BIOREMEDIATION PILOT STUDY WORK PLAN

WORK ASSIGNMENT D003825-61

CHEM CORE SITE
CITY OF BUFFALO (C)

SITE NO. 9-15-176
ERIE COUNTY, NY

Prepared for:
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
625 Broadway, Albany, New York

Denise M. Sheehan, Acting Commissioner

DIVISION OF ENVIRONMENTAL REMEDIATION

URS Corporation
77 Goodell Street
Buffalo, New York 14203

Final
April 2005

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CHEM-CORE SITE

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BUFFALO, NEW YORK

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NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION

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PREPARED BY:

URS CORPORATION GROUP CONSULTANTS

77 GOODELL STREET

BUFFALO, NEW YORK 14203

APRIL 2005

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1.0 INTRODUCTION

1.1 Scope

This Bioremediation Pilot Study Work Plan has been prepared for remedial action at the Chem Core site as required under Subtask 3.1 of Work Assignment D003825-61. The report describes the means and methods for implementing a bioremediation pilot study at an off-site location south of the site.

1.2 Background

The Record of Decision (ROD) for the Chem Core site includes the following elements to address groundwater remediation:

1. Install and operate a groundwater pump and treat system on site.
2. Evaluate results from the on-site pump and treat system after five years and determine if additional measures (e.g. bioremediation) are necessary to achieve the remediation goal.
3. Implement a bioremediation pilot study off site to use as a basis for full scale implementation of bioremediation at the five year point of remediation, if necessary.

This report addresses the conceptual design for the third element of groundwater remediation presented above.

1.3 Objectives

A 1-year pilot study will be implemented to satisfy the following objectives:

1. Evaluate the impact of in-situ bioremediation on concentrations of chlorinated hydrocarbons in groundwater south of the site.

2. Develop a basis for full scale design with regard to the quantity and frequency of injection of bioremediation products into the groundwater. (It should be noted that this basis will only be valid if groundwater concentrations at the source are reduced significantly by the pump and treat system so they are similar (no greater than 10 ppm VOCs) to concentrations in the pilot test area.)

2.0 DESIGN

2.1 Bioremediation Products

Bioremediation products chosen for this pilot study include compounds that act as hydrogen donors in biological reactions and stimulate anabolic biological activity that leads to reductive dechlorination of chlorinated aliphatic hydrocarbons. For the pilot study, chlorinated hydrocarbons of primary concern include vinyl chloride, cis 1,2 dichloroethene, trans 1,2 dichloroethene, trichloroethene, and tetrachlorethene. URS considered two bioremediation products for the bioremediation pilot test at the Chem Core site. These products are:

- Hydrogen Release Compound (HRC™) manufactured by Regenesis Bioremediation Products.
- Edible Oil Substrate (EOS™) manufactured by EOS Remediation, Inc.

Although experience using these products in fractured bedrock is believed to be limited, both products have been successfully used for chlorinated hydrocarbon remediation in groundwater. URS performed an analysis (Appendix 2A) of the two products. In our opinion EOS™ is more suitable for the pilot study for the following reasons:

- EOS™ has a lower viscosity than HRC™ and may spread more completely into bedrock fractures and joints since a lower viscosity means it can move more readily in the bedrock aquifer.
- EOS™ is a slower release compound than HRC™. A slow release compound is more appropriate for the site because of the relatively flat gradient and lower concentrations in the downgradient area.
- EOS™ is blended with vitamin B12 which provides micronutrients for enhancing bioremediation.
- HRC™ has to be heated before injection.

In addition, for this application, EOS™ is less costly than HRC™. As shown in Appendix 2A, Section 3.3, the estimated cost of EOS™ is about 40% less than HRC™. However it should be noted that the economics of a full scale application at the source could favor HRC™, so economics was not the major criterion for selecting EOS™ over HRC™. Depending on pilot scale results, it is possible that HRC™ or other hydrogen donors could be evaluated for full scale treatment at the source.

2.2 Injection Well Locations and Construction

2.2.1 Well Locations

EOS™ will be applied using 24 injection wells constructed in a nominal 4,000 square foot area, which is over two hundred feet south of the site (Figure 2-1). This area was chosen because it is easily accessible (no buildings restrict access) and because total chlorinated hydrocarbon concentrations in area monitoring wells are relatively high (1-2 parts per million - ppm), but not as high as the source area. In the source area, total chlorinated hydrocarbon concentrations are in the range of 10-50 ppm. Source area concentrations are expected to decrease as a result of implementing pump and treat technology at the source, and it is hoped that they will be comparable to the present downgradient pilot study concentrations in the future (i.e. after five years).

2.2.2 Well Construction

Injection wells will be installed in a grid pattern using spacing of approximately 15 feet. Each injection well will be installed to depth of approximately 40 feet (20 feet into the saturated zone.) Construction specifications shall be as follows:

- 4-inch diameter steel casing installed approximately 2-3 feet into bedrock.
- 3 ⅞-inch diameter open rock hole from the base of the casing to a depth of 40 feet.
- Annular backfill consisting of cement/bentonite grout.
- Flush-mount protective curb box with locking cover and concrete apron.

Prior to drilling, each proposed injection well location will be cleared to avoid underground utilities and structures. Commercial utility locating services, public utilities, and the City of Buffalo will be contacted to provide subsurface utility information.

2.2.3 Well Development

All new injection wells will be developed by pumping until the discharge water is relatively free of sediment and measured water quality parameters have stabilized. Measurements of pH, conductivity, and temperature will be taken from the pump discharge at the following frequency:

- Initial discharge
- Every static well water volume

The static water level will be measured in each well prior to and at the conclusion of development.

2.3 Injection Rate

As currently envisioned, EOS™ will be injected once at the beginning of the one-year pilot test period. URS and the Department will evaluate monitoring results periodically. Another injection may be performed during the one-year period if results of the first injection are not satisfactory.

EOS™ concentrate, in the amount of 844 pounds (110 gallons), will be used for the pilot study. Prior to injection, the concentrate will be mixed with water on site. The dilute solution will be prepared and applied to the saturated zone using a pressurized injection system that includes a motorized mixing hopper, hydraulic pump, and pneumatic packer assembly that will isolate each of three injection zones in each well. Approximately 1.5 gallons of concentrated EOS™ (see Appendix A) diluted in 50 gallons of water will be injected into each of three equal intervals (zones) in each well.

2.4 Groundwater Flow in the Pilot Study Area

Groundwater elevations were measured and potentiometric surfaces were plotted during Phase I and Phase II of the Remedial Investigation (1999 – 2002) and during the Remedial Design Investigation. These data showed the following:

- The potentiometric surface at the Chem-Core site and in and around the pilot study area is relatively flat.
- Groundwater beneath the Chem-Core site generally moves westward toward the Black Rock Canal.
- There is a southward component of flow from the Chem-Core site toward the pilot study area.
- During the Remedial Design Investigation, flow from the pilot study area was north to northeast, toward the site. This flow direction is attributed to influence of a pump test that was being performed on site during the Remedial Design Investigation.

The water level data from the Remedial Design Investigation was used to calculate the gradient, which is an input parameter to calculate the amount of bioremediation product required for the pilot test. Even though the gradient may be a temporary condition caused by pumping, it is believed this data provides a conservative estimate for bioremediation product use. Groundwater levels will continue to be monitored during the pilot test to insure conditions are favorable to bioremediation, and groundwater flow conditions remain in line with the model used to develop the remedial program.

Monitoring wells are located immediately north, south, and east of the pilot study area. An additional well will be installed north of the pilot study area as shown on Figure 2-1. These wells will be used to monitor groundwater flow and quality during the pilot study. Ideally, one or more monitoring wells would be installed immediately west of the pilot study area. However, property in this area is owned by CSX and access is restricted. Groundwater monitoring west of the pilot study area is not included in the pilot study program.

2.5 Sampling and Monitoring

Eight wells will be sampled four times during the pilot test. These wells include MW-8S, MW-8D, MW-12, MW-16, MW-18, a new well (see Figure 2-1) and two injection wells located on the east edge of the injection grid. Sampling activities are summarized in Table 2-1. Sampling will occur once before the pilot study begins (a baseline event), and three times during the one-year pilot study period. In addition, all wells will be monitored once a month for the following parameters: DO, ORP, pH, temperature, conductivity and static water level (See Table 2-1). A schedule for sampling events is included in Table 5-1.

3.0 FIELD PROGRAM

3.1 Injection Method

EOS™ will be mixed on site at a ratio of 33.3 gallons of water to 1 gallon of EOS™ concentrate. Five hundred milliliters of Vitamin B12 supplement, supplied by the manufacturer, will be added to each 55-gallon drum of EOS™ concentrate. In addition, sodium sulfite will be added as an oxygen scavenger to prevent the introduction of oxygen into the EOS™ mixture during injection. The dilute solution will be prepared and applied the saturated zone using a direct pressurized injection system that includes a motorized mixing hopper, hydraulic pump (with a minimum pressure rating of 1,500 pounds per square inch - psi), and pneumatic packer assembly. The solution will be injected under pressure in three successive increments of approximately 6 to 7 feet, starting from the bottom of each open rock intake. Each zone will be isolated by the packers. Approximately 1.5 gallons of concentrated EOS™ mixed in 50 gallons of water will be injected into each 6 to 7 foot increment. The quantity of water injected into each increment represents about one half the pore volume in a section of bedrock 15 feet in diameter (the distance between wells) and 7 feet high.

3.2 Decontamination

All drilling equipment will be steam cleaned prior to use at the site and prior to demobilization from the site. Downhole equipment, such as drive points and rods, will also be cleaned between well and injection locations.

3.3 Borehole Logging/Well Installation

A geologist will oversee the drilling and well construction processes. He/she will log each borehole and document the as-built well details on well construction log sheets.

3.3.1 Hydraulic Conductivity Testing

Slug tests will be performed in all 24 injection wells using a Hermit Data Logger, pressure transducer, and stainless-steel slugs. Both falling head (slug-in) and rising head (slug-out) tests will be performed. The tests will consist of inserting or removing the slug from the well and monitoring the recovery of the water level in the well to static conditions. If the recovery of the water level in the well is less than 30 minutes, only the relative order of magnitude of hydraulic conductivity will be estimated. If the recovery of the water level in the well is more than 30 minutes, then detailed calculations of the hydraulic conductivity will be conducted. These calculations will be made using the methods of Bouwer and Rice (1976) and Bouwer (1989). The field crew will conduct the slug tests using the procedures outlined in the work plan used as part of the Remedial Investigation.

3.4 Location of Injection Wells

Each injection well will be surveyed by URS. Survey will include northing, easting and elevations of ground and top of well casing.

3.5 Groundwater Sampling

The static groundwater level will be measured at each monitoring well prior to purging and sample collection. An electronic water level indicator will be used to measure the depth to the water surface, from the top of the well riser pipe, to the nearest 0.01-foot.

Groundwater samples will be collected using low-flow purging and sampling procedures. Water will be purged from each well using a low-flow peristaltic pump operated at a discharge rate of less than one (1) liter per minute. The purging rate will be maintained at a rate sufficient to prevent drawdown in excess of ten percent of the standing water column. Dedicated new discharge and intake tubing will be used for each well. The tubing inlet will be set at the midpoint of the well screen. Purging will continue until the water quality parameters have stabilized, determined by the following criteria:

- pH ± 0.10 SU
- Specific conductivity ± 3% of full scale
- Temperature ± 0.2° C

Water quality parameter readings will be recorded on low-flow purging and sampling procedures. Once purging is complete, groundwater samples will be collected using the peristaltic pump. Groundwater samples will be analyzed for the parameters listed in Table 2-1.

3.6 Chain of Custody and Shipping

Chain of Custody (COC) procedures will be used to ensure the custody and integrity of the samples from the time of sampling and continuing through transport, sample receipt, preparation, analysis, storage, reporting, and sample disposal. Records concerning the custody and condition of the samples will be maintained in the field and laboratory records. Information on the custody, transfer, and shipping of samples will be recorded on COC forms that will be initiated in the field by the sampler. Each COC form will include the following information:

- Project Number
- Site name
- Name of sampler(s)
- Unique sample identification
- Date and time of sample collection
- Sample type
- Preservative used
- Analytical requirements
- Method of shipment
- Custody transfer signatures and the dates and times of sample transfer from the field to the transporter and to the laboratory.

Samples collected in the field will be transported in coolers to the laboratory as expeditiously as possible. The samples will be packed with ice or freezer packs to maintain a temperature of 4° C.

3.7 Field Documentation

Field activities will be documented using field notebooks, photographs, and standard field forms. Field notebooks will serve as the primary record of activities at the site. Field notebooks will be bound with consecutively numbered pages. All entries into the notebook will contain a variety of information including: dates, times, weather, personnel at the site and affiliations, equipment being used, level of personnel protective equipment, instrument calibration, drilling information, sampling/measurement data, and any other relevant information. If any incorrect entry is made, the information will be crossed out with a single strike mark and initialed. Field notebooks will be stored in a project file when not in use.

4.0 DATA ANALYSIS AND REPORTING

A bioremediation pilot study report will be prepared under Subtask 3.4 of Work Assignment D003825-61 at the completion of the pilot test. The report will include the following:

1. Drilling Data
   a.) Boring logs
   b.) Well construction diagrams
   c.) Well development logs
   d.) Well purging and sampling logs
2. EOS™ Injection Data
   a.) Product data
   b.) Injection method
   c.) Injection parameters (interval, amount, and pressure)
3. Monitoring Data
   a.) Groundwater surface elevations
   b.) Chemical analytical data
   c.) Geochemical data (attenuation parameters)
4. Data Evaluation and Results
   a.) Temporal variations of contaminant concentrations
   b.) Geochemical and biological condition of aquifer
   c.) Biodegradation decay rates (if applicable)
5. Conclusions and Recommendations

A short monitoring report will be prepared after each monitoring event. These reports will summarize analytical results and water level data.

5.0 SCHEDULE

The proposed bioremediation pilot study schedule is presented on Table 5-1.

TABLES

TABLE 2-1

MONITORING/SAMPLING SCHEDULE
CHEM CORE SITE (ID# 9-15-176), BUFFALO, NY
BIOREMEDIATION PILOT STUDY
GROUNDWATER MONITORING SCHEDULE

Parameter	Method Number/ References[1]	Number of Samplers per Event	Number of Events	QA/QC Samples				Total No. of Samples
				MS/MSD/MD	Field Duplicates	Equipment Rinse Blanks	Trip Blanks	
TCL Volatiles	OLM04.2	8	4	4/4/0	0	4	8	52
Nitrate/Nitrite	9056	8	4	4/4/0	0	0	0	40
Total Kjeldahl Nitrogen	351.3	8	4	4/4/0	0	0	0	40
Ammonia	SM4500_NH3	8	4	4/4/0	0	0	0	40
Chloride	9056	8	4	4/4/0	0	0	0	40
Sulfate	9056	8	4	4/4/0	0	0	0	40
Total Iron	ILM04.1	8	4	4/0/4	0	0	0	40
Dissolved Iron	ILM04.1	8	4	4/0/4	0	0	0	40
TOC	415	8	4	0/0/0	0	0	0	32
Alkalinity	310	8	4	0/0/0	0	0	0	32
Ferric Iron (Fe^{+3})	calculation*	8	4	0/0/0	0	0	0	32
Ferrous Iron (Fe^{+2})	field	8	4	0/0/0	0	0	0	32
Methane, ethane, ethene	RSK-175	8	4	4/4/0	0	0	0	40
pH	Field	8	12	0/0/0	0	0	0	96
Temperature	Field	8	12	0/0/0	0	0	0	96
Dissolved Oxygen	Field	8	12	0/0/0	0	0	0	96
Redox Potential	Field	8	12	0/0/0	0	0	0	96
Conductivity	Field	8	12	0/0/0	0	0	0	96

***URS must provide results for Ferrous Iron from the field testing.**

Notes:
1) NYSDEC Analytical Services Protocol, June 2000

Field – Field Personnel will perform Analysis
TCL – Target Compound List
MS/MSD/MD – Matrix Spike/Matrix Spike Duplicate/Matrix Duplicate

TABLE 5-1

PILOT STUDY PROJECT SCHEDULE

Work Element	Duration (Weeks)	Completion Date
Submit Draft Work Plan		February 21, 2005
NYSDEC Review Draft Work Plan		February 28, 2005
Submit Final Work Plan		March 4, 2005
Perform Baseline Sampling		March 7, 2005
Install Injection Wells		March 11, 2005
Inject EOS™		March 18, 2005
Submit First Monitoring Report		April 20, 2005
Groundwater Monitoring (Round 1)		May 18, 2005
Submit Second Monitoring Report		July 6, 2005
Groundwater Monitoring (Round 2)		September 16, 2005
Submit Third Monitoring Report		November 2, 2005
Groundwater Monitoring (Round 3) – Complete Program		March 17, 2006
Submit Fourth Monitoring Report		April 28, 2006
Submit Pilot Study Report		June 2, 2006

FIGURES

J:\35890.00\GIS\chemical.apr BIOREMEDIATION INJECTION LOCATIONS
1/11/2005

N

BLACK ROCK CANAL

NYS THRUWAY (I-190)

(SOUTHBOUND LANE)

(NORTHBOUND LANE)

FORMERLY PENN-CENTRAL/NEW YORK CENTRAL RAILROAD

NIAGARA STREET

WEST DELAVAN AVENUE

1 STY. BRICK BUILDING

2 STY BRICK AND CONC. BLOCK BUILDING

CHEM-CORE 2 STY. BRICK AND CONC. BLOCK BUILDING

SUMP (TYP.)

