND	NA	ND
Additional Parameters				
Iron	mg/L or mg/Kg	ND(<0.1)	31,400	NA
Manganese	mg/L or mg/Kg	0.260	1,050	NA
Total Organic Carbon	mg/L or mg/Kg	NA	850	NA

Note:
- SL/ INITIAL is a laboratory prepared soil-slurry sample prepared in a 1:1 ratio of "GW-3034-032801" and "SO-4033-ISO" samples.
- J = Concentration detected at a value below the method detection limit.
- ND = Analyzed for but not detected at the method detection limit (MDL) indicated.
- NA = Parameter not analyzed for
- VOCs = Volatile organic compounds
- TIC's = Tentatively Identified Compounds or non-target compounds
- mg/Kg = milligrams per kilogram; µg/Kg = micrograms per kilogram
- mg/L = milligrams per liter; µg/L = micrograms per liter

Section 5 Treatability Study Results

5.1 GW-test

Results of the GW-Test experiment are discussed below, with analytical results tabulated in Table 5-1. The analytical data package is provided in Appendix 1.

The treated sample data when compared to control sample indicate 99.9% destruction of the target VOCs detected in the groundwater sample after two treatment dosages of the Catalyst 4260 reagent. Target compound TCE was treated to below the laboratory method detection limits in each of the treated samples. Catalyst 6260 showed identical reduction of the target contaminants, achieving 99.8% VOC reduction after one treatment dosage.

As may be noted from the final pH values, the treatment occurred in the circum-neutral pH range 6.31-6.61, which is desirable for maintaining natural subsurface conditions. A comparison of the GW-test Control data (Table 5-1) with GW-test Initial data (Table 4-1) shows that the VOC losses (volatilization, dilution, and sample preparation losses) were moderate (i.e. approximately 26%).

Table 5-1: Results of GW-Test VOC Experiment

		Control	Treated #1	Treated #2	Treated #3	Treated #4	Treated #5
Catalyst Used		None	Cat-4260	Cat-4260	Cat-4260	Cat-6260	Cat-6260
Oxidant Used		None	Stab. H_2O_2	Stab. H_2O_2	Stab. H_2O_2	Stab. H_2O_2	Stab. H_2O_2
No. of Treatments		0	1	2	3	1	2
Volatile Organic Compound	Units						
Trichloroethene	µg/L	793	ND(<0.36)	ND(<0.36)	ND(<0.36)	ND(<0.36)	ND(<0.36)
cis-1,2-Dichloroethene	µg/L	19.8	ND(<0.27)	ND(<0.27)	ND(<0.27)	ND(<0.27)	ND(<0.27)
Chloroform	µg/L	ND(<3.1)	1.34	1.15	1.04	1.37	1.23
1,1,2-Trichloroethane		ND(<3.1)	0.465	ND(<0.31)	ND(<0.31)	0.491	ND(<0.31)
Total target VOCs	µg/L	**812.8**	**1.805**	**1.15**	**1.04**	**1.861**	**1.23**
Total TIC's	µg/L	ND	ND	3.2	5.8	ND	3.9
Reduction (Target VOCs)		-	*99.8%*	*99.9%*	*99.9%*	*99.8%*	*99.9%*
Final pH of sample	- -	*7.08*	*6.61*	*6.39*	*6.31*	*6.60*	*6.47*

Note:
- ND = Analyzed for but not detected at the method detection limit (MDL) indicated.
- VOCs = Volatile organic compounds
- TIC's = Tentatively Identified Compounds or non-target compounds
- µg/L = micrograms per liter

5.2 SL-test

The results of the SL-Test experiments are discussed below, with analytical results tabulated in Tables 5-2. Analytical data packages are presented in Appendix 1.

The data indicate oxidation of targeted VOCs to non-detectable levels after one treatment dosage of ISOTEC Catalyst 4260 reagent. Treatment using Catalyst 6260 yielded identical reduction of VOCs. As may be observed from final pH values, treatments with Catalyst 4260 and Catalyst 6260 indicate that the oxidation occurred under circum-neutral pH conditions (i.e. pH = 6.31-6.61) and both are suitable for field application under natural subsurface conditions.

Table 5-2: Results of SL-Test VOC Experiment

	UNITS	Control	Treated #1	Treated #2	Treated #3	Treated #4	Treated #5
Catalyst Used		None	Cat-4260	Cat-4260	Cat-4260	Cat-6260	Cat-6260
Oxidant Used		None	Stab. H_2O_2	Stab. H_2O_2	Stab. H_2O_2	Stab. H_2O_2	Stab. H_2O_2
No. of Treatments		0	1	2	3	1	2
Volatile Organic Compound							
Trichloroethene	µg/kg	67.3	ND(<8.7)	ND(<9.5)	ND(<8.45)	ND(<8.1)	ND(<7.9)
cis-1,2-Dichloroethene	µg/kg	3.47 J	ND(<8.7)	ND(<9.5)	ND(<8.45)	ND(<8.1)	ND(<7.9)
Total target VOCs	µg/kg	**70.77 J**	**ND**	**ND**	**ND**	**ND**	**ND**
Total TICs	µg/kg	ND	ND	ND	ND	ND	ND
Reduction (Target VOCs)	-	-	**>75.4%**	**>73.2%**	**>76.1%**	**>77.1%**	**>77.7%**
Final pH of sample	-	**7.04**	**6.96**	**6.71**	**6.51**	**6.98**	**6.76**

Note:

- ND = Analyzed for but not detected at the method detection limit (MDL) indicated.
- VOCs = Volatile organic compounds
- TICs = Tentatively Identified Compounds or non-target compounds µg/L = micrograms per liter
- * = Percent reduction calculations are relative to control sample and assume ND values as equivalent to MDL value.

Section 6 Conclusions

The laboratory study results indicate that the ISOTEC process is effective in significantly reducing the concentration of volatile organic compounds in site soil and groundwater collected from the Weldon Springs site in St. Charles, Missouri. The data indicate that both the catalysts tested (i.e. Catalysts 4260 and 6260) achieved maximum contaminant reduction under close to natural subsurface pH conditions, with one application of each indicating reduction of target VOCs to non-detectable levels in site soils and groundwater.

A preliminary assessment of site-specific factors that could affect the ISOTEC process was performed on the content of iron, manganese and TOC in site soil. Iron was detected in site soil at a concentration of 31,400 mg/Kg (Table 4-1). Much of this iron is bound to the soil matrix and unavailable to catalyze the Fenton reaction that occurs in the aqueous phase. Iron was not detected in the site groundwater (< 0.1 mg/L). The soil manganese (1,050 mg/Kg) is also bound to the soil matrix and is not available to catalyze the Fenton reaction and the groundwater concentration (0.26 mg/L) is too low to promote effective Fenton-type reaction. The concentration of TOC was measured at 850 mg/Kg, which is moderate and may promote side reactions that compete for hydroxyl radicals. However, supplying additional reagent volumes will offset reagent losses due to such competition.

The ISOTEC study results suggest that a pilot application of the ISOTEC process should be completed at the site to gather additional data on the effectiveness of this remedial alternative on a large-scale basis. A pilot application would also serve as an initial step toward remediating the site; data obtained from the study indicate that the ISOTEC process could substantially reduce contaminant concentrations in the treated areas.

Section 7 Proposed Pilot Program

Based on the successful ISOTEC lab study results received, an ISOTEC pilot program can be performed within the source areas: (1) to gather additional data to evaluate the effectiveness of this remedial alternative; (2) as an initial step toward a full-scale remediation effort at the site; and (3) to substantially reduce the organic loading in the areas treated. The treatment program will consist of introducing ISOTEC's proprietary series catalysts, oxidizer and mobility control agents into the subsurface over a short time period.

The overall cost of full-scale remedial measures cannot be determined based on treatability study data alone. At the minimum, a field pilot study is required to provide necessary information to estimate a full-scale treatment cost. An initial field pilot study can be designed based on the laboratory treatability data and the site conditions described in data received to date.

7.1 The ISOTEC Process

The ISOTEC process is an in-situ remedial technology that destroys organic contamination using Fenton's reagent-based oxidation chemistry. ISOTEC's process treats organic contaminants in the subsurface, by utilizing our proprietary blends of catalysts, oxidizers, and stabilizers, which include stabilized hydrogen peroxide and a soluble iron catalyst at a neutral pH. ISOTEC compounds are injected through a site-specific delivery system providing sufficient distribution to selectively treat the contaminants in the area of concern. Site-specific stoichiometry is first determined through a laboratory study, with preliminary treatment quantities calculated. Application levels are typically tested in the field during a pilot study to determine the efficiency and extent of treatment, which varies depending on the site's subsurface characteristics. Based upon successful laboratory and pilot studies, design and implementation of full-scale remediation is undertaken. The ISOTEC approach works via the in-situ oxidation of contaminants, while creating minimal disturbance to site operations.

The ISOTEC process generates powerful oxidizing species known as hydroxyl radicals when the catalyst reacts with the oxidizer (stabilized hydrogen peroxide). Since hydroxyl radicals are generated in the aqueous form, it is necessary that the catalyst remain in a dissolved form to be available for reaction. The biggest challenge associated with in-situ application of a Fenton's process lies in maintaining an active, soluble catalyst that can be transported in the subsurface. When a catalyst is introduced into the subsurface in the form of a pure ferrous sulfate acidic solution it does not travel very far due to sorption and chemical reactions. For example, at natural ground water pH conditions (pH =6-7), a ferrous sulfate catalyst tends to precipitate as its oxidized (ferric) form, thereby, making hydroxyl radical generation somewhat localized. As a result as much as 95% to 97% of the ferrous sulfate catalyst may not be available for reaction.

When the ISOTEC catalyst is introduced into the subsurface, the catalyst mobility is significantly enhanced, as it is present in a proprietary chelated complex. In addition, ISOTEC's catalyst remains in dissolved form even under natural ground water pH conditions, thereby, making it readily available for hydroxyl radical generation upon addition of the oxidizer.