FORMERLY MENTHOLATUM INC. (BRICK BUILDING)

GARRETT LEATHER CORP.

PARKING LOT

MW-01S
MW-01D
MW-02
MW-03
MW-04D
MW-04S
MW-05
MW-06
MW-07
MW-08D
MW-08S
MW-09
MW-10
MW-11
MW-12
MW-14
MW-15
MW-16
MW-17
MW-18

PZ-1

FORMER PCE TANK

Legend

- Proposed Bioremediation Injection Location
- Proposed Monitoring Well
- Existing Monitoring Well
- Existing Piezometer

60 0 60 Feet

URS

CHEM CORE
CONCEPTUAL GROUNDWATER PILOT TEST PLAN
FOR IN-SITU BIOREMEDIATION

FIGURE 2-1

APPENDIX 2A

BIOREMEDIATION PRODUCT ANALYSIS

URS
77 Goodell Street
Buffalo, New York 14203
(716) 856-5636

CALCULATION COVER SHEET

Client: NYSDEC Project Name: Chem-Core Site

Project / Calculation Number: Bioremediation Pilot Study Work Plan/Rev_01

Title: HRC™ and EOS™ Injection Calculation

Total number of pages (including cover sheet): 64

Total number of computer runs: 0

Prepared by: Jim Stachowski Date: 16-Feb-05

Checked by: CRAIG PAWLEWSKI Date: 2/17/05

Description and Purpose: Estimate the amount of HRC™ and EOS™ to inject in a portion of a chlorinated hydrocarbon plume in groundwater at the Chem-Core Site, Buffalo, New York.

Design bases / references / assumptions: See Calculation Pages 1 and 2

Remarks / conclusions:

Amount of HRC™ required = 765 lbs (71 gals.)

Amount of EOS™ required = 844 lbs (110 gals.)

Calculation Approved by: 3/17/2005
Project Manager / Date

Revision No:	Description of Revisions	Approved by:
		Project Manager / Date

1.0 Purpose

This calculation estimates the amount of Hydrogen Release Compound (HRC™), manufactured by Regenesis Bioremediation Products, and Edible Oil Substrate, (EOS™), manufactured by EOS Remediation, Inc. to inject in a portion of a chlorinated hydrocarbon plume in groundwater at the Chem-Core Site in Buffalo, New York. Either substrate may be used for a pilot study to evaluate its effectiveness towards enhancing intrinsic bioremediation of hydrocarbons in the plume.

2.0 Data and Assumptions

2.1 Data

- Target compounds are Tetrachloroethylene, Trichloroethylene, cis-1,2 Dichloroethylene, trans-1,2 Dichloroethylene, and Vinyl Chloride. Contaminant concentrations are summarized on Pages 18 and 19 (Ref. 1).
- Contaminated groundwater occurs within fractured bedrock of the Akron Dolostone and Bertie Formation (Ref. 2).
- Transmissivity of the bedrock is estimated to range between 60 ft^2/day to 260 ft^2/day (Ref. 1).
- Groundwater flow direction appears to be northeast (at the pilot study area) at a gradient of approximately 0.003 ft/ft (refer to Pages 10 and 11) (Ref. 1).

2.2 Assumptions

- The pilot study will target dissolved phase contamination in groundwater.
- The pilot study will be conducted within an area of approximately 4,000 ft^2 that is located south of the Chem-Core Site and Gannett Leather Corp. building, shown on Page 41 (Ref. 3).
- The substrate will be installed using twenty-four (24) injection points constructed with grouted steel casing in the overburden and rock surface and an open rock intake within the bedrock, located between approximately 22 feet below ground surface (bgs) to 40 feet bgs (Ref. 4). The injection points will be spaced at a nominal distance of 15 feet, as shown on Page 41 (Ref. 3).
- The total and effective porosity of the Akron Dolostone and Bertie formation is estimated at 0.02 and 0.01, respectively. (Ref. 5).
- The mass of dissolved phase contamination in groundwater is estimated using analytical data from September 2004 (Ref. 1).
- The dissolved oxygen concentration in groundwater is estimated using field data from September 2004 (Ref. 1).
- The sulfate and nitrate concentrations in groundwater are estimated using analytical data from December 2004 (Ref. 6).

- The potential amount of Fe^{+2} formed is estimated using the average concentration of 16 samples from January 2002 (Ref. 2).

- The potential amount of Mn^{+2} formed is estimated using the average concentration of 2 samples from October 2001(Ref. 2).

3.0 Calculations

The amount of HRC™ and EOS™ to be injected in the pilot study area is determined using the estimated mass of dissolved contamination and contaminant flux through the study area for a period of one year.

3.1 HRC™ Amount and Application Rate

The amount of HRC™ is calculated using HRC Design Software (U.S. Version 2.0) developed by Regenesis Bioremediation Products and modified by URS Corporation (November, 2004).

The HRC™ calculation is provided on Pages 4 and 5. Results are summarized below.

HRC™ required:

765 lbs (approximately 71 gals).

31.9lbs/injection point (approximately 2.9-gal/point).

1.8lbs/ft (approximately 0.2 gal/ft).

3.2 EOS™ Amount and Application Rate

The amount of EOS™ is calculated using Emulsified Edible Oil Barrier Design Software, Beta Version 1.3 developed by EOS Remediation, Inc. and modified by URS Corporation (November 2004).

The EOS™ calculation is provided on Page 6. Results are summarized below.

EOS™ calculated = 422lbs (55 gals).

A safety factor of 2 is applied to account for unused material due to storage capacity (unknown) of the open rock holes at each injection point. Therefore, the amount of EOS™ that will be used is:

EOS™ required = 844lbs (approximately 110 gals).

EOS™ will be diluted with water at a ratio of 33.3: 1 (water volume: EOS™ volume).

The total amount of dilute EOS™ required =

(3,660 gals of water) + (110 gals of EOS™) = 3,770 gals.

157-gal/injection point (approximately 8.7-gal/ft.)

3.3 Material Costs

Estimated material costs are provided below.

Substrate	Quantity	Cost Estimate	Reference
HRC™	765 lbs	$6,055	HRC Design Software (U.S. Version 3.1, November 2004), unit price = $7.00/lb + shipping (est. $700).
EOS™	2 drums	$3,010	EOS Remediation, Inc. Quotation 598 B42, November 15, 2004 (Ref. 7) + 10% contingency + shipping (est. 700).

4.0 REFERENCES

1. URS Corporation. 2004. *Remedial Design Investigation Report, Chem-Core Site, Site #9-15-176, Buffalo, New York. Final.* December. Buffalo, New York.

2. URS Corporation Group Consultants. 2002. *Phase I & II Remedial Investigation Report, Chem-Core Site, Site #9-15-176, Buffalo, New York.* July. Buffalo, New York.

3. URS Corporation. No Date. Figure 2-1, Chem Core Conceptual Groundwater Pilot Test Plan For In-Situ Bioremediation.

4. URS Corporation. 2004. *Project Work Plan and Budget Estimate, Chem Core Site, Site #9-15-176, Buffalo, New York.* June. Buffalo, New York.

5. USEPA. 1998. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water.* EPA/600/R-98/128. September. Washington, DC.

6. _____. 2004. Laboratory Results, Lab Order 0412082. December . Lancaster, New York.

7. EOS Remediation, Inc. 2004. Quotation # EOS04115P. November 15. Raleigh, North Carolina.

HRC Design Software for Plume Area/Grid Treatment

Modified by URS Corp., Nov. 12, 2004

Regenesis Technical Support: USA (949) 366-8000, www.regenesis.com

Site Name: Chem Core
Location: Buffalo, New York
Consultant: URS Corporation

Product Information

Pure HRC H_2 Yield	22.5	lb HRC/lb H_2
HRC capacity to supply hydrogen	45	lb HRC/lb H_2
Density of HRC	1.3	g/cm^3
	10.8	lb/gal
	30.0	lb per bucket

Site Conceptual Model/Extent of Pilot Study Area

					Reference/Notes
Width of plume (intersecting gw flow direction) [W]	50	ft			Ref. 3
Length of plume (parallel to gw flow direction) [L]	80	ft	=	4,000 sq. ft.	Ref. 3
Depth to contaminated zone [d]	22	ft			Ref. 4
Thickness of contaminated saturated zone [b]	18	ft			Ref. 4
Aquifer matrix	bedrock				Ref. 2
Total porosity [n]	0.02		Eff. porosity:	0.01	Ref. 5
Transmissivity (T)	260	ft^2/day	=	2.8E+00 cm^2/sec	Ref. 1
Hydraulic gradient (i)	0.003	ft/ft			Ref. 1
Groundwater flow rate (T*W*i)	39	ft^3/day,		292 gal/day	
Treatment zone pore volume (v)	1,440	ft^3	=	10,773 gallons	

Dissolved Phase Electron Donor Demand - Pilot Study Area

Contaminants	Conc (mg/L)	Mass (lb)	Stoich. (wt/wt) Contam/H_2	H_2 Req. (lb)	Reference/Notes
Tetrachloroethene (PCE)	1.40	0.1	20.7	0.01	Ref. 1
Trichloroethene (TCE)	0.20	0.0	21.9	0.00	Ref. 1
cis-1,2-dichloroethene (DCE)	0.41	0.0	24.2	0.00	Ref. 1
trans-1,2-dichloroethene (DCE)	0.004	0.0	24.2	0.00	Ref. 1
Vinyl Chloride (VC)	0.003	0.0	31.2	0.00	Ref. 1
Carbon tetrachloride		0.0	19.2	0.00	
Chloroform	0.001	0.0	19.9	0.00	Ref. 1
1,1,1-Trichloroethane (TCA)		0.0	22.2	0.00	
1,1-Dichlorochloroethane (DCA)		0.0	24.7	0.00	
Hexavalent Chromium		0.0	17.3	0.00	
Subtotal		0.2		0.01	

Competing Electron Acceptors	Electron Acceptor Conc (mg/L)	Mass (lb)	Stoich. (wt/wt) elec acceptor/H_2	H_2 Req. (lb)	Reference/Notes
Oxygen	0	0.00	8.0	0.00	Ref. 1
Nitrate	0.5	0.04	12.4	0.00	Ref. 6
Est. Mn reduction demand (potential amt of Mn2+ formed)	0.10	0.01	27.5	0.00	Ref. 2
Est. Fe reduction demand (potential amt of Fe2+ formed)	1.50	0.13	55.9	0.00	Ref. 2
Estimated sulfate reduction demand	100	8.98	12.0	0.75	Ref. 6
Subtotal		9.2		0.8	

Pilot Study Area Flux

Treatment Period: 1 yr

Contaminants	Conc (mg/L)	Flux (lb/day)	Mass (lb)	Stoich. (wt/wt) contam/H_2	H_2 Req. (lb)	Reference/Notes
Tetrachloroethene (PCE)	1.40	0.00	1.24	20.7	0.06	Ref. 1
Trichloroethene (TCE)	0.20	0.000	0.18	21.9	0.01	Ref. 1
cis-1,2-dichloroethene (DCE)	0.41	0.001	0.36	24.2	0.02	Ref. 1
trans-1,2-dichloroethene (DCE)	0.004	0.000	0.00	24.2	0.0001	Ref. 1
Vinyl Chloride (VC)	0.003	0.00001	0.00	31.2	0.0001	Ref. 1
Carbon tetrachloride		0.00		19.2		
Chloroform	0.001	0.00000	0.001	19.9	0.0000	Ref. 1
1,1,1-Trichloroethane (TCA)		0.00		22.2		
1,1-Dichlorochloroethane (DCA)		0.00		24.7		
Hexavalent Chromium		0.00		17.3		
Subtotal			1.8		0.1	

Competing Electron Acceptors	Electron Acceptor Conc (mg/L)	Flux (lb/day)	Mass (lb)	Stoich. (wt/wt) elec acceptor/H_2	H_2 Req. (lb)	Reference/Notes
Oxygen	0	0.00	0.00	8.0	0.00	Ref. 1
Nitrate	0.5	0.00	0.44	12.4	0.04	Ref. 6
Est. Mn reduction demand	0.10	0.00	0.09	27.5	0.00	Ref. 2
Est. Fe reduction demand	1.50	0.00	1.33	55.9	0.02	Ref. 2
Estimated sulfate reduction demand	100	0.24	88.89	12.0	7.41	Ref. 6
Subtotal			90.8		7.5	

Microbial Demand Factor	2	Recommend 1-4x
Safety Factor (SF)	2	Recommend 1-4x

HRC Design Software for Plume Area/Grid Treatment

Modified by URS Corp., Nov. 12, 2004

Regenesis Technical Support: USA (949) 366-8000, www.regenesis.com

Site Name: Chem Core
Location: Buffalo, New York
Consultant: URS Corporation

Hydrogen Requirements			HRC Requirements		
Pilot Study Area					
Contaminants	0.01 lb	Contaminants	0.4 lb	0.04	gal.
CEAs	0.75 lb	CEAs	34.0 lb	3.13	gal.
Pilot Study Area Flux					
Contaminants	0.1 lb	Contaminants	3.8 lb	0.35	gal.
CEAs	7.5 lb	CEAs	336.2 lb	31.02	gal.
Microbial Demand					
	0.2 lb		8.3 lb	0.76	gal.
		Total HRC	383 lb	35.30	gal.
		Total w/ SF	765 lb	70.59	gal.

Injection Point Spacing and Dose

Injection spacing within rows (ft)	15.0	# of rows:	5		
Injection spacing between rows (ft)	15.0	Total # of points:	24		
points per row	4.8	HRC dose per point	31.9 lb	2.9	gal.
		HRC dose per foot	1.8 lb	0.16	gal.

EOS Remediation, Inc.