Safety is a priority with the ISOTEC process. Most negative effects noted with in-situ oxidation occur with aggressive oxidation reactions utilizing high concentration reagents under highly pressurized conditions. These conditions can create a significant temperature rise and an enormous amount of carbon dioxide and/or oxygen off-gas, which can mobilize vapors and contaminants within the subsurface. ISOTEC does not utilize this approach. Reagents utilized by ISOTEC are stabilized and at low concentrations, with injection in a controlled manner to reduce the possibility of surface breakout or subsequent migration. Furthermore, based on request to treat site contaminants within fracture zones, extreme caution must be exercised while injecting reagents as these preferred pathways will deliver the majority of chemical oxidation reagents. Again, the stabilized ISOTEC reagents utilized along with control of the injection process limit these concerns. **ISOTEC has a spotless record with respect to safety and the use of their chemical oxidation process.**

7.2 Design of an In-Situ Chemical Oxidation Treatment Program

The design and remedial treatment using in-situ chemical oxidation is like no other technology. Due to the nature of the chemical reaction, the ISOTEC process works through contaminant desorption from the saturated soil phase followed by oxidation in the aqueous phase. Therefore, detectable ground water VOC concentrations sometime increase in an area of the initial treatment. This is caused by the desorption process of organics from the site soils and initial reagent quantities calculated not being sufficient to oxidize all organic contamination which may have been present in the treatment area. The temporary increase in GW is marginal when compared to the reduction noted in the saturated soil where the majority of contamination exists. Regulators, Consultants and Clients look at this phenomenon and initially question the chem-ox approach and GW results, as post-treatment soil data is typically not available (and costly). However, this is simply the desorption process of organics from the site soils and initial reagent quantities calculated not being sufficient to oxidize all organic contamination which may have been present in the treatment area. The GW concerns are overcome by additional treatment applications, as typically proposed by ISOTEC, an increase in total reagent volume injected, with GW levels dropping sharply after all saturated soils have been treated.

Site subsurface characteristics play a significant role in the design of an in-situ chemical oxidation program. For the Weldon Spring site, ISOTEC must carefully evaluate the chemical reagent delivery system and the ability to inject the required amount of reagents into the subsurface throughout the entire treatment area. Previous experience with

injection of reagents into a fractured bedrock formation raises both positive and negative points of concern.

Positive points include:

- Obtaining desirable radius of influence (ROI) due to permeability through fractures.
- In a low permeability, matrix treatment results should be good since the majority of contaminant is within the fractures.

Negative points include:

- In a moderate to high permeability, matrix results may be reduced since much of the contaminant is located in the matrix and the majority of the reagent will travel through the fractures.
- Overloading of reagents could flush the fractures and move small amounts of dissolved contamination laterally. Only the dissolved contamination will be transported, the adsorbed mass will remain. Therefore, the long-term influence should be limited since the groundwater concentrations should return to equilibrium without the supporting contaminant mass in soil.

Therefore, injection delivery, volume and flow rate must be watched closely to overcome the above negative point scenarios.

Dissolved phase transport can be limited during a pilot study performed in the center of a plume. In order to limit the transport of dissolved phase contamination during full-scale, injections could start at the plume fringes and work towards the center.

Initial review of the Weldon Spring site notes varying permeability with dual porosity, which will most likely require the use of a pressurized system. Reagents would be delivered into the subsurface under a low constant pressure in an effort to distribute materials in a more homogeneous fashion throughout the injection interval. Reagent injection will be limited to 10' of screen per interval depth, which may require multiple depth screen installations (or nested wells). Installation of sound injection points, and development of such, is crucial.

7.3 Pilot Study Reagent Quantities

Results of the laboratory study were used to estimate preliminary reagent quantities for the initial field pilot program at the Weldon Spring facility. The estimated reagent quantities may be modified based on the results of field monitoring conducted during and after the initial pilot program. The estimates assume a treatment criterion of 90% reduction of the target contamination. The optimal treatment efficiency during the laboratory bench scale study is determined from the ratio of percent contaminant reduction (exceeding the desired criteria) to the number of treatment applications tested. Based on this criterion, one treatment of either catalyst 4260 or 6260 is optimal for contaminant destruction in the groundwater samples. General field pilot study assumptions included the following.

- Homogeneous subsurface conditions;
- Uniform contaminant distribution within the subsurface;
- Uniform treatment distribution within the subsurface;
- Lab bench scale study samples represented subsurface conditions at the subject site;
- A field reagent loss factor of 1.5;
- Estimated subsurface porosity = 0.40
- Estimated treatment depth per injection point = 10 feet; and
- Estimated number of treatment depths per injection point = 1 depth.

The estimated theoretical reagent volume calculations are shown in Appendix 2. The reagent volumes were estimated based on a 10-foot injection depth interval per point and assume a 100% displacement in pore volume by oxidizing reagents. Pilot study reagent volumes average between 30%-50% of the calculated pore volume. It should be noted that a 100% displacement in pore volume is not required to complete chemical oxidation objectives due to dispersion and concentration of reagents needed to oxidize contaminants of concern. Based on these calculations, a minimum reagent volume of 165 to 330 gallons will be injected per injection point depth to achieve the 10-12 foot radial effect proposed.

The ISOTEC process injection rate and volume of discharge are interrelated to the reaction rates of hydroxyl radicals with the contaminants, the contaminant distribution coefficients in the subsurface systems, and the rate of hydrogen peroxide decomposition within the subsurface. The rate at which the reagent flow can be injected into the subsurface is initially determined by the soil/aquifer characteristics, or possible premature stoppage due to reagent material seeping up from monitoring well seals or injection points, therefore installation of sound injection points is crucial. Field decisions regarding injection volumes will be based on the subsurface intake, radial effects noted during injection, and the distance of the injection point from the nearest monitoring point. If it becomes impossible to inject the above volume and/or no radial effects are noted in the monitoring point, the next closest injection point may be tested and/or reagent concentrations may be increased. Otherwise, an increasing volume may also be tested in the same injection point until influence can be determined in the nearest monitoring point. These radial effect estimates are conservative because of the large zone(s) of treatment and type of COCs noted in the subsurface. It is important to note that these estimates assume a uniform treatment distribution and are theoretical in nature. Under practical field conditions at the site, the reagents will tend to follow a preferential pathway through existing crevices/ fissures or through new channels created during drilling/ injection activities. The estimated radial effects may be lower or higher depending on whether the preferred pathways are vertical or horizontal in nature.

7.4 Pilot Study Monitoring and Reporting

Specific site monitoring will be performed during the pilot program to obtain information related to the treatment process and subsurface characteristics. For the Weldon Spring site, groundwater and soil (if available) samples would be collected prior to ISOTEC's treatment and approximately four weeks following the completion of each treatment application phase. An anticipated schedule for the pilot program monitoring activities will be included as part of the overall project schedule. This schedule will ensure adequate time lag for groundwater equilibration following oxidation treatment. For the treatment program, ISOTEC proposes the use of existing monitoring wells, along with each newly installed injection points as groundwater monitoring points. Samples from these wells would be collected and submitted to a certified laboratory for the following analysis – VOCs, total organic carbon (TOC), total dissolved solids (TDS), and dissolved iron (Fe-dissolved). In addition, trip and field blanks will also be collected during pre- and post sampling events.

Field monitoring parameters measured by ISOTEC during injection activities include pH and TDS. In addition, ISOTEC will perform qualitative tests for the oxidizer and iron (using Hach test kits) at selected locations. As stated, the above tests are qualitative, with results sometimes undetermined due to interference in the collected sample (i.e. solids in sample and unable to read color reference chart). ISOTEC typically analyzes, at a minimum, daily qualitative data during injection activities from monitoring locations (i.e. 2 locations), or until sufficient data is collected.

For field monitoring by ISOTEC, emphasis will be on sample collection and analysis from the monitoring points closest to the injection location being used. If influence is noted, samples will be collected from the next farthest monitoring point from the injection location. Increases in the oxidizer and iron concentrations greater than 30-50% over the base line data will reflect a radial influence due to injection in the vicinity. Greater the variation over the baseline data, greater is the radial effect. Radial effects for each pilot program event will be estimated based on ISOTEC-collected field data during the injection activities and combined with baseline and post-treatment monitoring sample data. For contaminant treatment, post-treatment VOC decreases over the baseline data greater than 40-50% will be considered as significant reduction to evaluate the effectiveness of the injection method and process.

Upon completion of the treatment program, a bound report will be submitted outlining details of the ISOTEC process, field activities, laboratory analysis summaries, with recommendations and/or a proposal for continued remediation of the entire contaminant plume, as may be necessary.

7.5 Intermediate Degradation Products

Vinyl chloride is a degradation product of the contaminant of concern (TCE). Chemical oxidation does not create contamination, nor does it create vinyl chloride from TCE. However, chemical oxidation may release sorbed contaminants from a matrix into the ground water matrix. These desorbed compounds may include vinyl chloride, which is treatable via chemical oxidation, and were previously not detected in samples collected.

7.6 Treatment Goals

Treatment goals for the Weldon Spring site are TCE levels less than 5 ppb within a one-year timeframe. As shown within the bench scale study, remedial goals can be achieved via in-situ chemical oxidation with the actual process being completed within seconds of reagent injection. The problem therefore lies in the field delivery of the reagent throughout the entire plume. ISOTEC (i.e. chemical oxidation) is a contact treatment, therefore, numerous injection points would be needed ensure total interaction of reagents within the plume area, with the ultimate goal of overlapping treatment areas. This is difficult in homogenous conditions, and even harder in heterogeneous groundwater flow environments, but not impossible, however, most likely costly.

ISOTEC's approach to full-scale treatment is to typically propose a more aggressive program and design injections at greater radius of influence then noted during the pilot program. After the 1st phase of full-scale treatment, ISOTEC would evaluate the locations of the injection points and determine if additional points would be required to treat the areas of concern. Upon review of the post-treatment monitoring data, an overall reduction of contaminant mass with isolated pockets of contamination would typically remain. ISOTEC, along with the Consultant, would review these smaller areas of contamination and design Phase 2 activities targeting these "hot spots", if required. The exact number injection points would be based on the ultimate treatment goal. This scenario is repeated until the treatment goal is reached.