Emulsified Edible Oil Barrier Design Software

Beta Version 1.3 (Modified by URS Corp. Nov. 15, 2004)
www.eosremediation.com

Site Name:	Chem Core Site
Location:	Buffalo, New York
Project No.:	11173755.93000

Design Inputs

Width of proposed barrier perpendicular to groundwater flow	50	ft	15.2	m	

Groundwater Flow Rate/ Site Data

Minimum depth to contamination	22	ft	6.7	m	
Maximum depth of contamination	40	ft	12.2	m	
Treatment thickness	18	ft	5.5	m	
Surface area of barrier face	900	ft^2	84	m^2	
Soil Characteristics					
Aquifer Matrix	rock				
Hydraulic Characteristics					
Total Porosity (n)	0.02	(decimal)			
Effective Porosity (n_e)	0.01	(decimal)			
Transmissivity (T)	260	ft^2/day	2.8E+00	cm^2/sec	
Hydraulic Gradient (i)	0.003	ft/ft			
Groundwater flowrate through barrier (Q)	39	ft^3/day	1.1044	m^3/day	1,104 L/day

Design Lifespan For One Application 1 year(s)

Electron Acceptors

Inputs	GW Conc. (mg/L)	MW (g/mole)	e^- equiv./ mole	Stoichmetry Contaminant/H_2 (wt/wt H_2)	Hydrogen Demand (Flux) (g H_2/ day)	Reference
Dissolved Oxygen (DO)		32.0	4	7.94		Ref. 1
Nitrate Nitrogen (NO_3^- - N)	0.5	62.0	5	12.30	0.0448804	Ref. 6
Sulfate (SO_4^{2-})	100	96.1	8	11.91	9.2704548	Ref. 6
Tetrachloroethene (PCE), C_2Cl_4	1.4	165.8	8	20.57	0.0751774	Ref. 1
Trichloroethene (TCE), C_2HCl_3	0.2	131.4	6	21.73	0.0101664	Ref. 1
cis-1,2-dichloroethene (c-DCE), $C_2H_2Cl_2$	0.41	96.9	4	24.05	0.0188307	Ref. 1
trans-1,2-dichloroethene (t-DCE), $C_2H_2Cl_2$	0.004	96.9	4	24.05	0.0001837	Ref. 1
Vinyl Chloride (VC), C_2H_3Cl	0.003	62.5	2	31.00	0.0001069	Ref. 1
Carbon tetrachloride, CCl_4		153.8	8	19.08		
Chloroform, $CHCl_3$	0.001	119.4	6	19.74	5.595E-05	Ref. 1
sym-tetrachloroethane, $C_2H_2Cl_4$		167.8	8	20.82		
1,1,1-Trichloroethane (TCA), CH_3CCl_3		133.4	6	22.06		
1,1-Dichloroethane (DCA), CH_2CHCl_2		99.0	4	24.55		
Chloroethane, C_2H_5Cl		64.9	2	32.18		
Perchlorate, ClO_4^-		99.4	8	12.33		
Hexavalent Chromium, Cr[VI]		52.0	3	17.20		
User added						
User added						
User added						

Generation (Potential Amount Formed)	Recommended Range	GW Conc. (mg/L)	MW (g/mole)	e^- equiv./ mole	Stoichmetry Contaminant/H_2 (wt/wt H_2)	Flux (g H_2/ day)	DOC Flux (moles/day)	Reference
Estimated Amount of Fe^{2+} Formed		1.5	55.8	1	55.41	0.0298985		Ref. 2
Estimated Amount of Manganese (Mn^{2+}) Formed		0.1	54.9	2	27.25	0.0040523		Ref. 2
Estimated Amount of CH_4 Formed		15	16.0	8	1.99	8.3262467		Estimate
Target Amount of DOC to Release		100	12.0				9.2	Default value

Note:

Calculations assume:

1.) that all reactions go to completion during passage through emulsified edible oil treated zone; and,

2.) perfect reaction stoichiometry.

Stoichiometric Hydrogen Demand 14 pounds

DOC Released 115 pounds

EOS® Concentrate Requirement 1 drums / 422 lbs.

(Note: drum size is 55-gal. and s.g. of EOS® is 0.92)

Emulsion Makeup

Concentrate : Water Ratio 1 Part EOS® Concentrate to	4	water	Minimum Value = 4; typical values 4 to 10	
Approximate Quantity of Emulsified edible oil substrate formed	2,100	pounds	275	gallons
Number of Injection Points and Dose:				
Spacing between injection points	15	ft on center spacing within rows between injection points (typical values 5 to 15)		
Overlap between injections, percent	25%	typical values 25 to 50%		
Number of injection points	24	points		
Emulsified edible oils injected per point	88	pounds	11.5	gallons
Cost of EOS®	Call for price quote			

Injection zone diameter	18.75	feet
Pore volume per injection point	372	gallons
Displacement flush pore volumes	0.17	
Displacement flush volume per point	50	gallons
Total injection volume per injection point	61	gallons

Reference 1

Ref. 1

8/63

REMEDIAL DESIGN INVESTIGATION REPORT

CHEM-CORE SITE

SITE # 9-15-176

BUFFALO, NEW YORK

Prepared For:

NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DIVISION OF ENVIRONMENTAL REMEDIATION

WORK ASSIGNMENT D003825-61

Prepared By:

URS CORPORATION

77 GOODELL STREET

BUFFALO, NEW YORK 14203

DRAFT

DECEMBER 2004

gradient is toward the north and west. The northerly component of groundwater flow may have been induced as part of the 72-hour pumping test. Figure 3-2 depicts the potentiometric surface at the site as nearly flat. There is a westward component to the gradient from the site toward the canal. South of the Garrett Leather Corp. building, the gradient is toward the north, but only slightly and less than that measured on September 10, 2004. Near MW-12, the gradient is nearly flat.

During the RI, wide ranges of hydraulic conductivities were estimated from slug tests. This is indicative of the aquifer's heterogeneity and the anisotropic nature of the fractured bedrock. The hydraulic conductivities ranged from negligible (i.e., estimated to be less than 10^{-6} cm/second in several wells) to 5.7 x 10^{-3} cm/second in MW-4S.

During the RDI, hydraulic conductivities of the newly installed bedrock monitoring wells and the extraction well (i.e., EX-01) were estimated by conducting slug tests. Tests were performed by inserting (falling head test) or removing (rising head test) a stainless steel slug of known volume and recording the rate of recovery of the water level in the well. Recovery data was gathered with an In-Situ down-hole data logger. The slug test data was analyzed using the methods of Bouwer and Rice (1976) and/or Bouwer (1989). Because the method of analyses assumes that the aquifer is a porous media, the values obtained by the methods should be considered as relative order of magnitude estimates. Results were consistent with those observed during the RI. The hydraulic conductivities range from 3.7 E-2 cm/second in well EX-01 to 2.2 E –4 cm/second in well MW-17. Likewise, the well transmissivities ranged from 2,535 square feet per day (ft^2/d) in well EX-01 to14 ft^2/d in well MW-17. Table 3-2 summarizes the hydraulic conductivity results. Appendix E presents all of the raw data.

The analysis of the aquifer test performed on EX-01 indicates the transmissivity of the water-bearing zone at the Chem Core site ranges from 60 to 260 square feet per day (ft^2/d). Storativity of the aquifer is estimated to range from 0.013 to 0.0060. Ranges are given because the aquifer responses observed did not fit any single coherent aquifer model. Two possible models were used to estimate the aquifer transmissivity. One model assumes the aquifer is limited by a no-flow barrier along the Black Rock Canal, possibly formed by the retaining walls and/or low permeability fill materials located along the canal. The other model assumes there is a

J:\Projects\GIS\geology.apr 09/10/04 GROUNDWATER ELEVATIONS
11/18/2004

URS	CHEM CORE GROUNDWATER POTENTIOMETRIC SURFACE MAP (SEPTEMBER 10, 2004)	FIGURE 3-1

J:\35890.00\GIS\geology.apr 12/06/04 GROUNDWATER ELEVATIONS
12/13/2004

URS

CHEM CORE
GROUNDWATER POTENTIOMETRIC SURFACE MAP (DECEMBER 6, 2004)

FIGURE 3-2

11/03

TABLE 4-3
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CHEM-CORE

Location ID			EX-01	MW-01D	MW-01S	MW-02	MW-02
Sample ID			EX-01-WG	MW-01D-WG	MW-01S-WG	MW-02-WG	MW-20-WG
Matrix			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Depth Interval (ft)			-	-	-	-	- -
Date Sampled			09/11/04	09/10/04	09/10/04	09/10/04	09/10/04
							Field Duplicate (1-1)
Parameter	**Units**	**Criteria***					
Volatiles							
1,1,1-Trichloroethane	UG/L	5	5,000 D	15	530 D	3,000 D	3,000
1,1,2-Trichloro-1,2,2-trifluoroethane	UG/L	5	5 J	10 U	10 U	10 U	200 U
1,1,2-Trichloroethane	UG/L	1	10 U	10 U	10 U	10 U	200 U
1,1-Dichloroethane	UG/L	5	510 DJ	10	280 D	720 D	660
1,1-Dichloroethene	UG/L	5	470 DJ	10 U	61	320 DJ	340
1,2-Dichlorobenzene	UG/L	3	4 J	10 U	10 U	2 J	200 U
1,2-Dichloroethane	UG/L	0.6	280 J	10 U	14	160	200 U
1,2-Dichloropropane	UG/L	1	7 J	10 U	10 U	7 J	200 U
4-Methyl-2-pentanone	UG/L	NS	4 J	10 U	10 U	2 J	200 U
Acetone	UG/L	50	18 J	10 UJ	11 J	10 UJ	200 UJ
Benzene	UG/L	1	14	10 U	3 J	30	22 J
Carbon disulfide	UG/L	60	10 U	10 U	10 U	10 U	200 U
Chlorobenzene	UG/L	5	1 J	10 U	10 U	10 U	200 U
Chloroethane	UG/L	5	10 U	10 U	10 U	10 U	200 U
Chloroform	UG/L	7	200 DJ	10 U	10	140	110 J
cis-1,2-Dichloroethene	UG/L	-	7,200 D	49	2,100 D	6,400 D	6,200 D
Ethylbenzene	UG/L	5	14	10 U	10 U	8 J	20 U
Methyl tert-butyl ether	UG/L	10	10 U	10 U	10 U	1 J	200 U
Methylene chloride	UG/L	5	320 DJ	10 U	28	170	150 J
Tetrachloroethene	UG/L	5	16,000 D	2 J	84	9,400 D	9,300 D
Toluene	UG/L	5	490 DJ	10 U	7 J	780 D	760
trans-1,2-Dichloroethene	UG/L	-	64	10 U	16	64	45 J

*Criteria- NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. June 1998 (includes 4/2000 Addendum). Class GA

Flags assigned during chemistry validation are shown.

Concentration Exceeds Criteria

U - The analyte was analyzed for, but not detected. The associated numerical value is at or below the method detection limit.

J - The analyte was positively identified, the quantitation is an estimation.

D - Value based on sample dilution.

Only Detected Results Reported.

Detection Limits shown are MDL

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[MATRIX] = 'WG' AND [LOGDATE] >= #07/14/04#

TABLE 4-3
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CHEM-CORE

Location ID			EX-01	MW-01D	MW-01S	MW-02	MW-02
Sample ID			EX-01-WG	MW-01D-WG	MW-01S-WG	MW-02-WG	MW-20-WG
Matrix			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Depth Interval (ft)			-	-	-	-	-
Date Sampled			09/11/04	09/10/04	09/10/04	09/10/04	09/10/04
Parameter	Units	Criteria*					Field Duplicate (1-1)
Volatiles							
Trichloroethene	UG/L	5	15,000 D	5 J	170 DJ	7,800 D	7,800 D
Vinyl chloride	UG/L	2	640 DJ	11	590 D	2,100 D	2,000
Xylene (Total)	UG/L	5	160	10 U	10 U	62	200 U

*Criteria- NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, June 1998 (includes 4/2000 Addendum). Class GA

Flags assigned during chemistry validation are shown.

(oval) Concentration Exceeds Criteria

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D - Value based on sample dilution.

Only Detected Results Reported.

Detection Limits shown are MDL

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[MATRIX] = 'WG' AND [LOGDATE] >= #07/14/04#

TABLE 4-3
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CHEM-CORE

Location ID			MW-03	MW-04D	MW-04S	MW-05	MW-06
Sample ID			MW-03-WG	MW-04D-WG	MW-04S-WG	MW-05-WG	MW-06-WG
Matrix			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Depth Interval (ft)			-	-	-	-	-
Date Sampled			09/10/04	09/08/04	09/08/04	09/07/04	09/11/04
Parameter	Units	Criteria*					
Volatiles							
1,1,1-Trichloroethane	UG/L	5	200	10 U	10 U	10 U	900 DJ
1,1,2-Trichloro-1,2,2-trifluoroethane	UG/L	5	10 U	10 U	10 U	10 U	10 U
1,1,2-Trichloroethane	UG/L	1	10 U	10 U	10 U	10 U	3 J
1,1-Dichloroethane	UG/L	5	16	10 U	10 U	2 J	5,300 D
1,1-Dichloroethene	UG/L	5	29	10 U	10 U	10 U	210 DJ
1,2-Dichlorobenzene	UG/L	3	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethane	UG/L	0.6	10 U	10 U	10 U	10 U	65
1,2-Dichloropropane	UG/L	1	10 U	10 U	10 U	10 U	10 U
4-Methyl-2-pentanone	UG/L	NS	10 U	10 U	10 U	10 U	3 J
Acetone	UG/L	50	10 UJ	10 UJ	10 UJ	10 UJ	100 J
Benzene	UG/L	1	10 U	10 U	10 U	10 U	18
Carbon disulfide	UG/L	60	10 U	10 U	10 U	10 U	2 J
Chlorobenzene	UG/L	5	10 U	10 U	10 U	10 U	10 U
Chloroethane	UG/L	5	10 U	10 U	10 U	10 U	10 U
Chloroform	UG/L	7	6 J	10 U	10 U	10 U	48
cis-1,2-Dichloroethene	UG/L	-	170 DJ	10 U	10 U	6 J	27,000 D
Ethylbenzene	UG/L	5	10 U	10 U	10 U	10 U	7 J
Methyl tert-butyl ether	UG/L	10	10 U	10 U	10 U	2 J	10 U
Methylene chloride	UG/L	5	10 U	10 U	10 U	10 U	350 DJ
Tetrachloroethene	UG/L	5	2,000 D	10 U	10 U	10 U	29
Toluene	UG/L	5	10 U	10 U	10 U	10 U	270 DJ
trans-1,2-Dichloroethene	UG/L	-	2 J	10 U	10 U	10 U	250 J

*Criteria- NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. June 1998 (includes 4/2000 Addendum). Class GA.

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Only Detected Results Reported.

Detection Limits shown are MDL

TABLE 4-3
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CHEM-CORE

Location ID			MW-03	MW-04D	MW-04S	MW-05	MW-06
Sample ID			MW-03-WG	MW-04D-WG	MW-04S-WG	MW-05-WG	MW-06-WG
Matrix			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Depth Interval (ft)			-	-	-	-	-
Date Sampled			09/10/04	09/08/04	09/08/04	09/07/04	09/11/04
Parameter	Units	Criteria*					
Volatiles							
Trichloroethene	UG/L	5	390 D	10 U	10 U	1 J	130
Vinyl chloride	UG/L	2	9 J	10 U	3 J	2 J	5,900 D
Xylene (Total)	UG/L	5	10 U	10 U	10 U	10 U	180

*Criteria- NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. June 1998 (includes 4/2000 Addendum). Class GA.

Flags assigned during chemistry validation are shown.

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J - The analyte was positively identified, the quantitation is an estimation.

D - Value based on sample dilution.

Only Detected Results Reported.