APPENDIX #1

LAB STUDY ANALYTICAL PACKAGE

Integrated Analytical Laboratories, LLC.

273 Franklin Road
Randolph, N.J. 07869

Phone: 973 361-4252
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ANALYTICAL DATA REPORT

for

Isotec
51 Everett Drive
Suite A-10
West Windsor,NJ 08550

Project: MK/WELDON SPRING RAP - 800346
Lab Case Number: E01-2055
Date Report Prepared: April 12, 2001

CLIENT SAMPLE ID	LABORATORY SAMPLE ID
SO-4033-ISO	2055-001
SL/INITIAL	2055-002
SL/CONTROL	2055-003
SL/T-A	2055-004
SL/T-B	2055-005
SL/T-C	2055-006
SL/T-D	2055-007
SL/T-E	2055-008
GW-3034-032801-ISO	2055-009
GW/CONTROL	2055-010
GW/T-A	2055-011
GW/T-B	2055-012
GW/T-C	2055-013
GW/T-D	2055-014
GW/T-E	2055-015

All required protocols were followed during analyses. These data have been reviewed and accepted by

Michael H. Leftin, Ph.D.
Laboratory Director

The liability of Integrated Analytical Laboratories, LLC. is limited to the actual cost of the analyses performed.

INTEGRATED ANALYTICAL LABORATORIES, LLC.

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* Subcontracted results from The Washington Group Laboratory

INTEGRATED ANALYTICAL LABORATORIES, LLC.

MATRIX QUALIFIERS

A - Indicates the sample is an Aqueous matrix.

O - Indicates the sample is an Oil matrix.

S - Indicates the sample is a Soil, Sludge or Sediment matrix.

X - Indicates the sample is an Other matrix as indicated by Client Chain of Custody.

DATA QUALIFIERS

B - Indicates the analyte was found in the Blank and in the sample. It indicates possible sample contamination and warns the data user to use caution when applying the results of the analyte.

C - Common Laboratory Contaminant.

D - The compound was reported from the Diluted analysis.

D.F. - Dilution Factor.

E - Estimated concentration, reported results are outside the calibrated range of the instrument.

J - Indicates an estimated value. The compound was detected at a value below the method detection limit but greater than zero. For GC/MS procedures, the mass spectral data meets the criteria required to identify the target compound.

MDL - Method Detection Limit.

MI - Indicates compound concentration could not be determined due to Matrix Interferences.

NA - Not Applicable.

ND - Indicates the compound was analyzed for but Not Detected at the MDL.

REPORT QUALIFIERS

All solid sample analyses are reported on a dry weight basis.

All solid sample values are corrected for original sample size and percent solids.

INTEGRATED ANALYTICAL LABORATORIES, LLC.

SUMMARY REPORT

Client: Isotec
Project: MK/WELDON SPRING RAP - 800346
Lab Case No.: E01-2055

Lab ID:	2055-001			2055-002			2055-003			2055-004		
Client ID:	SO-4033-ISO			SL/INITIAL			SL/CONTROL			SL/T-A		
Matrix:	Soil			Soil			Soil			Soil		
Sampled Date:	3/27/2001			3/29/2001			4/3/2001			4/3/2001		
PARAMETER(Units)	Conc	Q	MDL	Conc	Q	MDL	Conc	Q	MDL	Conc	Q	MDL
Volatiles (ppb) (Including MTBE, TBA & Cis 1,2-DCE)												
t-Butyl Alcohol(TBA)	~			ND		16.5	ND		14.9	ND		17.4
Methyl-t-Butyl Ether(MTBE)	~			ND		8.25	ND		7.45	ND		8.7
cis-1,2-Dichloroethene	~			2.48	J	8.25	3.47	J	7.45	ND		8.7
1,2-Dichloroethane(EDC)	~			ND		8.25	ND		7.45	ND		8.7
Trichloroethene	~			42.2		8.25	67.3		7.45	ND		8.7
Tetrachloroethene	~			19.6		8.25	ND		7.45	ND		8.7
TOTAL VO's:	~			64.28	J		70.77	J		ND		
TOTAL TIC's:	~			ND			ND			ND		
TOTAL VO's & TIC's:	~			64.28	J		70.77	J		ND		
Metals (ppm)												
Iron	31400		3.27	~			~			~		
Manganese	1050		0.436	~			~			~		
General Analytical												
*Total Organic Carbons (ppm)	850		NA	~			~			~		

Lab ID:	2055-005			2055-006			2055-007			2055-008		
Client ID:	SL/T-B			SL/T-C			SL/T-D			SL/T-E		
Matrix:	Soil			Soil			Soil			Soil		
Sampled Date:	4/3/2001			4/3/2001			4/3/2001			4/3/2001		
PARAMETER(Units)	Conc	Q	MDL	Conc	Q	MDL	Conc	Q	MDL	Conc	Q	MDL
Volatiles (ppb) (Including MTBE, TBA & Cis 1,2-DCE)												
t-Butyl Alcohol(TBA)	ND		19	ND		16.9	ND		16.2	ND		15.8
Methyl-t-Butyl Ether(MTBE)	ND		9.5	ND		8.45	ND		8.1	ND		7.9
1,2-Dichloroethane(EDC)	ND		9.5	ND		8.45	ND		8.1	ND		7.9
TOTAL VO's:	ND			ND			ND			ND		
TOTAL TIC's:	ND			ND			ND			ND		
TOTAL VO's & TIC's:	ND			ND			ND			ND		

~ = Sample not analyzed for
ND = Analyzed for but Not Detected at the MDL
J = The concentration was detected at a value below the MDL
All qualifiers on individual Volatiles are carried down through summation.
*Subcontracted results from The Washington Group Laboratory

INTEGRATED ANALYTICAL LABORATORIES, LLC.

SUMMARY REPORT

Client: Isotec
Project: MK/WELDON SPRING RAP - 800346
Lab Case No.: E01-2055

Lab ID:	2055-009			2055-010			2055-011			2055-012		
Client ID:	GW-3034-032801-ISO			GW/CONTROL			GW/T-A			GW/T-B		
Matrix:	Aqueous			Aqueous			Aqueous			Aqueous		
Sampled Date:	3/28/2001			4/3/2001			4/3/2001			4/3/2001		
PARAMETER(Units)	Conc	Q	MDL	Conc	Q	MDL	Conc	Q	MDL	Conc	Q	MDL
Volatiles (ppb) (Including MTBE, TBA & Cis 1,2-DCE)												
t-Butyl Alcohol(TBA)	ND		20.4	ND		10.2	ND		1.02	ND		1.02
Methyl-t-Butyl Ether(MTBE)	ND		10.6	ND		5.3	ND		0.53	ND		0.53
cis-1,2-Dichloroethene	26.2		5.4	19.8		2.7	ND		0.27	ND		0.27
Chloroform	ND		6.2	ND		3.1	1.34		0.31	1.15		0.31
1,2-Dichloroethane(EDC)	ND		7	ND		3.5	ND		0.35	ND		0.35
Trichloroethene	1070		7.2	793		3.6	ND		0.36	ND		0.36
1,1,2-Trichloroethane	ND		6.2	ND		3.1	0.465		0.31	ND		0.31
TOTAL VO's:	1096.2			812.8			1.805			1.15		
TOTAL TIC's:	ND			ND			ND			3.2		
TOTAL VO's & TIC's:	1096.2			812.8			1.805			4.35		
Metals (ppm)												
Iron	ND		0.100	~			~			~		
Manganese	0.260		0.010	~			~			~		

Lab ID:	2055-013			2055-014			2055-015		
Client ID:	GW/T-C			GW/T-D			GW/T-E		
Matrix:	Aqueous			Aqueous			Aqueous		
Sampled Date:	4/3/2001			4/3/2001			4/3/2001		
PARAMETER(Units)	Conc	Q	MDL	Conc	Q	MDL	Conc	Q	MDL
Volatiles (ppb) (Including MTBE, TBA & Cis 1,2-DCE)									
t-Butyl Alcohol(TBA)	ND		1.02	ND		1.02	ND		1.02
Methyl-t-Butyl Ether(MTBE)	ND		0.53	ND		0.53	ND		0.53
Chloroform	1.04		0.31	1.37		0.31	1.23		0.31
1,2-Dichloroethane(EDC)	ND		0.35	ND		0.35	ND		0.35
1,1,2-Trichloroethane	ND		0.31	0.491		0.31	ND		0.31
TOTAL VO's:	1.04			1.861			1.23		
TOTAL TIC's:	5.8			ND			3.9		
TOTAL VO's & TIC's:	6.84			1.861			5.13		

~ = Sample not analyzed for
ND = Analyzed for but Not Detected at the MDL

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-002
Client ID: SL/INITIAL
Date Received: 04/03/2001
Date Analyzed: 04/06/2001
Data file: I7809.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-µg/Kg (ppb)
Dilution Factor: 1
% Moisture: 39.5

Compound	Concentration	Q	MDL
Chloromethane	ND		8.25
Vinyl Chloride	ND		8.25
Bromomethane	ND		8.25
Chloroethane	ND		8.25
Trichlorofluoromethane	ND		8.25
Acrolein	ND		16.5
1,1-Dichloroethene	ND		8.25
Methylene Chloride	ND		8.25
Acrylonitrile	ND		16.5
t-Butyl Alcohol(TBA)	ND		16.5
trans-1,2-Dichloroethene	ND		8.25
Methyl-t-Butyl Ether(MTBE)	ND		8.25
1,1-Dichloroethane	ND		8.25
cis-1,2-Dichloroethene	2.48	J	8.25
Chloroform	ND		8.25
1,1,1-Trichloroethane	ND		8.25
Carbon Tetrachloride	ND		8.25
1,2-Dichloroethane(EDC)	ND		8.25
Benzene	ND		8.25
Trichloroethene	42.2		8.25
1,2-Dichloropropane	ND		8.25
Bromodichloromethane	ND		8.25
2-Chloroethylvinyl Ether	ND		8.25
cis-1,3-Dichloropropene	ND		8.25
Toluene	ND		8.25
trans-1,3-Dichloropropene	ND		8.25
1,1,2-Trichloroethane	ND		8.25
Tetrachloroethene	19.6		8.25
Dibromochloromethane	ND		8.25
Chlorobenzene	ND		8.25
Ethylbenzene	ND		8.25
Total Xylenes	ND		8.25
Bromoform	ND		8.25
1,1,2,2-Tetrachloroethane	ND		8.25
1,3-Dichlorobenzene	ND		8.25
1,4-Dichlorobenzene	ND		8.25
1,2-Dichlorobenzene	ND		8.25
Total Target Compounds:	64.28	J	