Detection Limits shown are MDL

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[MATRIX] = 'WG' AND [LOGDATE] >= #07/14/04#

TABLE 4-3
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CHEM-CORE

Location ID			MW-07	MW-08D	MW-08S	MW-09	MW-10
Sample ID			MW-07-WG	MW-08D-WG	MW-08S-WG	MW-09-WG	MW-10-WG
Matrix			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Depth Interval (ft)			-	-	-	-	-
Date Sampled			09/11/04	09/09/04	09/09/04	09/08/04	09/08/04
Parameter	Units	Criteria*					
Volatiles							
1,1,1-Trichloroethane	UG/L	5	490	10 J	10 UJ	10 U	10 U
1,1,2-Trichloro-1,2,2-trifluoroethane	UG/L	5	100 U	10 U	10 U	10 U	10 U
1,1,2-Trichloroethane	UG/L	1	100 U	10 U	10 U	10 U	10 U
1,1-Dichloroethane	UG/L	5	1,600	83	10 U	10 U	10 U
1,1-Dichloroethene	UG/L	5	94 J	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	UG/L	3	100 U	10 U	10 U	10 U	10 U
1,2-Dichloroethane	UG/L	0.6	100 U	10 U	10 U	10 U	10 U
1,2-Dichloropropane	UG/L	1	100 U	10 U	10 U	10 U	10 U
4-Methyl-2-pentanone	UG/L	NS	100 U	10 U	10 U	10 U	10 U
Acetone	UG/L	50	100 UJ	10 U	10 U	10 UJ	10 UJ
Benzene	UG/L	1	100 U	10 U	10 U	10 U	10 U
Carbon disulfide	UG/L	60	100 U	10 U	10 U	10 U	10 U
Chlorobenzene	UG/L	5	100 U	10 U	10 U	10 U	2 J
Chloroethane	UG/L	5	100 U	9 J	10 U	10 U	6 J
Chloroform	UG/L	7	46 J	10 U	10 U	10 U	10 U
cis-1,2-Dichloroethene	UG/L	-	7,000 D	5 J	140	10 U	10 U
Ethylbenzene	UG/L	5	100 U	10 U	10 U	10 U	10 U
Methyl tert-butyl ether	UG/L	10	100 U	10 U	10 U	10 U	10 U
Methylene chloride	UG/L	5	44 J	10 U	10 U	10 U	10 U
Tetrachloroethene	UG/L	5	360	10 U	180	10 U	10 U
Toluene	UG/L	5	39 J	10 U	10 U	10 U	10 U
trans-1,2-Dichloroethene	UG/L	-	35 J	2 J	1 J	10 U	10 U

*Criteria- NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. June 1998 (includes 4/2000 Addendum). Class GA.

Flags assigned during chemistry validation are shown.

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D - Value based on sample dilution.

Only Detected Results Reported.

Detection Limits shown are MDL

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[MATRIX] = 'WG' AND [LOGDATE] >= #07/14/04#

TABLE 4-3
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CHEM-CORE

Location ID			MW-07	MW-08D	MW-08S	MW-09	MW-10
Sample ID			MW-07-WG	MW-08D-WG	MW-08S-WG	MW-09-WG	MW-10-WG
Matrix			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Depth Interval (ft)			-	-	-	-	-
Date Sampled			09/11/04	09/09/04	09/09/04	09/08/04	09/08/04
Parameter	Units	Criteria*					
Volatiles							
Trichloroethene	UG/L	5	480	10 U	30	10 U	10 U
Vinyl chloride	UG/L	2	2,200 D	13	5 J	10 U	10 U
Xylene (Total)	UG/L	5	100 U	10 U	10 U	10 U	10 U

*Criteria- NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. June 1998 (includes 4/2000 Addendum). Class GA

Flags assigned during chemistry validation are shown.

Concentration Exceeds Criteria

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J - The analyte was positively identified, the quantitation is an estimation.

D - Value based on sample dilution.

Only Detected Results Reported.

Detection Limits shown are MDL

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[MATRIX] = 'WG' AND [LOGDATE] >= #07/14/04#

TABLE 4-3
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CHEM-CORE

Location ID			MW-11	MW-12	MW-13D	MW-13D	MW-13S
Sample ID			MW-11-WG	MW-12-WG	MW-13D-WG	MW-19-WG	MW-13S-WG
Matrix			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Depth Interval (ft)			-	-	-	-	-
Date Sampled			09/10/04	09/08/04	09/07/04	09/07/04	09/07/04
Parameter	Units	Criteria*				Field Duplicate (1-1)	
Volatiles							
1,1,1-Trichloroethane	UG/L	5	210 D	10 U	10 U	10 U	10 U
1,1,2-Trichloro-1,2,2-trifluoroethane	UG/L	5	10 U	10 U	10 U	10 U	170 D
1,1,2-Trichloroethane	UG/L	1	10 U	10 U	10 U	10 U	10 U
1,1-Dichloroethane	UG/L	5	54	10 U	10 U	10 U	10 U
1,1-Dichloroethene	UG/L	5	37	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	UG/L	3	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethane	UG/L	0.6	10 U	10 U	10 U	10 U	10 U
1,2-Dichloropropane	UG/L	1	10 U	10 U	10 U	10 U	10 U
4-Methyl-2-pentanone	UG/L	NS	10 U	10 U	10 U	10 U	10 U
Acetone	UG/L	50	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ
Benzene	UG/L	1	1 J	10 U	10 U	10 U	10 U
Carbon disulfide	UG/L	60	10 U	10 U	10 U	10 U	10 U
Chlorobenzene	UG/L	5	10 U	10 U	10 U	10 U	10 U
Chloroethane	UG/L	5	10 U	10 U	10 U	10 U	10 U
Chloroform	UG/L	7	3 J	1 J	10 U	10 U	10 U
cis-1,2-Dichloroethene	UG/L	-	420 D	410 D	2 J	2 J	39
Ethylbenzene	UG/L	5	10 U	10 U	10 U	10 U	10 U
Methyl tert-butyl ether	UG/L	10	10 U	10 U	10 U	10 U	10 U
Methylene chloride	UG/L	5	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	UG/L	5	340 D	1,400 D	10 U	10 U	4 J
Toluene	UG/L	5	10 U	10 U	10 U	10 U	10 U
trans-1,2-Dichloroethene	UG/L	-	5 J	4 J	10 U	10 U	10 U

*Criteria- NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, June 1998 (includes 4/2000 Addendum). Class GA.

Flags assigned during chemistry validation are shown.

Concentration Exceeds Criteria

U - The analyte was analyzed for, but not detected. The associated numerical value is at or below the method detection limit.

J - The analyte was positively identified, the quantitation is an estimation.

D - Value based on sample dilution.

Only Detected Results Reported.

Detection Limits shown are MDL

TABLE 4-3
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CHEM-CORE

Location ID			MW-11	MW-12	MW-13D	MW-13D	MW-13S
Sample ID			MW-11-WG	MW-12-WG	MW-13D-WG	MW-19-WG	MW-13S-WG
Matrix			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Depth Interval (ft)			-	-	-	-	- -
Date Sampled			09/10/04	09/08/04	09/07/04	09/07/04	09/07/04
Parameter	Units	Criteria*				Field Duplicate (1-1)	
Volatiles							
Trichloroethene	UG/L	5	240 D	200 D	10 U	10 U	5 J
Vinyl chloride	UG/L	2	120	3 J	2 J	2 J	4 J
Xylene (Total)	UG/L	5	10 U	10 U	10 U	10 U	10 U

*Criteria- NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. June 1998 (includes 4/2000 Addendum). Class GA

Flags assigned during chemistry validation are shown.

Concentration Exceeds Criteria

U - The analyte was analyzed for, but not detected. The associated numerical value is at or below the method detection limit.

J - The analyte was positively identified, the quantitation is an estimation.

D - Value based on sample dilution.

Only Detected Results Reported.

Detection Limits shown are MDL

TABLE 4-3
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CHEM-CORE

Location ID			MW-14	MW-15	MW-16	MW-17	MW-18
Sample ID			MW-14-WG	MW-15-WG	MW-16-WG	MW-17-WG	MW-18-WG
Matrix			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Depth Interval (ft)			-	-	-	-	-
Date Sampled			09/11/04	09/09/04	09/08/04	09/08/04	09/08/04
Parameter	Units	Criteria*					
Volatiles							
1,1,1-Trichloroethane	UG/L	5	1,500 D	10 UJ	10 UJ	10 UJ	10 U
1,1,2-Trichloro-1,2,2-trifluoroethane	UG/L	5	10 U	10 U	10 U	10 U	10 U
1,1,2-Trichloroethane	UG/L	1	10 U	10 U	10 U	10 U	10 U
1,1-Dichloroethane	UG/L	5	250 DJ	10 U	10 U	10 U	10 U
1,1-Dichloroethene	UG/L	5	150 DJ	10 U	10 U	10 U	10 U
1,2-Dichlorobenzene	UG/L	3	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethane	UG/L	0.6	94	10 U	10 U	10 U	10 U
1,2-Dichloropropane	UG/L	1	10	10 U	10 U	10 U	10 U
4-Methyl-2-pentanone	UG/L	NS	10 U	10 U	10 U	10 U	10 U
Acetone	UG/L	50	10 UJ	10 U	10 U	10 U	10 UJ
Benzene	UG/L	1	10	10 U	10 U	10 U	10 U
Carbon disulfide	UG/L	60	10 U	10 U	10 U	10 U	10 U
Chlorobenzene	UG/L	5	10 U	10 U	10 U	10 U	10 U
Chloroethane	UG/L	5	10 U	10 U	10 U	10 U	10 U
Chloroform	UG/L	7	73	10 U	1 J	10 U	10 U
cis-1,2-Dichloroethene	UG/L	-	4,900 D	62	460 D	24	58
Ethylbenzene	UG/L	5	10 U	10 U	10 U	10 U	10 U
Methyl tert-butyl ether	UG/L	10	10 U	10 U	10 U	10 U	10 U
Methylene chloride	UG/L	5	44	10 U	10 U	10 U	10 U
Tetrachloroethene	UG/L	5	5,600 D	53	940 D	62	14
Toluene	UG/L	5	1 J	10 U	10 U	10 U	10 U
trans-1,2-Dichloroethene	UG/L	-	35	1 J	6 J	10 U	10 U

*Criteria- NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, June 1998 (includes 4/2000 Addendum). Class GA.

Flags assigned during chemistry validation are shown.

( ) Concentration Exceeds Criteria

U - The analyte was analyzed for, but not detected. The associated numerical value is at or below the method detection limit.

J - The analyte was positively identified, the quantitation is an estimation.

D - Value based on sample dilution.

Only Detected Results Reported.

Detection Limits shown are MDL

TABLE 4-3
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CHEM-CORE

Location ID			MW-14	MW-15	MW-16	MW-17	MW-18
Sample ID			MW-14-WG	MW-15-WG	MW-16-WG	MW-17-WG	MW-18-WG
Matrix			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Depth Interval (ft)			-	-	-	-	-
Date Sampled			09/11/04	09/09/04	09/08/04	09/08/04	09/08/04
Parameter	Units	Criteria*					
Volatiles							
richloroethene	UG/L	5	3,800 D	10	150	7 J	6 J
Vinyl chloride	UG/L	2	410 DJ	2 J	8 J	10 U	10 U
Xylene (Total)	UG/L	5	23	10 U	10 U	10 U	10 U

*Criteria- NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. June 1998 (includes 4/2000 Addendum). Class GA.

Flags assigned during chemistry validation are shown.

Concentration Exceeds Criteria

U - The analyte was analyzed for, but not detected. The associated numerical value is at or below the method detection limit.

J - The analyte was positively identified, the quantitation is an estimation.

D - Value based on sample dilution.

Only Detected Results Reported.

Detection Limits shown are MDL

J:\35690.00\db\Program\Program.mdb
Printed: 12/06/04 8:33:34 AM
(MATRIX) = 'WG' AND [LOGDATE] >= #07/14/04#

TABLE 4-3
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CHEM-CORE

Location ID			PZ-1
Sample ID			PZ1-WG
Matrix			Groundwater
Depth Interval (ft)			-
Date Sampled			09/10/04
Parameter	**Units**	**Criteria***	
Volatiles			
1,1,1-Trichloroethane	UG/L	5	7,200 D
1,1,2-Trichloro-1,2,2-trifluoroethane	UG/L	5	10 U
1,1,2-Trichloroethane	UG/L	1	26
1,1-Dichloroethane	UG/L	5	860 D
1,1-Dichloroethene	UG/L	5	60 DJ
1,2-Dichlorobenzene	UG/L	3	10 U
1,2-Dichloroethane	UG/L	0.6	35
1,2-Dichloropropane	UG/L	1	10 U
4-Methyl-2-pentanone	UG/L	NS	25
Acetone	UG/L	50	570 DJ
Benzene	UG/L	1	10 U
Carbon disulfide	UG/L	60	10 U
Chlorobenzene	UG/L	5	10 U
Chloroethane	UG/L	5	10 U
Chloroform	UG/L	7	10 U
cis-1,2-Dichloroethene	UG/L	-	7,100 D
Ethylbenzene	UG/L	5	1 J
Methyl tert-butyl ether	UG/L	10	10 U
Methylene chloride	UG/L	5	590 D
Tetrachloroethene	UG/L	5	760 D
Toluene	UG/L	5	31
trans-1,2-Dichloroethene	UG/L	-	35

*Criteria- NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. June 1998 (includes 4/2000 Addendum). Class GA.

Flags assigned during chemistry validation are shown.

( ) Concentration Exceeds Criteria

U - The analyte was analyzed for, but not detected. The associated numerical value is at or below the method detection limit.

J - The analyte was positively identified, the quantitation is an estimation.

D - Value based on sample dilution.

Only Detected Results Reported.

Detection Limits shown are MDL

J:\35890.00\dbf\Progrum\Program.mdb
Printed: 12/06/04 6:33:35 AM
[MATRIX] = 'WG' AND [LOGDATE] >= #07/14/04#

TABLE 4-3
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CHEM-CORE

Location ID			PZ-1
Sample ID			PZ1-WG
Matrix			Groundwater
Depth Interval (ft)			-
Date Sampled			09/10/04
Parameter	Units	Criteria*	
Volatiles			
Trichloroethene	UG/L	5	8,200 D
Vinyl chloride	UG/L	2	520 D
Xylene (Total)	UG/L	5	2 J

*Criteria- NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. June 1998 (includes 4/2000 Addendum). Class GA.

Flags assigned during chemistry validation are shown.

Concentration Exceeds Criteria

U - The analyte was analyzed for, but not detected. The associated numerical value is at or below the method detection limit.

J - The analyte was positively identified, the quantitation is an estimation.

D - Value based on sample dilution.

Only Detected Results Reported.

Detection Limits shown are MDL

LOW FLOW GROUNDWATER PURGING/SAMPLING LOG

Project: Chem-Core Remedial Design Investigation Site: Chem-Core Well I.D.: MW-8D

Date: 9/9/04 Sampling Personnel: Scott McCabe/John Doerr Company: URS Corporation

Purging/Sampling Device: Grundfos Redi-Flo 2 Tubing Type: High Density Polyethylene Pump/Tubing Inlet Location: ~1-2 feet off bottom

Measuring Point: Top of Riser Initial Depth to Water: 16.00 Depth to Well Bottom: 44.49 Well Diameter: 4" Screen Length:

Casing Type: Steel Volume in 1 Well Casing (liters): 70.4 Estimated Purge Volume (liters):

Sample ID: MW-08D-WG Sample Time: 1045 QA/QC:

Sample Paramaters: TCL VOCs

Other Information: Used dedicated/disposable tubing.

PURGE PARAMETERS

TIME	pH	TEMP (°C)	COND. (µmhos)	DISS. O_2 (mg/l)	TURB. (NTU)	Eh (mV)	FLOW RATE (ml/min.)	DEPTH TO WATER (btor)
955	7.23	13.85	2370	9.38	35	-263	1000	15.86
1000	7.22	14.41	2380	6.64	21.5	291	1000	15.72
1005	7.18	14.69	2400	4.27	16.0	-307	1000	15.68
1010	7.16	14.69	2400	2.76	14.0	313	1000	15.62
1015	7.15	14.70	2400	1.35	4.4	-319	1000	15.62
1020	7.15	14.71	2390	0.61	0.5	-323	1000	15.62
1025	7.14	14.66	2380	0.00	-1.1	-327	1000	15.62
1030	7.14	14.69	2380	0.00	-2.4	-329	1000	15.62
1035	7.13	14.71	2370	0.00	-2.2	-331	1000	15.62
Tolerance:	0.1	---	3%	10%	10%	+ or - 10	---	

Information: WATER VOLUMES--0.75 inch diameter well = 87 ml/ft; 1 inch diameter well = 154 ml/ft; 2 inch diameter well = 617 ml/ft; 4 inch diameter well = 2470 ml/ft (vol $_{cyl} = \pi r^2 h$)

LOW FLOW GROUNDWATER PURGING/SAMPLING LOG

Project: Chem-Core Remedial Design Investigation Site: Chem-Core Well I.D.: MW-12

Date: 9/8/04 Sampling Personnel: Scott McCabe/John Doerr Company: URS Corporation

Purging/ Sampling Device: Grundfos Redi-Flo 2 Tubing Type: High Density Polyethylene Pump/Tubing Inlet Location: ~1-2 feet off bottom

Measuring Point: Top of Riser Initial Depth to Water: 25.10 Depth to Well Bottom: 37.40 Well Diameter: 6" Screen Length:

Casing Type: Steel Volume in 1 Well Casing (liters): 68.4 Estimated Purge Volume (liters):

Sample ID: MW-12-WG Sample Time: 1700 QA/QC:

Sample Paramaters: TCL VOCs

Other Information: Used dedicated/disposable tubing.