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Tentatively Identified Compounds

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-002
Client ID: SL/INITIAL
Date Received: 04/03/2001
Date Analyzed: 04/06/2001
Data file: I7809.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-μg/Kg (ppb)
Dilution Factor: 1
% Moisture: 39.5

CAS #	Compound	Estimated Concentration	Retention Time
	No peaks detected		

Total TICs = 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-003
Client ID: SL/CONTROL
Date Received: 04/03/2001
Date Analyzed: 04/06/2001
Data file: I7810.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-µg/Kg (ppb)
Dilution Factor: 1
% Moisture: 33

Compound	Concentration	Q	MDL
Chloromethane	ND		7.45
Vinyl Chloride	ND		7.45
Bromomethane	ND		7.45
Chloroethane	ND		7.45
Trichlorofluoromethane	ND		7.45
Acrolein	ND		14.9
1,1-Dichloroethene	ND		7.45
Methylene Chloride	ND		7.45
Acrylonitrile	ND		14.9
t-Butyl Alcohol(TBA)	ND		14.9
trans-1,2-Dichloroethene	ND		7.45
Methyl-t-Butyl Ether(MTBE)	ND		7.45
1,1-Dichloroethane	ND		7.45
cis-1,2-Dichloroethene	3.47	J	7.45
Chloroform	ND		7.45
1,1,1-Trichloroethane	ND		7.45
Carbon Tetrachloride	ND		7.45
1,2-Dichloroethane(EDC)	ND		7.45
Benzene	ND		7.45
Trichloroethene	67.3		7.45
1,2-Dichloropropane	ND		7.45
Bromodichloromethane	ND		7.45
2-Chloroethylvinyl Ether	ND		7.45
cis-1,3-Dichloropropene	ND		7.45
Toluene	ND		7.45
trans-1,3-Dichloropropene	ND		7.45
1,1,2-Trichloroethane	ND		7.45
Tetrachloroethene	ND		7.45
Dibromochloromethane	ND		7.45
Chlorobenzene	ND		7.45
Ethylbenzene	ND		7.45
Total Xylenes	ND		7.45
Bromoform	ND		7.45
1,1,2,2-Tetrachloroethane	ND		7.45
1,3-Dichlorobenzene	ND		7.45
1,4-Dichlorobenzene	ND		7.45
1,2-Dichlorobenzene	ND		7.45
Total Target Compounds:	70.77	J	

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Tentatively Identified Compounds

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-003
Client ID: SL/CONTROL
Date Received: 04/03/2001
Date Analyzed: 04/06/2001
Data file: I7810.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-μg/Kg (ppb)
Dilution Factor: 1
% Moisture: 33

CAS #	Compound	Estimated Concentration	Retention Time
	No peaks detected		

Total TICs = 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-004
Client ID: SL/T-A
Date Received: 04/03/2001
Date Analyzed: 04/06/2001
Data file: I7811.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-µg/Kg (ppb)
Dilution Factor: 1
% Moisture: 42.4

Compound	Concentration	Q	MDL
Chloromethane	ND		8.7
Vinyl Chloride	ND		8.7
Bromomethane	ND		8.7
Chloroethane	ND		8.7
Trichlorofluoromethane	ND		8.7
Acrolein	ND		17.4
1,1-Dichloroethene	ND		8.7
Methylene Chloride	ND		8.7
Acrylonitrile	ND		17.4
t-Butyl Alcohol(TBA)	ND		17.4
trans-1,2-Dichloroethene	ND		8.7
Methyl-t-Butyl Ether(MTBE)	ND		8.7
1,1-Dichloroethane	ND		8.7
cis-1,2-Dichloroethene	ND		8.7
Chloroform	ND		8.7
1,1,1-Trichloroethane	ND		8.7
Carbon Tetrachloride	ND		8.7
1,2-Dichloroethane(EDC)	ND		8.7
Benzene	ND		8.7
Trichloroethene	ND		8.7
1,2-Dichloropropane	ND		8.7
Bromodichloromethane	ND		8.7
2-Chloroethylvinyl Ether	ND		8.7
cis-1,3-Dichloropropene	ND		8.7
Toluene	ND		8.7
trans-1,3-Dichloropropene	ND		8.7
1,1,2-Trichloroethane	ND		8.7
Tetrachloroethene	ND		8.7
Dibromochloromethane	ND		8.7
Chlorobenzene	ND		8.7
Ethylbenzene	ND		8.7
Total Xylenes	ND		8.7
Bromoform	ND		8.7
1,1,2,2-Tetrachloroethane	ND		8.7
1,3-Dichlorobenzene	ND		8.7
1,4-Dichlorobenzene	ND		8.7
1,2-Dichlorobenzene	ND		8.7

Total Target Compounds: 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Tentatively Identified Compounds

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-004
Client ID: SL/T-A
Date Received: 04/03/2001
Date Analyzed: 04/06/2001
Data file: I7811.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-μg/Kg (ppb)
Dilution Factor: 1
% Moisture: 42.4

CAS #	Compound	Estimated Concentration	Retention Time
	No peaks detected		

Total TICs = 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-005
Client ID: SL/T-B
Date Received: 04/03/2001
Date Analyzed: 04/06/2001
Data file: I7812.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-µg/Kg (ppb)
Dilution Factor: 1
% Moisture: 47.5

Compound	Concentration	Q	MDL
Chloromethane	ND		9.5
Vinyl Chloride	ND		9.5
Bromomethane	ND		9.5
Chloroethane	ND		9.5
Trichlorofluoromethane	ND		9.5
Acrolein	ND		19
1,1-Dichloroethene	ND		9.5
Methylene Chloride	ND		9.5
Acrylonitrile	ND		19
t-Butyl Alcohol(TBA)	ND		19
trans-1,2-Dichloroethene	ND		9.5
Methyl-t-Butyl Ether(MTBE)	ND		9.5
1,1-Dichloroethane	ND		9.5
cis-1,2-Dichloroethene	ND		9.5
Chloroform	ND		9.5
1,1,1-Trichloroethane	ND		9.5
Carbon Tetrachloride	ND		9.5
1,2-Dichloroethane(EDC)	ND		9.5
Benzene	ND		9.5
Trichloroethene	ND		9.5
1,2-Dichloropropane	ND		9.5
Bromodichloromethane	ND		9.5
2-Chloroethylvinyl Ether	ND		9.5
cis-1,3-Dichloropropene	ND		9.5
Toluene	ND		9.5
trans-1,3-Dichloropropene	ND		9.5
1,1,2-Trichloroethane	ND		9.5
Tetrachloroethene	ND		9.5
Dibromochloromethane	ND		9.5
Chlorobenzene	ND		9.5
Ethylbenzene	ND		9.5
Total Xylenes	ND		9.5
Bromoform	ND		9.5
1,1,2,2-Tetrachloroethane	ND		9.5
1,3-Dichlorobenzene	ND		9.5
1,4-Dichlorobenzene	ND		9.5
1,2-Dichlorobenzene	ND		9.5

Total Target Compounds: 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Tentatively Identified Compounds

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-005
Client ID: SL/T-B
Date Received: 04/03/2001
Date Analyzed: 04/06/2001
Data file: I7812.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-μg/Kg (ppb)
Dilution Factor: 1
% Moisture: 47.5

CAS #	Compound	Estimated Concentration	Retention Time
	No peaks detected		

Total TICs = 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-006
Client ID: SL/T-C
Date Received: 04/03/2001
Date Analyzed: 04/06/2001
Data file: I7813.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-µg/Kg (ppb)
Dilution Factor: 1
% Moisture: 40.8

Compound	Concentration	Q	MDL
Chloromethane	ND		8.45
Vinyl Chloride	ND		8.45
Bromomethane	ND		8.45
Chloroethane	ND		8.45
Trichlorofluoromethane	ND		8.45
Acrolein	ND		16.9
1,1-Dichloroethene	ND		8.45
Methylene Chloride	ND		8.45
Acrylonitrile	ND		16.9
t-Butyl Alcohol(TBA)	ND		16.9
trans-1,2-Dichloroethene	ND		8.45
Methyl-t-Butyl Ether(MTBE)	ND		8.45
1,1-Dichloroethane	ND		8.45
cis-1,2-Dichloroethene	ND		8.45
Chloroform	ND		8.45
1,1,1-Trichloroethane	ND		8.45
Carbon Tetrachloride	ND		8.45
1,2-Dichloroethane(EDC)	ND		8.45
Benzene	ND		8.45
Trichloroethene	ND		8.45
1,2-Dichloropropane	ND		8.45
Bromodichloromethane	ND		8.45
2-Chloroethylvinyl Ether	ND		8.45
cis-1,3-Dichloropropene	ND		8.45
Toluene	ND		8.45
trans-1,3-Dichloropropene	ND		8.45
1,1,2-Trichloroethane	ND		8.45
Tetrachloroethene	ND		8.45
Dibromochloromethane	ND		8.45
Chlorobenzene	ND		8.45
Ethylbenzene	ND		8.45
Total Xylenes	ND		8.45
Bromoform	ND		8.45
1,1,2,2-Tetrachloroethane	ND		8.45
1,3-Dichlorobenzene	ND		8.45
1,4-Dichlorobenzene	ND		8.45
1,2-Dichlorobenzene	ND		8.45

Total Target Compounds: 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Tentatively Identified Compounds