PURGE PARAMETERS

TIME	pH	TEMP (°C)	COND. (µmhos)	DISS. O_2 (mg/l)	TURB. (NTU)	Eh (mV)	FLOW RATE (ml/min.)	DEPTH TO WATER (btor)
1605	715.00	12.34	710	1.24	135	-183	1100	25.10
1610	7.08	12.69	711	0.08	198	-185	1000	25.80
1615	7.03	12.80	707	0.10	195	-184	1000	25.88
1620	7.01	12.82	702	0.34	206	-184	1000	25.90
1625	6.99	12.88	699	0.50	189	-184	1000	25.92
1630	6.98	12.87	696	0.51	189	-183	1000	25.93
1635	6.95	12.86	696	0.26	161	-184	1000	25.98
1640	6.96	12.86	699	0.00	141	-184	1000	25.98
1645	6.96	12.90	702	0.00	125	-185	1000	26.01
1650	6.96	12.91	704	0.00	111	-185	1000	26.00
1655	6.96	12.93	706	0.00	89.0	-186	1000	26.00
1700	6.96	12.94	707	0.00	82.4	-186	1000	26.00
Tolerance:	0.1	---	3%	10%	10%	+ or - 10	---	

Information: WATER VOLUMES–0.75 inch diameter well = 87 ml/ft; 1 inch diameter well = 154 ml/ft; 2 inch diameter well = 617 ml/ft; 4 inch diameter well = 2470 ml/ft (vol $_{cyl} = \pi r^2 h$)

Reference 2

Ref. 2

27/63

PHASE I & II REMEDIAL INVESTIGATION REPORT

CHEM-CORE SITE
SITE #9-15-176
BUFFALO, NEW YORK

Prepared For:

NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF ENVIRONMENTAL REMEDIATION
WORK ASSIGNMENT D003825-29

FINAL

Prepared By:

URS CORPORATION GROUP CONSULTANTS
282 DELAWARE AVENUE
BUFFALO, NEW YORK 14202

JULY 2002

concrete, bricks, cinders and slag. At the site, fill thickness ranged from 1 to 8 feet and fill was thickest beneath the building. Off site, fill was thickest near the Erie Canal at MW-10 (i.e., 17 feet). Silty clay and clayey silt was encountered beneath the fill. The thickness ranged from approximately 9 feet in MW-03 to 17.5 feet in MW-01. The clayey silt and silty clay unit was stratified and/or laminated and contained siltier and fine sand partings where distinct wet seams occurred. In a few instances, seams containing saturated mixtures of sand and gravel were encountered, typically immediately above the bedrock. Bedrock was encountered beneath the silts and clays.

Bedrock was encountered at depths ranging from 12.8 feet in MW-03 to 30 feet in MW-10. Bedrock was identified as dolostone with argillaceous partings. It was characterized as light gray, thin to medium bedded, fine to medium grained dolomite. It also contained thin beds of dark gray, medium hard, thinly bedded shale. The upper several feet of bedrock has been mapped as the Akron Dolostone (Buehler and Tesmer 1963). Although difficult to discern, the contact with the underlying Bertie Formation appears to be 15 to 20 feet below ground surface. The upper portions of the Bertie Formation consist of dark gray shale and dolostone beds of variable thickness. Figure 3-3 depicts the bedrock surface in the vicinity of the site. Bedrock surface elevation ranges from a high at MW-03 of 585.83 feet amsl to a low of 552.87 feet amsl at MW-10. Bedrock surface slopes steeply toward the Black Rock Canal from MW-03.

3.5.2 Site Hydrogeology

3.5.2.1 Phase I RI

The primary hydrogeologic unit identified beneath the site is the unconfined water-table aquifer present in the Akron Dolostone and Bertie Formation. However, groundwater is present in the overburden and is found in the coarser sand and sandy silt partings and seams within the silty clay/clayey silt deposits. The extent and quantity of the overburden water is limited, but the overburden immediately above bedrock was wet at several boring locations. The water in the overburden is perched above the water levels measured in the bedrock. Groundwater in the bedrock flows through primarily secondary porosity features in the rock including faults, joints, solution cavities and bedding planes. Both the Akron Dolostone and Bertie Formation have little primary porosity so groundwater flow is controlled by the distribution of fractures within the rock.

J:\35890.02\CAD\ 1=50' 11/12/01-1 PAL

B
SOUTH

B'
NORTH

ELEVATION IN FEET

600
590
580
570
560
550

GARRETT LEATHER BLDG.

FORMER
CHEM CORE BLDG.

1396
NIAGARA
ST.
BLDG.

MW-8

MW-3 PROJECTED

MW-2 PROJECTED

MW-5

WEST DELAVAN AVE.
(GRAVEL COVERED)

(570.35)

(569.85)

(569.69)

(569.73)

LEGEND

MW-3 — MONITORING WELL NUMBER

(569.85) POTENTIOMETRIC SURFACE (569.85) GROUNDWATER ELEVATION (11/02/01) UNLESS OTHERWISE SPECIFIED

SCREENED INTERVAL OF MONITORING WELL

BOREHOLE TERMINATION

FILL

SILTY CLAY/
CLAYEY SILT

DOLOMITE AND SHALE

SHALE AND
ARGILLACEOUS
DOLOMITE

NOTES:

1. GEOLOGIC CONDITIONS SHOWN ARE REPRESENTATIVE OF CONDITIONS ENCOUNTERED AT EACH BORING LOCATION TO THE DEPTH DRILLED. EXTRAPOLATIONS BETWEEN BORINGS HAVE BEEN INTERPRETED USING STANDARD ACCEPTED GEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY BETWEEN BORINGS FROM THOSE SHOWN.
2. ELEVATIONS BASED ON THE NORTH AMERICAN VERTICAL DATUM, 1988.

50' 0 50'
SCALE: 1"=50' HORIZONTAL

10' 0 10'
SCALE: 1"=10' VERTICAL

CHEM-CORE
GEOLOGICAL CROSS-SECTION B-B'

URS

FIGURE 3-2

CC-7092

TABLE 4-9
STATISTICAL SUMMARY GROUNDWATER - PHASE I RI OCTOBER 2001
CHEM-CORE

Parameter	Units	Criteria*	Num. of Samples	Num. of Detections	Range of Detections			Num. Exceed	LOCID of Max Value
					Min	Max	Avg		
Volatiles									
1,1,1-Trichloroethane	UG/L	5	12	7	2.0	9,000.0	2,100.143	6	MW-01S
1,1-Dichloroethane	UG/L	5	12	6	2.0	4,800.0	1,719.333	5	MW-06
1,1-Dichloroethene	UG/L	5	12	6	1.0	980.0	326.333	5	MW-01S
Benzene	UG/L	1	12	1	42.0	42.0	42.0	1	MW-02
Chloroethane	UG/L	5	12	1	6.0	6.0	6.0	1	MW-10
Chloroform	UG/L	7	12	1	2.0	2.0	2.0	-	MW-05
cis-1,2-Dichloroethene	UG/L	5	12	8	7.0	28,000.0	8,265.875	8	MW-01S
Tetrachloroethene	UG/L	5	12	6	2.0	5,400.0	1,163.667	5	MW-03
Toluene	UG/L	5	12	5	1.0	710.0	264.8	2	MW-02
Trichloroethene	UG/L	5	12	6	6.0	1,600.0	592.5	6	MW-07
Vinyl chloride	UG/L	2	12	8	2.0	10,000.0	2,591.0	7	MW-06
Semivolatiles									
bis(2-Ethylhexyl)phthalate	UG/L	5	2	1	3.0	3.0	3.0	-	MW-07
Caprolactam	UG/L	-	2	1	3.0	3.0	3.0	-	MW-07
Metals									
Aluminum	UG/L	-	2	2	91.5	158.0	124.75	-	MW-01D
Arsenic	UG/L	25	2	2	2.1	6.8	4.45	-	MW-01D
Barium	UG/L	1000	2	2	54.3	124.0	89.15	-	MW-01D
Beryllium	UG/L	3	2	1	0.3	0.3	0.3	-	MW-07
Calcium	UG/L	-	2	2	1.28E+05	1.71E+05	1.50E+05	-	MW-01D
Chromium	UG/L	50	2	2	1.5	16.4	8.95	-	MW-01D
Cobalt	UG/L	-	2	2	1.3	1.6	1.45	-	MW-01D
Copper	UG/L	200	2	2	1.0	2.7	1.85	-	MW-07
Iron	UG/L	300	2	2	336.0	657.0	496.5	2	MW-07
Magnesium	UG/L	35000	2	2	17,200.0	61,400.0	39,300.0	1	MW-07
Manganese	UG/L	300	2	2	72.8	83.6	78.2	-	MW-07

*Criteria: NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. June 1998, Revised April 2000, Class GA.

Concentration Exceeds Criteria

Only Detected Results Reported.

Advanced Selection: 01-WG
J:\35890.00\db\Program\program.mde
Printed: 12/12/01 12:55:56 PM
YEAR([LOGDATE]) =2001 AND [MATRIX] = "WG"

TABLE 4-9
STATISTICAL SUMMARY GROUNDWATER - PHASE I RI OCTOBER 2001
CHEM-CORE

Parameter	Units	Criteria*	Num. of Samples	Num. of Detections	Range of Detections			Num. Exceed	LOCID of Max Value
					Min	Max	Avg		
Metals									
Nickel	UG/L	100	2	2	6.6	18.4	12.5	-	MW-01D
Potassium	UG/L	-	2	2	6,220.0	9,170.0	7,695.0	-	MW-07
Silver	UG/L	50	2	2	1.6	3.0	2.3	-	MW-01D
Sodium	UG/L	20000	2	2	1.69E+05	2.28E+05	1.99E+05	2	MW-01D
Vanadium	UG/L	-	2	2	0.72	23.7	12.21	-	MW-07
Zinc	UG/L	2000	2	2	4.7	11.4	8.05	-	MW-01D
Miscellaneous Parameters									
Cyanide	UG/L	200	2	1	3.2	3.2	3.2	-	MW-07

*Criteria- NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. June 1998, Revised April 2000, Class GA.

Concentration Exceeds Criteria

Only Detected Results Reported.

Advanced Selection: 01-WG
J:\35898 00\db\Progr am\progr am.mde
Printed: 12/12/01 12:55:56 PM
YEAR([LOGDATE]) =2001 AND [MATRIX] = 'WG'

TABLE 4-11
STATISTICAL SUMMARY GROUNDWATER
PHASE II RI JANUARY/MARCH 2002
CHEM-CORE

Parameter	Units	Criteria*	Num. of Samples	Num. of Detections	Range of Detections			Num. Exceed	LOCID of Max Value
					Min	Max	Avg		
Volatiles									
1,1,1-Trichloroethane	UG/L	5	19	10	38.0	25,000.0	4,006.4	10	PZ-1
1,1,2-Trichloro-1,2,2-trifluoroethane	UG/L	5	19	1	46.0	46.0	46.0	1	MW-13S
1,1-Dichloroethane	UG/L	5	19	11	1.0	4,500.0	954.545	9	MW-06
1,1-Dichloroethene	UG/L	5	19	9	10.0	1,400.0	412.333	9	PZ-1
Acetone	UG/L	50	19	1	1,000.0	1,000.0	1,000.0	1	PZ-1
Benzene	UG/L	1	19	3	2.0	52.0	18.667	3	MW-02
Chlorobenzene	UG/L	5	19	1	2.0	2.0	2.0	-	MW-10
Chloroethane	UG/L	5	19	1	8.0	8.0	8.0	1	MW-10
Chloroform	UG/L	7	19	1	180.0	180.0	180.0	1	MW-07
cis-1,2-Dichloroethene	UG/L	5	19	17	1.0	30,000.0	5,901.176	30	MW-14
Cyclohexane	UG/L	-	19	2	2.0	2.0	2.0	-	MW-09
Methylcyclohexane	UG/L	-	19	2	2.0	3.0	2.5	-	MW-09
Methylene chloride	UG/L	5	19	4	1.0	3,000.0	770.0	2	PZ-1
Tetrachloroethene	UG/L	5	19	11	1.0	21,000.0	2,903.818	10	MW-14
Toluene	UG/L	5	19	2	480.0	2,200.0	1,340.0	2	MW-02
trans-1,2-Dichloroethene	UG/L	5	19	7	2.0	56.0	22.0	8	MW-07
Trichloroethene	UG/L	5	19	12	2.0	16,000.0	3,116.167	11	PZ-1
Vinyl chloride	UG/L	2	19	9	3.0	9,300.0	2,041.0	9	MW-06
Metals									
Iron	UG/L	300	16	13	60.3	17,000.0	1,510.708	3	PZ-1
Miscellaneous Parameters									
Hardness	MG/L	-	16	16	290.0	1,900.0	628.125	-	MW-04D

*Criteria- NYSDEC TOGS (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. June 1998 (includes 4/2000 Addendum). Class GA.

Concentration Exceeds Criteria

Only Detected Results Reported.

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Printed: 5/8/02 2:47:21 PM
YEAR([LOGDATE]) =2002 AND [MATRIX] = "WG"

URS Corporation

TEST BORING LOG

PROJECT:	Chem Core
CLIENT:	New York State DEC
BORING CONTRACTOR:	Buffalo Drilling Co.
GROUNDWATER:	Not Encountered

DATE	TIME	LEVEL	TYPE

	CAS.	SAMPLER	CORE	TUBE
TYPE	HSA	Split spoon	NX	
DIA.	8 1/4"	2"	2"	
WT.	-	140#	-	
FALL	-	30"	-	

* POCKET PENETROMETER READING

BORING NO:	MW-8S
SHEET:	1 of 1
JOB NO.:	05-00035890.02
BORING LOCATION:	N 1064443.28/ E 1063740.85
GROUND ELEVATION:	587.82
DATE STARTED:	08/22/01
DATE FINISHED:	08/30/01
DRILLER:	Joe Gardner
GEOLOGIST:	Scott McCabe
REVIEWED BY:	

DEPTH FEET	SAMPLE STRATA	NO.	TYPE	BLOWS PER 6"	REC% RQD%	DESCRIPTION COLOR	CONSIST HARD	MATERIAL DESCRIPTION	USCS	REMARKS PID	
		1	ss	- 14 / 11 9	100%	black	m. dense	4" asphalt Fill: Fine to coarse sand and gravel,		9.4	dry
		2	ss	3 5 / 3 3	75%		loose	trace concrete and brick	---	14.3	moist
5		3	ss	2 2 / 5 3	75%					3.1	
6											
7		4	ss	4 50/2	100%	r. brown	soft	Silty Clay, trace dolomite gravel	CL	1.4	
		c-1	NX	4.2 5	84% / 0%	light brown	hard	Dolomite Thin to medium bedded, fine grained, with 1/16"-1/8" thick argillaceous partings fractures typically spaced 2-6" most fractures along argillaceous partings few small vugs throught cores, some filled with gypsum	broken		core #1 took 11 min. no water lost PID = 0
10											
15		c-2	NX	7 7	100% / 46%	brown					core #2 took 18 min. no water lost PID = 0
20		c-3	NX	6 6	100% / 60%						core #3 took 11 min. no water lost PID = 0
25											
								Boring completed at 25.0' bgs.			
30											
35											

Comments: Boring advanced with truck-mounted Mobil B-61 using 8 1/4" ID HSA to 7.0' NX cored 7.0-25.0' bgs. Reamed with 5 7/8" roller bit to 25.0'

PROJECT NO.	05-00035890.02
BORING NO.	MW-8S

DRILLING SUMMARY

Geologist: Scott McCabe

Drilling Company: Buffalo Drilling Co.