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-006
Client ID: SL/T-C
Date Received: 04/03/2001
Date Analyzed: 04/06/2001
Data file: I7813.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-μg/Kg (ppb)
Dilution Factor: 1
% Moisture: 40.8

CAS #	Compound	Estimated Concentration	Retention Time
	No peaks detected		

Total TICs = 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-007
Client ID: SL/T-D
Date Received: 04/03/2001
Date Analyzed: 04/06/2001
Data file: I7814.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-µg/Kg (ppb)
Dilution Factor: 1
% Moisture: 38.3

Compound	Concentration	Q	MDL
Chloromethane	ND		8.1
Vinyl Chloride	ND		8.1
Bromomethane	ND		8.1
Chloroethane	ND		8.1
Trichlorofluoromethane	ND		8.1
Acrolein	ND		16.2
1,1-Dichloroethene	ND		8.1
Methylene Chloride	ND		8.1
Acrylonitrile	ND		16.2
t-Butyl Alcohol(TBA)	ND		16.2
trans-1,2-Dichloroethene	ND		8.1
Methyl-t-Butyl Ether(MTBE)	ND		8.1
1,1-Dichloroethane	ND		8.1
cis-1,2-Dichloroethene	ND		8.1
Chloroform	ND		8.1
1,1,1-Trichloroethane	ND		8.1
Carbon Tetrachloride	ND		8.1
1,2-Dichloroethane(EDC)	ND		8.1
Benzene	ND		8.1
Trichloroethene	ND		8.1
1,2-Dichloropropane	ND		8.1
Bromodichloromethane	ND		8.1
2-Chloroethylvinyl Ether	ND		8.1
cis-1,3-Dichloropropene	ND		8.1
Toluene	ND		8.1
trans-1,3-Dichloropropene	ND		8.1
1,1,2-Trichloroethane	ND		8.1
Tetrachloroethene	ND		8.1
Dibromochloromethane	ND		8.1
Chlorobenzene	ND		8.1
Ethylbenzene	ND		8.1
Total Xylenes	ND		8.1
Bromoform	ND		8.1
1,1,2,2-Tetrachloroethane	ND		8.1
1,3-Dichlorobenzene	ND		8.1
1,4-Dichlorobenzene	ND		8.1
1,2-Dichlorobenzene	ND		8.1

Total Target Compounds: 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Tentatively Identified Compounds

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-007
Client ID: SL/T-D
Date Received: 04/03/2001
Date Analyzed: 04/06/2001
Data file: I7814.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-μg/Kg (ppb)
Dilution Factor: 1
% Moisture: 38.3

CAS #	Compound	Estimated Concentration	Retention Time
	No peaks detected		

Total TICs = 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-008
Client ID: SL/T-E
Date Received: 04/03/2001
Date Analyzed: 04/06/2001
Data file: I7815.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-µg/Kg (ppb)
Dilution Factor: 1
% Moisture: 36.8

Compound	Concentration	Q	MDL
Chloromethane	ND		7.9
Vinyl Chloride	ND		7.9
Bromomethane	ND		7.9
Chloroethane	ND		7.9
Trichlorofluoromethane	ND		7.9
Acrolein	ND		15.8
1,1-Dichloroethene	ND		7.9
Methylene Chloride	ND		7.9
Acrylonitrile	ND		15.8
t-Butyl Alcohol(TBA)	ND		15.8
trans-1,2-Dichloroethene	ND		7.9
Methyl-t-Butyl Ether(MTBE)	ND		7.9
1,1-Dichloroethane	ND		7.9
cis-1,2-Dichloroethene	ND		7.9
Chloroform	ND		7.9
1,1,1-Trichloroethane	ND		7.9
Carbon Tetrachloride	ND		7.9
1,2-Dichloroethane(EDC)	ND		7.9
Benzene	ND		7.9
Trichloroethene	ND		7.9
1,2-Dichloropropane	ND		7.9
Bromodichloromethane	ND		7.9
2-Chloroethylvinyl Ether	ND		7.9
cis-1,3-Dichloropropene	ND		7.9
Toluene	ND		7.9
trans-1,3-Dichloropropene	ND		7.9
1,1,2-Trichloroethane	ND		7.9
Tetrachloroethene	ND		7.9
Dibromochloromethane	ND		7.9
Chlorobenzene	ND		7.9
Ethylbenzene	ND		7.9
Total Xylenes	ND		7.9
Bromoform	ND		7.9
1,1,2,2-Tetrachloroethane	ND		7.9
1,3-Dichlorobenzene	ND		7.9
1,4-Dichlorobenzene	ND		7.9
1,2-Dichlorobenzene	ND		7.9

Total Target Compounds: 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Tentatively Identified Compounds

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-008
Client ID: SL/T-E
Date Received: 04/03/2001
Date Analyzed: 04/06/2001
Data file: I7815.D

GC/MS Column: DB-624
Sample wt/vol: 5g
Matrix-Units: Soil-μg/Kg (ppb)
Dilution Factor: 1
% Moisture: 36.8

CAS #	Compound	Estimated Concentration	Retention Time
	No peaks detected		

Total TICs = 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-009
Client ID: GW-3034-032801-ISO
Date Received: 04/03/2001
Date Analyzed: 04/04/2001
Data file: E7979.D

GC/MS Column: DB-624
Sample wt/vol: 0.25mL
Matrix-Units: Aqueous-μg/L (ppb)
Dilution Factor: 20
% Moisture: 100

Compound	Concentration	Q	MDL
Chloromethane	ND		12.2
Vinyl Chloride	ND		6.6
Bromomethane	ND		9.4
Chloroethane	ND		13
Trichlorofluoromethane	ND		7.6
Acrolein	ND		119
1,1-Dichloroethene	ND		10
Methylene Chloride	ND		38.2
Acrylonitrile	ND		25.4
t-Butyl Alcohol(TBA)	ND		20.4
trans-1,2-Dichloroethene	ND		7.8
Methyl-t-Butyl Ether(MTBE)	ND		10.6
1,1-Dichloroethane	ND		6.6
cis-1,2-Dichloroethene	26.2		5.4
Chloroform	ND		6.2
1,1,1-Trichloroethane	ND		7.6
Carbon Tetrachloride	ND		7.8
1,2-Dichloroethane(EDC)	ND		7
Benzene	ND		6
Trichloroethene	1070		7.2
1,2-Dichloropropane	ND		5
Bromodichloromethane	ND		5
2-Chloroethylvinyl Ether	ND		5
cis-1,3-Dichloropropene	ND		3.8
Toluene	ND		6.6
trans-1,3-Dichloropropene	ND		5.4
1,1,2-Trichloroethane	ND		6.2
Tetrachloroethene	ND		7.6
Dibromochloromethane	ND		6.2
Chlorobenzene	ND		5.6
Ethylbenzene	ND		6
Total Xylenes	ND		18
Bromoform	ND		5.6
1,1,2,2-Tetrachloroethane	ND		5.4
1,3-Dichlorobenzene	ND		4.4
1,4-Dichlorobenzene	ND		4.4
1,2-Dichlorobenzene	ND		3.8

Total Target Compounds: 1096.2

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Tentatively Identified Compounds

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-009
Client ID: GW-3034-032801-ISO
Date Received: 04/03/2001
Date Analyzed: 04/04/2001
Data file: E7979.D

GC/MS Column: DB-624
Sample wt/vol: 0.25mL
Matrix-Units: Aqueous-μg/L (ppb)
Dilution Factor: 20
% Moisture: 100

CAS #	Compound	Estimated Concentration	Retention Time
	No peaks detected		

Total TICs = 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-010
Client ID: GW/CONTROL
Date Received: 04/03/2001
Date Analyzed: 04/04/2001
Data file: E7980.D

GC/MS Column: DB-624
Sample wt/vol: 0.5mL
Matrix-Units: Aqueous-µg/L (ppb)
Dilution Factor: 10
% Moisture: 100

Compound	Concentration	Q	MDL
Chloromethane	ND		6.1
Vinyl Chloride	ND		3.3
Bromomethane	ND		4.7
Chloroethane	ND		6.5
Trichlorofluoromethane	ND		3.8
Acrolein	ND		59.4
1,1-Dichloroethene	ND		5
Methylene Chloride	ND		19.1
Acrylonitrile	ND		12.7
t-Butyl Alcohol(TBA)	ND		10.2
trans-1,2-Dichloroethene	ND		3.9
Methyl-t-Butyl Ether(MTBE)	ND		5.3
1,1-Dichloroethane	ND		3.3
cis-1,2-Dichloroethene	19.8		2.7
Chloroform	ND		3.1
1,1,1-Trichloroethane	ND		3.8
Carbon Tetrachloride	ND		3.9
1,2-Dichloroethane(EDC)	ND		3.5
Benzene	ND		3
Trichloroethene	793		3.6
1,2-Dichloropropane	ND		2.5
Bromodichloromethane	ND		2.5
2-Chloroethylvinyl Ether	ND		2.5
cis-1,3-Dichloropropene	ND		1.9
Toluene	ND		3.3
trans-1,3-Dichloropropene	ND		2.7
1,1,2-Trichloroethane	ND		3.1
Tetrachloroethene	ND		3.8
Dibromochloromethane	ND		3.1
Chlorobenzene	ND		2.8
Ethylbenzene	ND		3
Total Xylenes	ND		9
Bromoform	ND		2.8
1,1,2,2-Tetrachloroethane	ND		2.7
1,3-Dichlorobenzene	ND		2.2
1,4-Dichlorobenzene	ND		2.2
1,2-Dichlorobenzene	ND		1.9

Total Target Compounds: 812.8

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Tentatively Identified Compounds

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-010
Client ID: GW/CONTROL
Date Received: 04/03/2001
Date Analyzed: 04/04/2001
Data file: E7980.D

GC/MS Column: DB-624
Sample wt/vol: 0.5mL
Matrix-Units: Aqueous-μg/L (ppb)
Dilution Factor: 10
% Moisture: 100

CAS #	Compound	Estimated Concentration	Retention Time
	No peaks detected		

Total TICs = 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-011
Client ID: GW/T-A
Date Received: 04/03/2001
Date Analyzed: 04/04/2001
Data file: E7981.D

GC/MS Column: DB-624
Sample wt/vol: 5mL
Matrix-Units: Aqueous-µg/L (ppb)
Dilution Factor: 1
% Moisture: 100

Compound	Concentration	Q	MDL
Chloromethane	ND		0.61
Vinyl Chloride	ND		0.33
Bromomethane	ND		0.47
Chloroethane	ND		0.65
Trichlorofluoromethane	ND		0.38
Acrolein	ND		5.94
1,1-Dichloroethene	ND		0.5
Methylene Chloride	ND		1.91
Acrylonitrile	ND		1.27
t-Butyl Alcohol(TBA)	ND		1.02
trans-1,2-Dichloroethene	ND		0.39
Methyl-t-Butyl Ether(MTBE)	ND		0.53
1,1-Dichloroethane	ND		0.33
cis-1,2-Dichloroethene	ND		0.27
Chloroform	1.34		0.31
1,1,1-Trichloroethane	ND		0.38
Carbon Tetrachloride	ND		0.39
1,2-Dichloroethane(EDC)	ND		0.35
Benzene	ND		0.3
Trichloroethene	ND		0.36
1,2-Dichloropropane	ND		0.25
Bromodichloromethane	ND		0.25
2-Chloroethylvinyl Ether	ND		0.25
cis-1,3-Dichloropropene	ND		0.19
Toluene	ND		0.33
trans-1,3-Dichloropropene	ND		0.27
1,1,2-Trichloroethane	0.465		0.31
Tetrachloroethene	ND		0.38
Dibromochloromethane	ND		0.31
Chlorobenzene	ND		0.28
Ethylbenzene	ND		0.3
Total Xylenes	ND		0.9
Bromoform	ND		0.28
1,1,2,2-Tetrachloroethane	ND		0.27
1,3-Dichlorobenzene	ND		0.22
1,4-Dichlorobenzene	ND		0.22
1,2-Dichlorobenzene	ND		0.19

Total Target Compounds: 1.805

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Tentatively Identified Compounds

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-011
Client ID: GW/T-A
Date Received: 04/03/2001
Date Analyzed: 04/04/2001
Data file: E7981.D

GC/MS Column: DB-624
Sample wt/vol: 5mL
Matrix-Units: Aqueous-μg/L (ppb)
Dilution Factor: 1
% Moisture: 100

CAS #	Compound	Estimated Concentration	Retention Time
	No peaks detected		

Total TICs = 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-012
Client ID: GW/T-B
Date Received: 04/03/2001
Date Analyzed: 04/04/2001
Data file: E7982.D

GC/MS Column: DB-624
Sample wt/vol: 5mL
Matrix-Units: Aqueous-µg/L (ppb)
Dilution Factor: 1
% Moisture: 100

Compound	Concentration	Q	MDL
Chloromethane	ND		0.61
Vinyl Chloride	ND		0.33
Bromomethane	ND		0.47
Chloroethane	ND		0.65
Trichlorofluoromethane	ND		0.38
Acrolein	ND		5.94
1,1-Dichloroethene	ND		0.5
Methylene Chloride	ND		1.91
Acrylonitrile	ND		1.27
t-Butyl Alcohol(TBA)	ND		1.02
trans-1,2-Dichloroethene	ND		0.39
Methyl-t-Butyl Ether(MTBE)	ND		0.53
1,1-Dichloroethane	ND		0.33
cis-1,2-Dichloroethene	ND		0.27
Chloroform	1.15		0.31
1,1,1-Trichloroethane	ND		0.38
Carbon Tetrachloride	ND		0.39
1,2-Dichloroethane(EDC)	ND		0.35
Benzene	ND		0.3
Trichloroethene	ND		0.36
1,2-Dichloropropane	ND		0.25
Bromodichloromethane	ND		0.25
2-Chloroethylvinyl Ether	ND		0.25
cis-1,3-Dichloropropene	ND		0.19
Toluene	ND		0.33
trans-1,3-Dichloropropene	ND		0.27
1,1,2-Trichloroethane	ND		0.31
Tetrachloroethene	ND		0.38
Dibromochloromethane	ND		0.31
Chlorobenzene	ND		0.28
Ethylbenzene	ND		0.3
Total Xylenes	ND		0.9
Bromoform	ND		0.28
1,1,2,2-Tetrachloroethane	ND		0.27
1,3-Dichlorobenzene	ND		0.22
1,4-Dichlorobenzene	ND		0.22
1,2-Dichlorobenzene	ND		0.19

Total Target Compounds: 1.15

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Tentatively Identified Compounds

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-012
Client ID: GW/T-B
Date Received: 04/03/2001
Date Analyzed: 04/04/2001
Date File: E7982.D

GC/MS Column: DB-624
Sample wt/vol: 5mL
Matrix-Units: Aqueous-μg/L (ppb)
Dilution Factor: 1
% Moisture: 100

CAS #	Compound	Estimated Concentration	Retention Time
	Unknown	3.2	5.91

Total TICs = 3.2

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-013
Client ID: GW/T-C
Date Received: 04/03/2001
Date Analyzed: 04/04/2001
Data file: E7983.D

GC/MS Column: DB-624
Sample wt/vol: 5mL
Matrix-Units: Aqueous-µg/L (ppb)
Dilution Factor: 1
% Moisture: 100

Compound	Concentration	Q	MDL
Chloromethane	ND		0.61
Vinyl Chloride	ND		0.33
Bromomethane	ND		0.47
Chloroethane	ND		0.65
Trichlorofluoromethane	ND		0.38
Acrolein	ND		5.94
1,1-Dichloroethene	ND		0.5
Methylene Chloride	ND		1.91
Acrylonitrile	ND		1.27
t-Butyl Alcohol(TBA)	ND		1.02
trans-1,2-Dichloroethene	ND		0.39
Methyl-t-Butyl Ether(MTBE)	ND		0.53
1,1-Dichloroethane	ND		0.33
cis-1,2-Dichloroethene	ND		0.27
Chloroform	1.04		0.31
1,1,1-Trichloroethane	ND		0.38
Carbon Tetrachloride	ND		0.39
1,2-Dichloroethane(EDC)	ND		0.35
Benzene	ND		0.3
Trichloroethene	ND		0.36
1,2-Dichloropropane	ND		0.25
Bromodichloromethane	ND		0.25
2-Chloroethylvinyl Ether	ND		0.25
cis-1,3-Dichloropropene	ND		0.19
Toluene	ND		0.33
trans-1,3-Dichloropropene	ND		0.27
1,1,2-Trichloroethane	ND		0.31
Tetrachloroethene	ND		0.38
Dibromochloromethane	ND		0.31
Chlorobenzene	ND		0.28
Ethylbenzene	ND		0.3
Total Xylenes	ND		0.9
Bromoform	ND		0.28
1,1,2,2-Tetrachloroethane	ND		0.27
1,3-Dichlorobenzene	ND		0.22
1,4-Dichlorobenzene	ND		0.22
1,2-Dichlorobenzene	ND		0.19

Total Target Compounds: 1.04

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Tentatively Identified Compounds

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-013
Client ID: GW/T-C
Date Received: 04/03/2001
Date Analyzed: 04/04/2001
Date File: E7983.D

GC/MS Column: DB-624
Sample wt/vol: 5mL
Matrix-Units: Aqueous-μg/L (ppb)
Dilution Factor: 1
% Moisture: 100

CAS #	Compound	Estimated Concentration	Retention Time
	Unknown	5.8	5.91

Total TICs = 5.8

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-014
Client ID: GW/T-D
Date Received: 04/03/2001
Date Analyzed: 04/04/2001
Data file: E7984.D

GC/MS Column: DB-624
Sample wt/vol: 5mL
Matrix-Units: Aqueous-µg/L (ppb)
Dilution Factor: 1
% Moisture: 100

Compound	Concentration	Q	MDL
Chloromethane	ND		0.61
Vinyl Chloride	ND		0.33
Bromomethane	ND		0.47
Chloroethane	ND		0.65
Trichlorofluoromethane	ND		0.38
Acrolein	ND		5.94
1,1-Dichloroethene	ND		0.5
Methylene Chloride	ND		1.91
Acrylonitrile	ND		1.27
t-Butyl Alcohol(TBA)	ND		1.02
trans-1,2-Dichloroethene	ND		0.39
Methyl-t-Butyl Ether(MTBE)	ND		0.53
1,1-Dichloroethane	ND		0.33
cis-1,2-Dichloroethene	ND		0.27
Chloroform	1.37		0.31
1,1,1-Trichloroethane	ND		0.38
Carbon Tetrachloride	ND		0.39
1,2-Dichloroethane(EDC)	ND		0.35
Benzene	ND		0.3
Trichloroethene	ND		0.36
1,2-Dichloropropane	ND		0.25
Bromodichloromethane	ND		0.25
2-Chloroethylvinyl Ether	ND		0.25
cis-1,3-Dichloropropene	ND		0.19
Toluene	ND		0.33
trans-1,3-Dichloropropene	ND		0.27
1,1,2-Trichloroethane	0.491		0.31
Tetrachloroethene	ND		0.38
Dibromochloromethane	ND		0.31
Chlorobenzene	ND		0.28
Ethylbenzene	ND		0.3
Total Xylenes	ND		0.9
Bromoform	ND		0.28
1,1,2,2-Tetrachloroethane	ND		0.27
1,3-Dichlorobenzene	ND		0.22
1,4-Dichlorobenzene	ND		0.22
1,2-Dichlorobenzene	ND		0.19

Total Target Compounds: 1.861

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Tentatively Identified Compounds

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-014
Client ID: GW/T-D
Date Received: 04/03/2001
Date Analyzed: 04/04/2001
Data file: E7984.D

GC/MS Column: DB-624
Sample wt/vol: 5mL
Matrix-Units: Aqueous-μg/L (ppb)
Dilution Factor: 1
% Moisture: 100