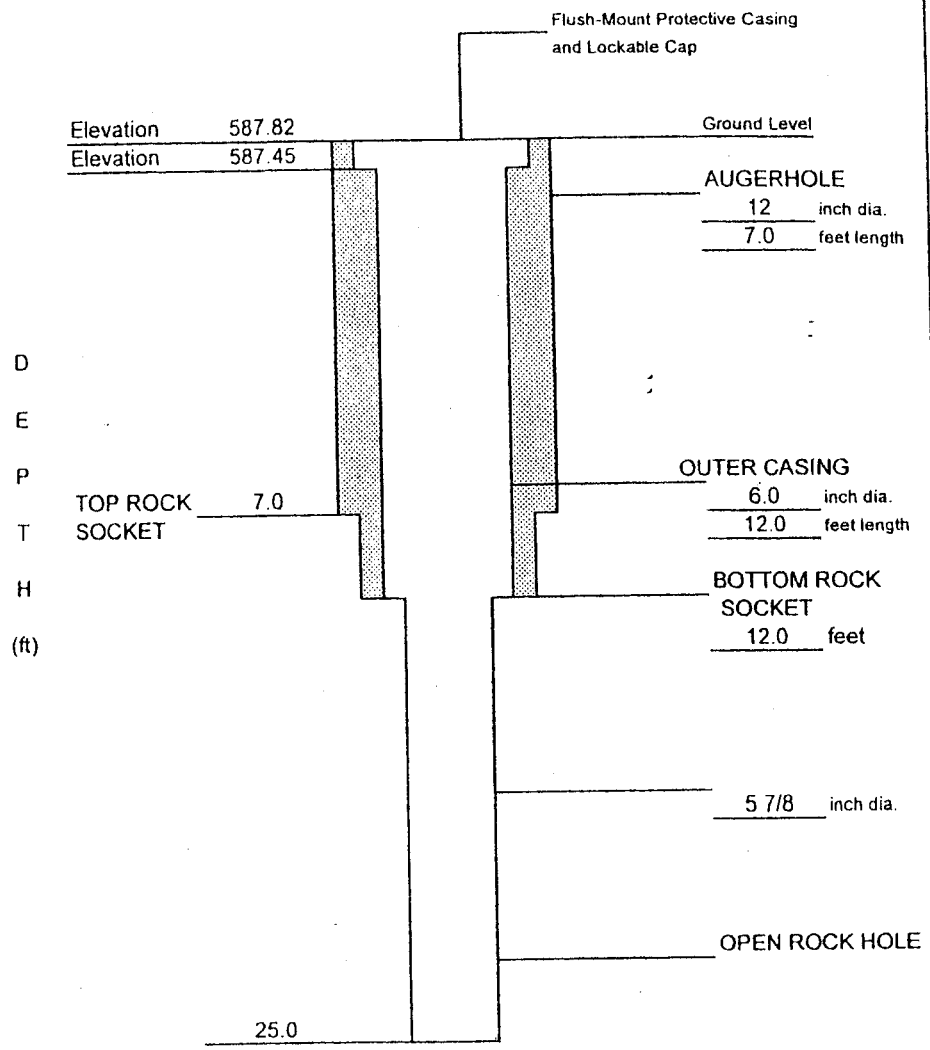
Driller: Joe Gardner

Rig Make/Model: Mobil B-61

Date: 8/30/01

GEOLOGIC LOG

Depth(ft.)	Description
0-.5	Asphalt
.5-6.0	Fill: Fine to coarse sand and gravel, trace brick and concrete
6.0-7.0	Silty Clay
7.0-25.0	Dolomite



WELL DESIGN

CASING MATERIAL	SCREEN MATERIAL	FILTER MATERIAL
Surface: 8-inch steel flush-mount	Type: Open Rock Hole	Type: None Setting:
Well: 6-inch steel		SEAL MATERIAL
Monitor: open rock hole		Type: None Setting:

COMMENTS:

ROCK CORING

Cored Interval: 7-25.0

Core Diameter: NX

Reamed Diameter: 5 7/8

LEGEND

Cement/Bentonite Grout

Client: NYSDEC	**Location:** Chem Core	**Project No.:** 05-00035890.02
URS Corporation	**BEDROCK MONITORING WELL CONSTRUCTION DETAILS**	**Well Number:** MW-8S

URS Corporation

TEST BORING LOG

PROJECT:	Chem Core
CLIENT:	New York State DEC
BORING CONTRACTOR:	Buffalo Drilling Co.
GROUNDWATER:	Not Encountered

DATE	TIME	LEVEL	TYPE

	CAS.	SAMPLER	CORE	TUBE
TYPE	HSA		NX	
DIA.	8 1/4"		2"	
WT.	-		-	
FALL	-		-	

* POCKET PENETROMETER READING

BORING NO:	MW-8D
SHEET:	1 of 1
JOB NO.:	05-00035890.03
BORING LOCATION:	N 1064444.68/E 1063735.80
GROUND ELEVATION:	587.61
DATE STARTED:	12/18/01
DATE FINISHED:	01/02/02
DRILLER:	Joe Gardner
GEOLOGIST:	Scott McCabe
REVIEWED BY:	

DEPTH FEET	SAMPLE STRATA	NO.	TYPE	BLOWS PER 6"		REC% / RQD%	DESCRIPTION COLOR	CONSIST HARD	MATERIAL DESCRIPTION	USCS	REMARKS PID	
5									See MW-8S boring log for lithologic description.			
6.5									See MW-8S boring log for lithologic description.			
10												
15												
20												
25									contact approximated from nearby borings (MW-7 and MW-12)			
27												
30							medium gray	medium hard	Interbedded shale and argillaceous dolomite thin to medium bedded, typically alternating ~2'	broken		
33									typical fractures spaced 3-6"			core #1 took 16 min. ~ 50 gallons lost PID=0
35		c-1	NX	9.1	9.5	96% / 34%						

Comments: Boring advanced with truck-mounted Mobil B-61 using 8 1/4" ID HSA to 6.5' NX cored 33.0-42.5' bgs. Reamed with 5 7/8" roller bit 10.0-33.0' and 3 7/8" roller bit 33.0-45.0'

PROJECT NO.	05-00035890.02
BORING NO.	MW-8D

URS Corporation	TEST BORING LOG
	BORING NO: MW-8D
PROJECT: Chem Core	SHEET: 2 of 2
CLIENT: New York State DEC	JOB NO.: 05-00035890.03

DEPTH FEET	SAMPLE STRATA	NO.	TYPE	BLOWS PER 6"	REC% RQD%	DESCRIPTION COLOR	CONSIST HARD	MATERIAL DESCRIPTION	USCS	REMARKS PID	REMARKS
		c-1	NX	9.1 / 9.5	96% / 34%	medium gray	medium hard	Interbedded shale and argillaceous dolomite thin to medium bedded, typically alternating ~2' typical fractures spaced 2-3"	broken		core #1 took 16 min. ~ 50 gallons lost PID=0
40											
45								Boring completed at 45.0' bgs			
50											
55											
60											
65											
70											
75											

Comments: Boring advanced with truck-mounted Mobil B-61 using 8 1/4" ID HSA to 6.5' NX cored 33.0-42.5' bgs. Reamed with 5 7/8" roller bit 10.0-33.0' and 3 7/8" roller bit 33.0-45.0'

PROJECT NO. 05-00035890.03
BORING NO. MW-8D

DRILLING SUMMARY

Geologist: Scott McCabe

Drilling Company: Buffalo Drilling Co.

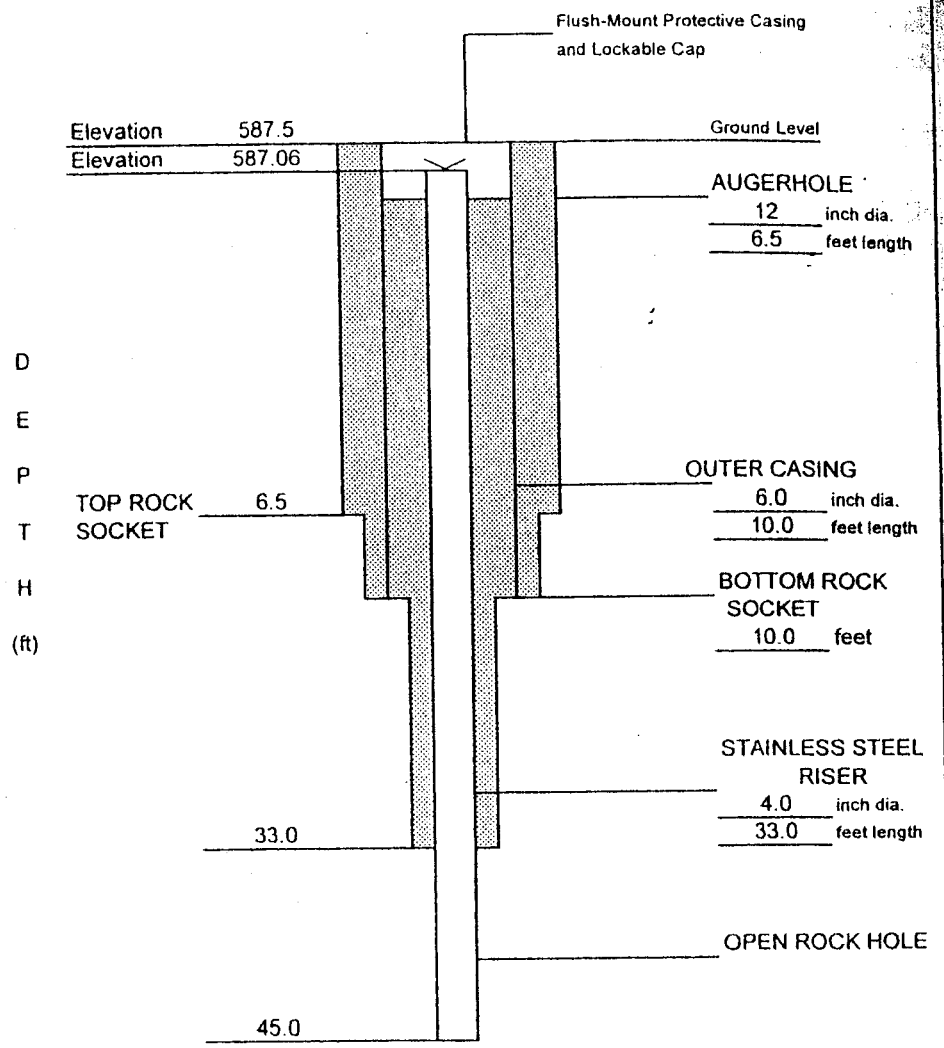
Driller: Joe Gardner

Rig Make/Model: Mobil B-61

Date: 1/2/02

GEOLOGIC LOG

Depth(ft.)	Description
0-6.5	See MW-8S for lithologic description
6.5-27.0	Dolomite
27.0-45.0	Interbedded shale and Dolomite



WELL DESIGN

CASING MATERIAL	SCREEN MATERIAL	FILTER MATERIAL
Surface: 8-inch steel flush-mount	Type: Open Rock Hole	Type: None Setting:
Well: 4-inch type 304 stainless steel		SEAL MATERIAL
Monitor: open rock hole		Type: None Setting:

COMMENTS:

ROCK CORING

Cored Interval: 33.0-42.5

Core Diameter: 2"

Reamed Diameter: 3 7/8"

LEGEND

Cement/Bentonite Grout

Client: NYSDEC	**Location: Chem Core**	**Project No.: 05-00035890.03**
URS Corporation	**BEDROCK MONITORING WELL CONSTRUCTION DETAILS**	**Well Number: MW-8D**

URS Corporation

TEST BORING LOG

PROJECT:	Chem Core
CLIENT:	New York State DEC
BORING CONTRACTOR:	Buffalo Drilling Co.
GROUNDWATER:	Perched 4-6'

DATE	TIME	LEVEL	TYPE

TYPE	CAS.	SAMPLER	CORE	TUBE
DIA.	8 1/4"	2"	2"	
WT.	-	140#	-	
FALL	-	30"	-	

* POCKET PENETROMETER READING

BORING NO:	MW-12
SHEET:	1 of 2
JOB NO.:	05-00035890.03
BORING LOCATION:	N 1064350.54/E 1063660.96
GROUND ELEVATION:	596.22
DATE STARTED:	12/18/01
DATE FINISHED:	12/26/01
DRILLER:	Joe Gardner
GEOLOGIST:	Scott McCabe
REVIEWED BY:	

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6"	REC% / RQD%	COLOR	CONSIST / HARD	MATERIAL DESCRIPTION	USCS	PID	REMARKS
		1	ss	- 4 / 5 12	50%	black / gray	loose	Fill: Gravel, some sand and brick		0.0	dry
		2	ss	50/4 - / - -	75%		v. dense			0.0	
5		3	ss	3 9 / 7 4	100%		medium dense		—	0.0	wet 4.0-6.0'
		4	ss	5 8 / 11 12	75%	reddish brown		Fill: regraded Silty Clay ,some gravel, brick		0.0	moist
8											
		5	ss	7 19 / 21 27	100%	reddish brown	hard	Silty Clay, thinly laminated, trace coarse sand	CL	0.0	
10		6	ss	17 19 / 13 30	100%					0.0	
		7	ss	3 9 / 14 12	75%		very stiff			0.0	
15		8	ss	3 9 / 14 19	100%					0.0	
16											
		9	ss	20 31 / 50/5 -	100%	reddish brown	very dense	Clayey Silt, trace fine to coarse sand and gravel	ML	0.0	wet ~17.8'
20										0.0	
		c-1	NX	4.75 5	95% / 31%	light brown	hard	Dolomite Thin to medium bedded, fine grained, with 1/16"-1/8" thick argillaceous partings	broken		core #1 took 13 min. no water lost PID=0
25											
		c-2	NX	4.4 4.5	99% / 42%			fractures typically spaced 3-6" most fractures along argillaceous partings			core #2 took 10 min. no water lost PID=0
30											
		c-3	NX	7 7	100% / 39%			vertical fractures: 30.25-31.25			core #3 took 15 min. ~ 50 gallons lost PID=0
35						m. gray	m. hard	Interbedded shales and dolomite			