CAS #	Compound	Estimated Concentration	Retention Time
	No peaks detected		

Total TICs = 0

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-015
Client ID: GW/T-E
Date Received: 04/03/2001
Date Analyzed: 04/05/2001
Data file: E7985.D

GC/MS Column: DB-624
Sample wt/vol: 5mL
Matrix-Units: Aqueous-µg/L (ppb)
Dilution Factor: 1
% Moisture: 100

Compound	Concentration	Q	MDL
Chloromethane	ND		0.61
Vinyl Chloride	ND		0.33
Bromomethane	ND		0.47
Chloroethane	ND		0.65
Trichlorofluoromethane	ND		0.38
Acrolein	ND		5.94
1,1-Dichloroethene	ND		0.5
Methylene Chloride	ND		1.91
Acrylonitrile	ND		1.27
t-Butyl Alcohol(TBA)	ND		1.02
trans-1,2-Dichloroethene	ND		0.39
Methyl-t-Butyl Ether(MTBE)	ND		0.53
1,1-Dichloroethane	ND		0.33
cis-1,2-Dichloroethene	ND		0.27
Chloroform	1.23		0.31
1,1,1-Trichloroethane	ND		0.38
Carbon Tetrachloride	ND		0.39
1,2-Dichloroethane(EDC)	ND		0.35
Benzene	ND		0.3
Trichloroethene	ND		0.36
1,2-Dichloropropane	ND		0.25
Bromodichloromethane	ND		0.25
2-Chloroethylvinyl Ether	ND		0.25
cis-1,3-Dichloropropene	ND		0.19
Toluene	ND		0.33
trans-1,3-Dichloropropene	ND		0.27
1,1,2-Trichloroethane	ND		0.31
Tetrachloroethene	ND		0.38
Dibromochloromethane	ND		0.31
Chlorobenzene	ND		0.28
Ethylbenzene	ND		0.3
Total Xylenes	ND		0.9
Bromoform	ND		0.28
1,1,2,2-Tetrachloroethane	ND		0.27
1,3-Dichlorobenzene	ND		0.22
1,4-Dichlorobenzene	ND		0.22
1,2-Dichlorobenzene	ND		0.19

Total Target Compounds: 1.23

INTEGRATED ANALYTICAL LABORATORIES

VOLATILE ORGANICS

Tentatively Identified Compounds

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-015
Client ID: GW/T-E
Date Received: 04/03/2001
Date Analyzed: 04/05/2001
Date File: E7985.D

GC/MS Column: DB-624
Sample wt/vol: 5mL
Matrix-Units: Aqueous-μg/L (ppb)
Dilution Factor: 1
% Moisture: 100

CAS #	Compound	Estimated Concentration	Retention Time
	Unknown	3.9	5.91

Total TICs = 3.9

INTEGRATED ANALYTICAL LABORATORIES, LLC.

METALS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-001
Client ID: SO-4033-ISO
Date Received: 4/3/01
Date Analyzed: 4/5/01
Matrix-Units: Soil-mg/Kg (ppm)
% Moisture: 8.2

Compound	Result	Q	DF	MDL
Iron	31400		1	3.27
Manganese	1050		1	0.436

INTEGRATED ANALYTICAL LABORATORIES, LLC.

METALS

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-009
Client ID: GW-3034-032801-ISO
Date Received: 4/3/01
Date Analyzed: 4/5/01
Matrix-Units: Aqueous-mg/L (ppm)
% Moisture: 100

Compound	Result	Q	DF	MDL
Iron	ND		1	0.100
Manganese	0.260		1	0.010

INTEGRATED ANALYTICAL LABORATORIES, LLC.

GENERAL ANALYTICAL

Client/Project: ISOTEC/MK/WELDON SPRING

Lab ID: 2055-001
Client ID: SO-4033-ISO
Date Received: 4/3/01
% Moisture: 8.2

Compound	Result	Q	Matrix Unit	DF	MDL	Date Analyzed
*Total Organic Carbons	850		Soil-mg/Kg	NA	NA	4/11/01

***Subcontracted results from The Washington Group Laboratory**

Phone # (973) 361-4252
Fax # (973) 989-5288

INTEGRATED ANALYTICAL LABORATORIES
CHAIN OF CUSTODY

273 Franklin Rd
Randolph, NJ 07869

CLIENT & PROJECT

Company Name:	ISOTEC
Address:	51 Everett Dr, #A-10
	West Windsor, NJ 08550
Telephone #:	609-275-8500
Fax #:	609-275-9608
Project Name:	MK/Weldon Spring RAP
Project Manager:	Prasad Kakarla TA
Reference ID#:	800346 PO#: 1691

REPORTING

Fax to:	Prasad Kakarla
Fax #:	
Report to:	— Same —
Address:	
Invoice to:	— Same —
Address:	

Turnaround Time

Conditional / TPHC: 24 hr* 48 hr 72 hr 1 wk NA Other:

Verbal/Fax: 24 hr* 48 hr* 72 hr* 1 wk* 2 wk Other:

Hard Copy: 72 hr* 1 wk* 2 wk* 3 wk Other:

*Prior to sample arrival, Lab notification is required.

Report Format: Results Only; Reduced; Regulatory; SRP Disk**: dbf or wk1; Other:

ANALYTICAL PARAMETERS / PRESERVATIVES

** Circle format required

Preservatives: 1. HCL 2. NaOH 3. HNO_3 4. H_2SO_4 5. MeOH 6. Other

COOLER TEMP 4 °C

SAMPLE INFORMATION

SAMPLE MATRIX: W - Waste, SL - Sludge, A - Aqueous, O - Oil, X - Other, S - Soil, GW - Groundwater, SOL - Solid

Sample ID	Sample Description	Sampling Date	Sampling Time	am	pm	Matrix	# of Containers	Lab ID	(No TID)	Iron	Manganese	TOC						Comments
SO-4033-ISO	Field Soil	3/27	?			S	2	01		X	X	X						
SL/Initial	Lab Initial	3/29	1000	✓		SL	1	2	X									
SL/Control	" Control	4/3	1000	✓		SL	1	3										
SL/T-A	" Treated						1	4										
SL/T-B							1	5										
SL/T-C							1	6										
SL/T-D							1	7										
SL/T-E							1	8										

Please print legibly and fill out completely. Samples cannot be processed and the turnaround time will not start until any ambiguities have been resolved.

Concentrations Expected: LOW MED HIGH

Known Hazard yes no — Describe: TCE

Comments: TCE up to 780 ppb; use low MDL's

CUSTODY LOG

	Signature	Date	Time		Signature
Relinquished by:	[illegible]	4/3	1100	Received by:	[illegible]
Relinquished by:	[illegible]	4-3-01	1700	Received by:	Paul Cornista
Relinquished by:				Received by:	
Relinquished by:				Received by:	
Relinquished by:				Received by:	

LAB COPIES - WHITE & YELLOW; CLIENT COPY - PINK

Lab Case # 2055

Phone # (973) 361-4252
Fax # (973) 989-5288

INTEGRATED ANALYTICAL LABORATORIES
CHAIN OF CUSTODY

273 Franklin Rd
Randolph, NJ 07869

CLIENT & PROJECT

Company Name:	ISOTEC
Address:	51 Everett Dr, # A-10
	West Windsor, NJ 08550
Telephone #:	609-275-8500
Fax #:	609-275-9608
Project Name:	MK/Delaware Spring RAP
Project Manager:	Prasad Kakarla TP
Reference ID#:	800346 PO#: 1691

REPORTING

Fax to:	Prasad Kakarla
Fax #:	
Report to:	— Same —
Address:	
Invoice to:	— Same —
Address:	

Turnaround Time

Conditional / TPHC
24 hr* 48 hr 72 hr 1 wk NA Other:

Verbal/Fax
24 hr* 48 hr* 72 hr* 1 wk* 2 wk Other:

Hard Copy
72 hr* 1 wk* 2 wk* 3 wk Other:

*Prior to sample arrival, Lab notification is required.

Report Format
Results Only
Reduced
Regulatory
SRP Disk**: dbf or wk1
Other:

ANALYTICAL PARAMETERS / PRESERVATIVES

** Circle format required

Preservatives: 1. HCL 2. NaOH 3. HNO_3 4. H_2SO_4 5. MeOH 6. Other

COOLER TEMP 4 °C

SAMPLE INFORMATION

SAMPLE MATRIX: W - Waste, SL - Sludge, A - Aqueous, O - Oil, X - Other, S - Soil, GW - Groundwater, SOL - Solid

Sample ID	Sample Description	Sampling Date	Sampling Time	am	pm	Matrix	# of Containers	Lab ID	VOC+10	Iron, dissolved	Manganese dissolved								Comments
GW-3034-032801-ISO	Field QC	3/28	?			A	3	9	X	X	X								
GW/Control	Lab Control	4/3	1000	✓		A	2	10											
GW/T-A	Lab Treatd					A	2	11											
GW/T-B						A	2	12											
GW/T-C						A	2	13											
GW/T-D						A	2	14											
GW/T-E						A	2	15											

Please print legibly and fill out completely. Samples cannot be processed and the turnaround time will not start until any ambiguities have been resolved.

Concentrations Expected: LOW MED HIGH

Known Hazard: yes no
Describe: TCE

CUSTODY LOG

	Signature	Date	Time		Signature
Relinquished by:	[signature]	4/3	1100	Received by:	[signature]
Relinquished by:	[signature]	4-3-01	17:00	Received by:	Paul Carrista
Relinquished by:				Received by:	
Relinquished by:				Received by:	
Relinquished by:				Received by:	

Comments: — Same as Pg 1 —

Lab Case #: 2055

PAGE: 2 OF 2

LAB COPIES - WHITE & YELLOW; CLIENT COPY - PINK

CHAIN OF CUSTODY

Case No.: E01-2055
Project : MK/WELDON SPRING RAP - 800346
Client/Project: ISOTEC/MK/WELDON SPRING
Client Address:
Isotec
51 Everett Drive
Suite A-10
West Windsor, NJ 08550
Date Received: 04/03/01
Time Received: 17:00
Report Format: Standard

P.O. #: 1691
Billing Address:
Isotec
51 Everett Drive
Suite A-10
West Windsor, NJ 08550
Verbal Due: Apr 17
Report Due: Apr 24

# of Containers	2	1	1	1	1	1
IAL ID #	2055-001	2055-002	2055-003	2055-004	2055-005	2055-006
Client ID #	SO-4033-ISO	SL/INITIAL	SL/CONTROL	SL/T-A	SL/T-B	SL/T-C
Matrix	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	03/27/01	03/29/01	04/03/01	04/03/01	04/03/01	04/03/01
Sample Time	:	10:00	10:00	10:00	10:00	10:00
MTBE + TBA		√	√	√	√	√
VO+10, PP LIST		√	√	√	√	√
Cis 1,2-DCE		√	√	√	√	√
Fe-Iron	√					
Mn-Manganese	√					
% Solids	√	√	√	√	√	√
TOC	√					

Comments: NOTE 1: AS PER COC, EXPECT TCE CONCENTRATIONS OF 780 ppb. PLEASE REPORT LOWEST MDLs POSSIBLE.
NOTE 2: PLEASE MEET GROUNDWATER LIMITS FOR AQUEOUS METALS.
NOTE 3: SAMPLE #9 FOR DISSOLVED METALS TO BE FILTERED AT LAB.

CHAIN OF CUSTODY

Case No.: E01-2055
Project : MK/WELDON SPRING RAP - 800346
Client/Project: ISOTEC/MK/WELDON SPRING
Client Address:
Isotec
51 Everett Drive
Suite A-10
West Windsor, NJ 08550
Date Received: 04/03/01
Time Received: 17:00
Report Format: Standard

P.O. #: 1691
Billing Address:
Isotec
51 Everett Drive
Suite A-10
West Windsor, NJ 08550
Verbal Due: Apr 17
Report Due: Apr 24

# of Containers	1	1	3	2	2	2
IAL ID #	2055-007	2055-008	2055-009	2055-010	2055-011	2055-012
Client ID #	SL/T-D	SL/T-E	GW-3034-	GW/CONTR	GW/T-A	GW/T-B
			032801-I	OL		
			SO			
Matrix	Soil	Soil	Aqueous	Aqueous	Aqueous	Aqueous
Sample Date	04/03/01	04/03/01	03/28/01	04/03/01	04/03/01	04/03/01
Sample Time	10:00	10:00	:	10:00	10:00	10:00
MTBE + TBA	√	√	√	√	√	√
VO+10, PP LIST	√	√	√	√	√	√
Cis 1,2-DCE	√	√	√	√	√	√
Fe-Iron			√			
Mn-Manganese			√			
% Solids	√	√				
Spl Filtration			√			

Comments: NOTE 1: AS PER COC, EXPECT TCE CONCENTRATIONS OF 780 ppb. PLEASE REPORT LOWEST MDLs POSSIBLE.
NOTE 2: PLEASE MEET GROUNDWATER LIMITS FOR AQUEOUS METALS.
NOTE 3: SAMPLE #9 FOR DISSOLVED METALS TO BE FILTERED AT LAB.

CHAIN OF CUSTODY

Case No.: E01-2055
Project : MK/WELDON SPRING RAP - 800346
Client/Project: ISOTEC/MK/WELDON SPRING
Client Address:
Isotec
51 Everett Drive
Suite A-10
West Windsor, NJ 08550
Date Received: 04/03/01
Time Received: 17:00
Report Format: Standard

P.O. #: 1691
Billing Address:
Isotec
51 Everett Drive
Suite A-10
West Windsor, NJ 08550
Verbal Due: Apr 17
Report Due: Apr 24

# of Containers	2	2	2
IAL ID #	2055-013	2055-014	2055-015
Client ID #	GW/T-C	GW/T-D	GW/T-E
Matrix	Aqueous	Aqueous	Aqueous
Sample Date	04/03/01	04/03/01	04/03/01
Sample Time	10:00	10:00	10:00
MTBE + TBA	√	√	√
VO+10, PP LIST	√	√	√
Cis 1,2-DCE	√	√	√

Comments: NOTE 1: AS PER COC, EXPECT TCE CONCENTRATIONS OF 780 ppb. PLEASE REPORT LOWEST MDLs POSSIBLE.
NOTE 2: PLEASE MEET GROUNDWATER LIMITS FOR AQUEOUS METALS.
NOTE 3: SAMPLE #9 FOR DISSOLVED METALS TO BE FILTERED AT LAB.

INTEGRATED ANALYTICAL LABORATORIES, LLC

SAMPLE RECEIPT VERIFICATION

CASE NO: 2055 CLIENT: ISOTEC

COOLER TEMPERATURE: 2° - 6°C: ✓ (See Chain of Custody)

CHAIN OF CUSTODY: COMPLETE / INCOMPLETE Comments:

		Comments:
Sample Bottles Intact:	✓	
Sample Labels Intact/ Correct:	✓	
Sufficient Sample Volume:	✓	
Correct bottles/ preservative:	✓	
Samples received in holding time/ prep time:	✓	
Headspace/ bubbles in voa samples:	✓	Lab ID # 9, 10 one sample has bubble, 11-15, 2 voas have bubbles
Samples to be subcontracted:	✓	

Preserved Sample pH checked: (Excluding voa samples) ✓

KEY
✓ = YES
✗ = NO
(✓) = N/A

ADDITIONAL COMMENTS:

SAMPLE(S) VERIFIED BY: INITIAL BP DATE 4/4

CORRECTIVE ACTION REQUIRED: YES ☐ (SEE BELOW) **NO** ✓

CLIENT NOTIFIED: YES ☐ Date/ Time: _____ NO ☐

PROJECT CONTACT:

SUBCONTRACTED LAB:

DATE SHIPPED:

ADDITIONAL COMMENTS:

VERIFIED/TAKEN BY: INITIAL [illegible] DATE

000040

REV 10/00

Integrated Analytical Laboratories, LLC.

Laboratory Custody Chronicle

Case No : E01-2055
Client : Isotec
Project : MK/WELDON SPRING RAP - 800346

	GC/MS V		EXTRACT DATE	EXTRACT TIME	EXTRACT INITIAL	ANALYSIS DATE	ANALYSIS TIME	ANALYSIS INITIAL
VO+10, PP LIST	2055-002	S				4/3-4/17		BS
	2055-003	S						
	2055-004	S						
	2055-005	S						
	2055-006	S						
	2055-007	S						
	2055-008	S						
	2055-009	A						
	2055-010	A						
	2055-011	A						
	2055-012	A						
	2055-013	A						
	2055-014	A						
	2055-015	A						
	METALS							
Fe-Iron	2055-001	S	4/4/01	[illegible]		4/5	1400	[illegible]
	2055-009	A	4/4/01	[illegible]		4/4	1400	[illegible]
Mn-Manganese	2055-001	S	4/4/01	[illegible]		4/5	1400	[illegible]
	2055-009	A	4/4/01	[illegible]		4/4	1400	[illegible]
	WETCHEM							
% Solids	2055-001	S	4/4		KC			
	2055-002	S						
	2055-003	S						
	2055-004	S						
	2055-005	S						
	2055-006	S						
	2055-007	S						
	2055-008	S						
Spl Filtration	2055-009	A						
	SUB-CON							
TOC	2055-001	S	—			—		

REVIEW & APPROVAL: [illegible]
REMARKS :

APPENDIX #2

ESTIMATED REAGENT QUANTITIES

Appendix #2: Estimated Reagent Quantities for the Initial Pilot Program
Weldon Spring Chemical Plant
St. Charles, Missouri
ISOTEC Project #800346

General Assumptions

Uniform Contaminant Distribution
Uniform Treatment Distribution
Homogeneous subsurface
Representative composite sample tested during bench scale study
Optimal Treatment Criteria = 90% destruction
Treatment Efficiency = Ratio of percent contaminant destruction/no. of treatments

From Bench Scale Study	Calculations	Value
Sample Volume tested	-	130 ml
Selected Catalyst	-	Cat-4260/6260
Optimal Treatment Dosages Determined	-	1
Reagent Volume for Optimal Treatment Efficiency	-	3 ml
Assumed Loss Factor	-	2
Estimated reagent volume with loss factor	2 x 3 ml	6 ml
Estimated reagent volume as percent sample volume	(6 ml/130 ml)x100	4.62%

Pilot Study Assumptions

Site Area	-	Pilot Program Area
Reagent Loss Factor	-	1.5
Subsurface Porosity	-	0.4
Number of injection depths per injection point	-	1
Injection depth of treatment	-	10 ft
Estimated radial effect	-	10 ft to 15 ft

Pilot Study Initial Reagent Volumes (see notes #1 and #2)

Site Volume for radial effect = 5 ft	0.4 x 3.14 x (5)^2 x 10	315 cu ft
Estimated reagents required per 10-ft depth/ injection point	4.62% of 315 cu ft	14.5 cu ft or 109 gallons
Site Volume for radial effect = 10 ft	0.4 x 3.14 x (10)^2 x 10	1,257 cu ft
Estimated reagents required per 10-ft depth/ injection point	4.62% of 1,257 cu ft	58 cu ft or 435 gallons
Site Volume for radial effect = 15 ft	0.4 x 3.14 x (15)^2 x 10	2,828 cu ft
Estimated reagents required per 10-ft depth/ injection point	4.62% of 2,828 cu ft	130.6 cu ft or 977 gallons
Site Volume for radial effect = 20 ft	0.4 x 3.14 x (20)^2 x 10	5,027 cu ft
Estimated reagents required per 10-ft depth/ injection point	4.62% of 5,027 cu ft	232 cu ft or 1,737 gallons

Note #1: Above volumes assume a 100% homogeneous displacement in pore volume by oxidizing reagents. Pilot study reagent volumes average between 30%-50% of the pore volume noted above.
Note #2: A 100% displacement in pore volume is not required to complete chemical oxidation objectives due to dispersion and concentration needed to oxidize contaminant of concern.