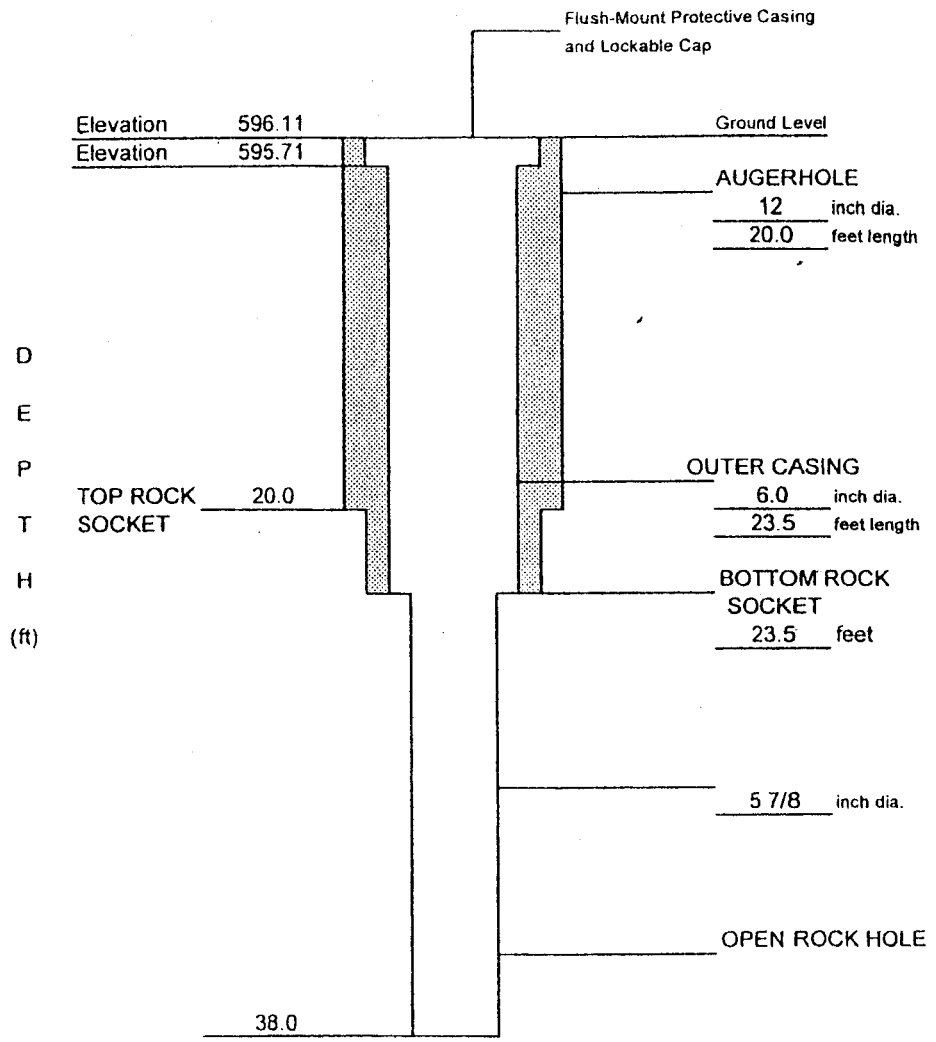
Comments: Boring advanced with truck-mounted Mobil B-61 using 8 1/4" ID HSA to 20.0' NX cored 20.0-36.5' bgs. Reamed with 5 7/8" roller bit to 38.0'

PROJECT NO.	05-00035890.03
BORING NO.	MW-12

DRILLING SUMMARY
Geologist: Scott McCabe
Drilling Company: Buffalo Drilling Co.
Driller: Joe Gardner
Rig Make/Model: Mobil B-61
Date: 12/26/01

GEOLOGIC LOG

Depth(ft.)	Description
0-6.0	Fill: Gravel, some sand and brick
6.0-8.0	Fill: Regraded Silty Clay, some gravel and brick
8.0-16.0	Silty Clay
16.0-20.0	Clayey silt, trace fine to coarse sand and gravel
20.0-35.0	Dolomite
35.0-38.0	Interbedded shale and Dolomite



Not to Scale

WELL DESIGN

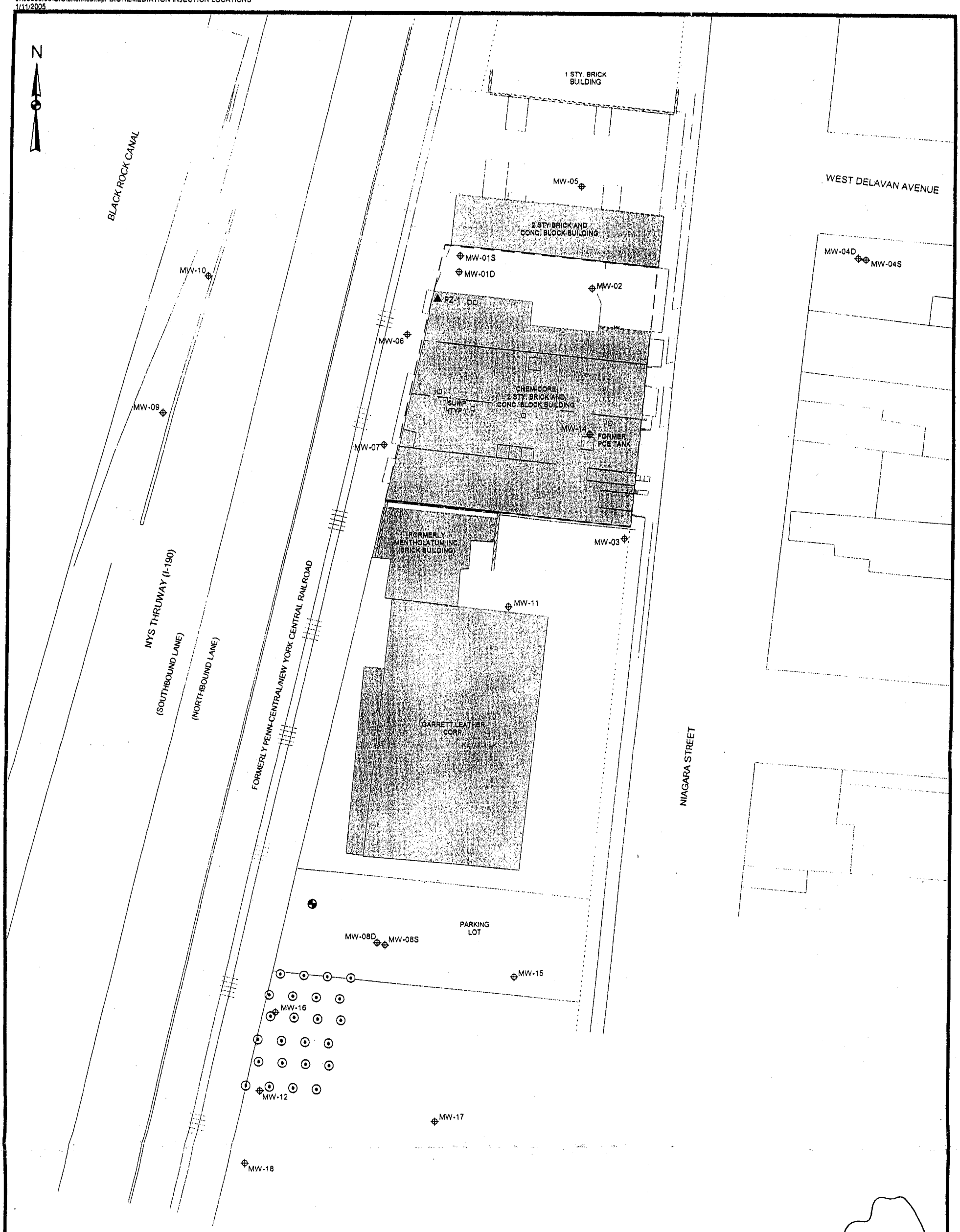
CASING MATERIAL	SCREEN MATERIAL	FILTER MATERIAL
Surface: 8-inch steel flush-mount Well: 6-inch steel Monitor: open rock hole	Type: Open Rock Hole	Type: None Setting: SEAL MATERIAL Type: None Setting:

COMMENTS:	ROCK CORING	LEGEND
	Cored Interval: 20.0-36.5 Core Diameter: 2" Reamed Diameter: 5 7/8	Cement/Bentonite Grout

Client: NYSDEC	Location: Chem Core	Project No.: 05-00035890.03
URS Corporation	BEDROCK MONITORING WELL CONSTRUCTION DETAILS	Well Number: MW-12

Reference 3

J:\35890.00\GIS\chemical.apr BIOREMEDIATION INJECTION LOCATIONS
1/11/2005



Ref 3

URS	CHEM CORE CONCEPTUAL GROUNDWATER PILOT TEST PLAN FOR IN-SITU BIOREMEDIATION	FIGURE 2-1

41/63

Reference 4

Ref. 4

REMEDIAL DESIGN INVESTIGATION/REMEDIAL DESIGN (RDI/DESIGN)

PROJECT MANAGEMENT WORK PLAN AND BUDGET ESTIMATE

CHEM CORE SITE
SITE # 9-15-176
BUFFALO, NEW YORK

Prepared for:

NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF ENVIRONMENTAL REMEDIATION
WORK ASSIGNMENT D003825-61

Prepared by:

URS CORPORATION
640 ELLICOTT ST.
BUFFALO, NEW YORK 14203

FINAL
JUNE 2004

Deliverables

- Six double-sided copies of the final *Pre-Design Investigation Report* will be submitted to NYSDEC, as well as an electronic version of the report.
- Two double-sided copies of the final *DUSR* will be submitted to NYSDEC, as well as an electronic version of the report.

2.3 Task 3 – Bioremediation Pilot Study

The work elements of the bioremediation pilot study include the following:

- Evaluate and design a pilot-scale bioremediation pilot study to address the off-site groundwater contamination.
- Prepare a work plan and revise the cost estimate (if necessary) for the implementation of the pilot study.
- Install injection wells and monitoring wells as necessary.
- Implement the pilot study. Collect groundwater samples as needed to determine the effectiveness of the study.
- Prepare and submit a report summarizing the results of the study and discuss its feasibility at the site on a full-scale basis.
- Monitor the groundwater for one-year after the implementation of the pilot study.

It should be noted that the scope and budget for Task 3 presented below is based upon a modified conceptual design for the pilot study presented in the Feasibility Study. Task 3 includes a final design for the pilot study that could result in the need to modify both the scope and budget for Task 3, if necessary. The final design will be based upon new information obtained as part of the pre-design investigation. Four new monitoring wells will be installed and sampled during the pre-design investigation. Based upon the new data, the final design for the pilot study may be modified affecting the scope and budget.

2.3.1 Subtask 3.1: Evaluate and Design Pilot Test and Revise Cost Estimate

Description of Work

The enhanced in-situ bioremediation pilot study will be implemented in a portion of the off-site groundwater plume south of the source area. As part of this task, URS will evaluate the preliminary design presented here and modify accordingly. However, for cost estimating purposes, we are assuming that the pilot test area will be approximately 7,000 square feet as shown in Figure 3.1-1. Approximately 24 injection points will comprise the injection well array spaced at approximately 15 feet apart. Injection points will be approximately 40 feet deep. Approximately 200 pounds of hydrogen release compound (HRC) will be injected at each point. Three existing monitoring wells, MW-8S/MW-8D and MW-12 together with four new monitoring wells installed as part of the pre-design investigation will be monitored for VOCs, and miscellaneous natural attenuation parameters (Table 2.2-1). Each monitoring well will be sampled quarterly for one year. If necessary, a revised cost estimate will be completed as part of this subtask. Modifications to the proposed pilot study as presented herein may be needed based upon the results of the groundwater monitoring conducted as part of Task 2.

JRS 11/15/04

Budget Assumptions

- URS will evaluate the preliminary design information as presented above and modify Task 3 accordingly.

Deliverables

- Six double-sided copies of a conceptual design bioremediation pilot test will be submitted to NYSDEC, as well as an electronic version of the report (draft and final).
- Field Activities Plan developed as part of the Pre-Design investigation will be adopted for all field work associated with bioremediation pilot test.

2.3.2 Subtask 3.2: Install Injection Wells

Description of Work

The 24 injection wells will be completed as 4-inch diameter open bedrock monitors. Well depths will be targeted to monitor the shallow bedrock groundwater, approximately 40 feet below ground surface (bgs). The wells will be installed in boreholes advanced using 6 ¼-inch inner diameter (ID) hollow-stem augers (HSAs) advanced to top of bedrock. Soil sampling will not be conducted. After encountering bedrock, drilling will be completed using a 5 7/8-inch roller bit to create a 2- to 3-foot rock socket. A permanent 4-inch carbon steel casing will then be grouted from the bottom of the rock socket to the ground surface. After the grout has cured for at least 24 hours, the boring can be advanced using a 3 7/8-inch roller bit to the desired depth. Injection wells will be completed with a flush-mount protective curb box with a locking cover and concrete apron. Locks will be provided for all injection wells. The wells will be keyed alike.

Budget Assumptions

- One mobilization will be required.
- Approximately 24 injection wells will be installed to approximately 40 feet deep.
- All drilling will be completed in Level D personal protective equipment (PPE).
- PPE will be double bagged and disposed of as non-hazardous waste.
- Approximately 10 cubic yard roll off will be required for soil cuttings. Soil cuttings will be profiled non-hazardous.
- Approximately 1,000 gallons of drilling fluid, decontamination water, and development water will be generated as part of the monitoring and injection well installation. The drilling fluid will be profiled as hazardous waste and disposed off-site to a permitted facility. Injection wells will not be developed.
- The NYSDEC will obtain access from property owners for all drilling locations.
- All injection wells will be surveyed.

2.3.3 Subtask 3.3: Implement Pilot Study

Description of Work

URS will inject HRC at all injection points, and sample seven monitoring wells to evaluate the impact of HRC on groundwater quality.

Budget Assumptions

It is assumed that HRC injection will take 10 days (2.5 injection points per day). This number could change based on the actual hydraulic conductivity of the fractured rock which will be better known after pump tests.

- Seven monitoring wells will be sampled on a quarterly basis for one year (28 total samples) to evaluate the impact of injection.

2.3.4 Subtask 3.4: Prepare and Submit Bioremediation Pilot Study Report

Description of Work

The results of the enhanced bioremediation pilot study will be used to evaluate the applicability of the remedy selected in the ROD. The results of the bioremediation pilot study will be presented at a meeting at the NYSDEC Headquarters in Albany, New York. The purpose of the meeting will be to discuss the results of the study and assess the applicability of enhanced bioremediation in other offsite areas and in the source area. Based upon the discussions at the meeting, URS will prepare and submit to NYSDEC a report of findings summarizing the bioremediation pilot test. NYSDEC will then review and comment on the report.

Budget Assumptions

- One meeting in Albany to be attended by URS project manager and remedial design coordinator to discuss results of the bioremediation pilot study.

Deliverables

- Seven copies of bioremediation pilot study report will be submitted to NYSDEC, as well as an electronic version of the report (draft and final).

2.3.5 Subtask 3.5: Groundwater Monitoring

Description of Work

Four monitoring wells installed as part of the pre-design field investigation along with three existing monitoring wells (i.e., MW-8S/MW-8D and MW-12) will be sampled quarterly for one year. Groundwater sampling will be as described in section 2.2.4 and samples will be analyzed for TCL VOCs and miscellaneous natural attenuation parameters (Table 2.2-1).

Budget Assumptions

- Seven monitoring wells will be sampled quarterly for 1 year.
- Samples will be analyzed for TCL VOCs and miscellaneous natural attenuation parameters.
- All purge water will be contained in 55-gallon drums. Drums of water will be disposed of and treated off-site as hazardous waste.
- Approximately 3 drums will be generated per sampling event.

Deliverables

- Groundwater monitoring results will be incorporated into the final bioremediation pilot study report and will be submitted to NYSDEC, as well as an electronic version of the report (final only).

2.4 Task 4 - Plans and Specifications

URS shall prepare performance-based plans and specifications (including design drawings) to be used in competitively bidding the construction of the remediation and initiation of

Reference 5

(Ref. 5)

50/63

United States
Environmental Protection
Agency

Office of Research and
Development
Washington DC 20460

EPA/600/R-98/128
September 1998

EPA

Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water

TECHNICAL PROTOCOL FOR EVALUATING NATURAL ATTENUATION OF CHLORINATED SOLVENTS IN GROUND WATER

by

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accepted literature values until the modeled and observed contaminant distribution patterns match. Because aquifer materials can have a range of effective porosity, sensitivity analyses should be performed to determine the effect of varying the effective porosity on numerical model results. Values of effective porosity chosen for the sensitivity analyses should vary over the accepted range for the aquifer matrix material. Table C.3.2 presents accepted literature values for total porosity and effective porosity.

Table C.3.2 *Representative Values of Dry Bulk Density, Total Porosity, and Effective Porosity for Common Aquifer Matrix Materials (After Walton, 1988 and Domenico and Schwartz, 1990)*

Aquifer Matrix	Dry Bulk Density (gm/cm^3)	Total Porosity	Effective Porosity
Clay	1.00-2.40	0.34-0.60	0.01-0.2
Peat	—	---	0.3-0.5
Glacial Sediments	1.15-2.10	---	0.05-0.2
Sandy Clay	---	---	0.03-0.2
Silt	—	0.34-0.61	0.01-0.3
Loess	0.75-1.60	---	0.15-0.35
Fine Sand	1.37-1.81	0.26-0.53	0.1-0.3
Medium Sand	1.37-1.81	---	0.15-0.3
Coarse Sand	1.37-1.81	0.31-0.46	0.2-0.35
Gravely Sand	1.37-1.81	---	0.2-0.35
Fine Gravel	1.36-2.19	0.25-0.38	0.2-0.35
Medium Gravel	1.36-2.19	—	0.15-0.25
Coarse Gravel	1.36-2.19	0.24-0.36	0.1-0.25
Sandstone	1.60-2.68	0.05-0.30	0.1-0.4
Siltstone	---	0.21-0.41	0.01-0.35
Shale	1.54-3.17	0.0-0.10	---
Limestone	1.74-2.79	0.0-50	0.01-0.24
Granite	2.24-2.46	---	---
Basalt	2.00-2.70	0.03-0.35	---
Volcanic Tuff	---	---	0.02-0.35

C.3.1.5 Linear Ground-water Flow Velocity (Seepage or Advective Velocity)

The average linear ground-water flow velocity (seepage velocity) in one dimension in the direction parallel to ground-water flow in a saturated porous medium is given by:

Reference 6

Analytical Services Center (Ref. 6)
International Specialists in Environmental Analysis
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

Client: URS Corporation
Lab Order: 0412082
Project: Chem Core Site

Client Sample ID: MW-08D-WG
Alt. Client ID:
Collection Date: 12/6/2004 10:28:00 AM **% Moist:**

Lab ID: 0412082-01A **Sample Type:** SAMP **Matrix:** Water **Test Code:** 1_9056_W

ANIONS BY ION CHROMATOGRAPHY METHOD 9056 **Method:** SW9056 **Prep Method:** NA

Analyte	Result	Q	RL	Units	DF	Date Analyzed	Run Batch ID	Analyst
Nitrate-N	0.159		0.100	mg/L	1	12/7/2004 5:04:00 PM	DIONEX-120_0412078	PAN
Sulfate	148		1.00	mg/L	10	12/11/2004 1:44:00 PM	DIONEX-120_041211A	

Definitions:

* - Recovery outside QC limits
DF - Dilution Factor
H - Value Exceeds Maximum Contaminant Level
N - Single Column Analysis
NP - Petroleum Pattern is not present
B - Analyte found in Method blank
DNI - Did not Ignite
J - Estimated value
NC - Not Calculated
P - Post Spike Recovery outside limits
D - Diluted due to maxtrix or extended target compounds
E - Result above quantitation limit (high standard or ICP linear range).
M - Matrix Spike Recovery outside limits
ND - Not Detected at the Reporting Limit
R - RPD outside recovery limits

Analytical Services Center

International Specialists in Environmental Analysis
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

Client: URS Corporation
Lab Order: 0412082
Project: Chem Core Site
Lab ID: 0412082-02A **Sample Type:** SAMP **Matrix:** Water

Client Sample ID: MW-15-WG
Alt. Client ID:
Collection Date: 12/6/2004 10:58:00 AM **% Moist:**
Test Code: 1_9056_W

ANIONS BY ION CHROMATOGRAPHY METHOD 9056 **Method:** SW9056 **Prep Method:** NA

Analyte	Result	Q	RL	Units	DF	Date Analyzed	Run Batch ID	Analyst
Nitrate-N	0.347		0.100	mg/L	1	12/7/2004 5:23:00 PM	DIONEX-120_041207B	PAN
Sulfate	126		1.00	mg/L	10	12/11/2004 2:04:00 PM	DIONEX-120_041211A	

Definitions:

* - Recovery outside QC limits
DF - Dilution Factor
H - Value Exceeds Maximum Contaminant Level
N - Single Column Analysis
NP - Petroleum Pattern is not present
B - Analyte found in Method blank
DNI - Did not Ignite
J - Estimated value
NC - Not Calculated
P - Post Spike Recovery outside limits
D - Diluted due to maxtrix or extended target compounds
E - Result above quantitation limit (high standard or ICP linear range).
M - Matrix Spike Recovery outside limits
ND - Not Detected at the Reporting Limit
R - RPD outside recovery limits

LIMS Version #: 041210 1300

Printed: Monday, December 13, 2004 1:10:07 PM

Analytical Services Center

International Specialists in Environmental Analysis
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

Client: URS Corporation
Lab Order: 0412082
Project: Chem Core Site

Client Sample ID: MW-18-WG
Alt. Client ID:
Collection Date: 12/6/2004 11:25:00 AM **% Moist:**

Lab ID: 0412082-03A **Sample Type:** SAMP **Matrix:** Water **Test Code:** 1_9056_W

ANIONS BY ION CHROMATOGRAPHY METHOD 9056 **Method:** SW9056 **Prep Method:** NA

Analyte	Result	Q	RL	Units	DF	Date Analyzed	Run Batch ID	Analyst
Nitrate-N	ND		0.100	mg/L	1	12/7/2004 5:43:00 PM	DIONEX-120_041207B	PAN
Sulfate	108		1.00	mg/L	10	12/11/2004 2:23:00 PM	DIONEX-120_041211A	

Definitions:

* - Recovery outside QC limits
B - Analyte found in Method blank
D - Diluted due to maxtrix or extended target compounds
DF - Dilution Factor
DNI - Did not Ignite
E - Result above quantitation limit (high standard or ICP linear range).
H - Value Exceeds Maximum Contaminant Level
J - Estimated value
M - Matrix Spike Recovery outside limits
N - Single Column Analysis
NC - Not Calculated
ND - Not Detected at the Reporting Limit
NP - Petroleum Pattern is not present
P - Post Spike Recovery outside limits
R - RPD outside recovery limits

Analytical Services Center

International Specialists in Environmental Analysis
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

Client: URS Corporation
Lab Order: 0412082
Project: Chem Core Site

Client Sample ID: MW-16-WG
Alt. Client ID:
Collection Date: 12/6/2004 11:48:00 AM % Moist:

Lab ID: 0412082-04A Sample Type: SAMP Matrix: Water Test Code: 1_9056_W

ANIONS BY ION CHROMATOGRAPHY METHOD 9056 Method: SW9056 Prep Method: NA

Analyte	Result	Q	RL	Units	DF	Date Analyzed	Run Batch ID	Analyst
Nitrate-N	0.619		0.100	mg/L	1	12/7/2004 7:59:00 PM	DIONEX-120_041207B	PAN
Sulfate	102		1.00	mg/L	10	12/11/2004 4:40:00 PM	DIONEX-120_041211A	

Definitions:

* - Recovery outside QC limits
DF - Dilution Factor
H - Value Exceeds Maximum Contaminant Level
N - Single Column Analysis
NP - Petroleum Pattern is not present

B - Analyte found in Method blank
DNI - Did not Ignite
J - Estimated value
NC - Not Calculated
P - Post Spike Recovery outside limits

D - Diluted due to maxtrix or extended target compounds
E - Result above quantitation limit (high standard or ICP linear range).
M - Matrix Spike Recovery outside limits
ND - Not Detected at the Reporting Limit
R - RPD outside recovery limits

Analytical Services Center

International Specialists in Environmental Analysis
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

Client: URS Corporation
Lab Order: 0412082
Project: Chem Core Site

Client Sample ID: MW-12-WG
Alt. Client ID:
Collection Date: 12/6/2004 1:18:00 PM **% Moist:**

Lab ID: 0412082-05A **Sample Type:** SAMP **Matrix:** Water **Test Code:** 1_9056_W

ANIONS BY ION CHROMATOGRAPHY METHOD 9056 **Method:** SW9056 **Prep Method:** NA

Analyte	Result	Q	RL	Units	DF	Date Analyzed	Run Batch ID	Analyst
Nitrate-N	0.499		0.100	mg/L	1	12/7/2004 8:19:00 PM	DIONEX-120_041207B	PAN
Sulfate	99.0		1.00	mg/L	10	12/11/2004 4:59:00 PM	DIONEX-120_041211A	

Definitions:

* - Recovery outside QC limits
DF - Dilution Factor
H - Value Exceeds Maximum Contaminant Level
N - Single Column Analysis
NP - Petroleum Pattern is not present

B - Analyte found in Method blank
DNI - Did not Ignite
J - Estimated value
NC - Not Calculated
P - Post Spike Recovery outside limits

D - Diluted due to maxtrix or extended target compounds
E - Result above quantitation limit (high standard or ICP linear range)
M - Matrix Spike Recovery outside limits
ND - Not Detected at the Reporting Limit
R - RPD outside recovery limits

Analytical Services Center

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4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

Client: URS Corporation
Lab Order: 0412082
Project: Chem Core Site

Client Sample ID: MW-17-WG
Alt. Client ID:
Collection Date: 12/6/2004 1:45:00 PM **% Moist:**

Lab ID: 0412082-06A **Sample Type:** SAMP **Matrix:** Water **Test Code:** 1_9056_W

ANIONS BY ION CHROMATOGRAPHY METHOD 9056 **Method:** SW9056 **Prep Method:** NA

Analyte	Result	Q	RL	Units	DF	Date Analyzed	Run Batch ID	Analyst
Nitrate-N	0.614		0.100	mg/L	1	12/7/2004 8:38:00 PM	DIONEX-120_041207B	PAN
Sulfate	151		1.00	mg/L	10	12/11/2004 5:19:00 PM	DIONEX-120_041211A	

Definitions:

* - Recovery outside QC limits
DF - Dilution Factor
H - Value Exceeds Maximum Contaminant Level
N - Single Column Analysis
NP - Petroleum Pattern is not present

B - Analyte found in Method blank
DNI - Did not Ignite
J - Estimated value
NC - Not Calculated
P - Post Spike Recovery outside limits

D - Diluted due to maxtrix or extended target compounds
E - Result above quantitation limit (high standard or ICP linear range)
M - Matrix Spike Recovery outside limits
ND - Not Detected at the Reporting Limit
R - RPD outside recovery limits

Analytical Services Center

International Specialists in Environmental Analysis
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

Client: URS Corporation
Lab Order: 0412082
Project: Chem Core Site

Client Sample ID: MW-11-WG
Alt. Client ID:
Collection Date: 12/6/2004 2:28:00 PM **% Moist:**

Lab ID: 0412082-08A **Sample Type:** SAMP **Matrix:** Water **Test Code:** 1_9056_W

ANIONS BY ION CHROMATOGRAPHY METHOD 9056 **Method:** SW9056 **Prep Method:** NA

Analyte	Result	Q	RL	Units	DF	Date Analyzed	Run Batch ID	Analyst
Nitrate-N	2.02		0.100	mg/L	1	12/7/2004 9:17:00 PM	DIONEX-120_0412078	PAN
Sulfate	138		1.00	mg/L	10	12/11/2004 5:58:00 PM	DIONEX-120_041211A	

Definitions:

* - Recovery outside QC limits
DF - Dilution Factor
H - Value Exceeds Maximum Contaminant Level
N - Single Column Analysis
NP - Petroleum Pattern is not present
B - Analyte found in Method blank
DNI - Did not Ignite
J - Estimated value
NC - Not Calculated
P - Post Spike Recovery outside limits
D - Diluted due to maxtrix or extended target compounds
E - Result above quantitation limit (high standard or ICP linear range).
M - Matrix Spike Recovery outside limits
ND - Not Detected at the Reporting Limit
R - RPD outside recovery limits

Analytical Services Center

International Specialists in Environmental Analysis
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

Client: URS Corporation
Lab Order: 0412082
Project: Chem Core Site

Client Sample ID: MW-085-WG
Alt. Client ID:
Collection Date: 12/6/2004 3:53:00 PM **% Moist:**

Lab ID: 0412082-09A **Sample Type:** SAMP **Matrix:** Water **Test Code:** 1_9056_W

ANIONS BY ION CHROMATOGRAPHY METHOD 9056 **Method:** SW9056 **Prep Method:** NA

Analyte	Result	Q	RL	Units	DF	Date Analyzed	Run Batch ID	Analyst
Nitrate-N	0.363		0.100	mg/L	1	12/7/2004 9:37:00 PM	DIONEX-120_041207B	PAN
Sulfate	261		1.00	mg/L	10	12/11/2004 6:17:00 PM	DIONEX-120_041211A	

Definitions:

* - Recovery outside QC limits
DF - Dilution Factor
H - Value Exceeds Maximum Contaminant Level
N - Single Column Analysis
NP - Petroleum Pattern is not present
B - Analyte found in Method blank
DNI - Did not Ignite
J - Estimated value
NC - Not Calculated
P - Post Spike Recovery outside limits
D - Diluted due to maxtrix or extended target compounds
E - Result above quantitation limit (high standard or ICP linear range)
M - Matrix Spike Recovery outside limits
ND - Not Detected at the Reporting Limit
R - RPD outside recovery limits

Reference 7

EOS Remediation, Inc.

3722 Benson Drive, Suite 101
Raleigh, NC
(919) 873-2204 • fax (919) 873-1074
www.eosremediation.com

Quotation

EOS® Concentrate 598 B42

DATE 11/15/2004
Quotation # EOS04115P
Client ID - URS

Quotation For: ***EOS® Concentrate 598 B42***
Name: Mr. James R Stachowski, P.E.
Company: URS Corporation
Address: 640 Ellicott Street, 3rd Floor
City, State ZIP: Buffalo, NY 14203
Phone: (716) 856-5636 Fax: (716) 856-2545
Email: jim_stachowski@urscorp.com

Quotation valid until: 12/31/04
Prepared by: Gary Birk
Sales Rep: Mark Kluger

Comments or Special Instructions: EOS Remediation, Inc. is a licensed distributor of EOS® concentrate, an engineered emulsified edible oil substrate. We are licensed to sell EOS® concentrate throughout the United States. **EOS® Concentrate 598 B42** contains both slow and fast release hydrogen donor compounds, amino acids, trace minerals, and B vitamins (including a B12 supplement)

Freight: Product is shipped in 55-gallon drums (420 pounds per drum), unless otherwise specified. All shipments are FOB. Shipments will be by common carrier. Lift gates must be specified and may incur additional expense.

Terms and Conditions of Sale: The attached Terms and Conditions are incorporated as a part of this quotation. This quotation is based on a minimum order of **nine (9) drums**. Sales are made to Open Accounts, only if requirements are met; otherwise, cash in advance.

TECHNICAL CONTACT	P.O. NUMBER	SHIP DATE	SHIP VIA	F.O.B. POINT	TERMS
Gary Birk		T.B.D.	Ground (2 to 3 days LTL)	Delafield, Wisconsin	Due on receipt

QUANTITY	DESCRIPTION	UNIT RATE	AMOUNT
9	**EOS® Concentrate 598 B42** (approximately 74% by weight organic substrate)	$1,050.00/drum	$9,450.00
9	**EOS® B12 Supplement (500 ml)**	~~Included with~~ Drum Purchase	*
		SUBTOTAL	**$9,450.00**
		Shipping & Handling	$700.50
		Misc. (Lift Gate Services)	$80.00
		Tax Rate	
		Sales Tax	
		TOTAL	$10,230.50

Ship to: Address provided by URS (Estimate based on Buffalo, NY)

*Note: In the event URS elects to purchase fewer than nine (9) drums, URS may purchase **EOS® 598 B42** at the unit rate of $1,260.00/drum F.O.B. Delafield, Wisconsin. Shipping and handling fees will apply.*

If you have any questions concerning this quotation contact Gary Birk at (919) 873-2204 or by email at gbirk@eosremediation.com.

Sincerely,
EOS Remediation, Inc.

Gary Birk
Director of Marketing & Sales

Quotation Acceptance:
URS Corporation

Name (Signature): _____ Title: _____

Print Name: _____ Date: _____