BUILDING 820
NATURAL ATTENUATION MODELING

MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

August 9, 2006

Prepared for:

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1.0 INTRODUCTION

1.1 PURPOSE OF INVESTIGATION

The purpose of this Natural Attenuation Modeling Report is to evaluate the fate and transport of the dissolved Methyl Tert-Butyl Ether (MTBE) contamination in the deep (50-feet) aquifer at the Building 820 project site. The analytical transport model, *Bioscreen™ 1.4*, was utilized to help predict the time and direction of dissolved MTBE migration and assess the risk to potential receptors proximate to the Building 820 project site. While MTBE is not the only contaminant of concern detected in groundwater samples collected from 50 feet deep (benzene, toluene, ethylbenzene and xylene have also been detected) it is the most problematic as it does not breakdown easily under natural conditions. A site location map has been provided on Figure 1.

CATLIN Engineers and Scientists (CATLIN) has been tasked to evaluate the fate and transport of deep (50-feet) groundwater contamination present at the Building 820 project site by NAVFAC Mid-Atlantic through Osage of Virginia. This request was based on the North Carolina Department of Environment and Natural Resources (NCDENR), Wilmington Regional Office response (dated April 12, 2006) to the Remedial Action Optimization and Revised Corrective Action Plan Addendum (RAO & RCAPA) prepared by CATLIN dated March 20, 2006.

1.2 SCOPE OF WORK

As previously stated, based on NCDENR's response to the RAO & RCAPA, CATLIN was tasked to evaluate the fate and transport of deep (50-feet) groundwater contamination at the Building 820 project site. Specific methods utilized to develop this report included a thorough collection and review of available reports and historical field data. Also, additional field data was

collected by CATLIN personnel on June 6, 2006 to help further evaluate the current deep (50-feet) groundwater conditions.

All site field and laboratory data was evaluated and utilized in the analytical transport model, *Bioscreen™ 1.4* to help predict the fate and transport of dissolved MTBE contamination in the deep (50-feet) aquifer at the Building 820 project site.

2.0 SITE INVESTIGATION

2.1 HISTORICAL GROUNDWATER DATA

Historical groundwater laboratory data was evaluated to analyze the historical trends of dissolved MTBE migration in the deep (50-feet) aquifer at the Building 820 project site. Based on a review of historical groundwater laboratory data, the dissolved MTBE contaminant plume has generally moved in a north-northwestern direction from the known source location, indicated as UST Basin on Figure 2. Historical groundwater laboratory results in monitoring well MW-09, proximate to the known source of release, indicate a general decrease in MTBE concentrations over time. However, monitoring well MW-17 has shown a general upward trend in MTBE concentrations. These results are consistent with the general migration of the dissolved MTBE contaminant plume.

Benzene, toluene, ethylbenzene, and xylenes concentrations have shown a general downward trend over time in the deep monitoring wells.

Please refer to Appendix B for historical groundwater laboratory data of the deep (50-feet) conditions.

2.2 DEEP (50-FEET) GROUNDWATER GAUGING

On June 6, 2006, CATLIN personnel gauged all deep (50-feet) Type III monitoring wells at the Building 820 project site for depth to groundwater. All wells were opened for a minimum of one hour to allow groundwater equilibration prior to gauging. This data was utilized to help determine pertinent groundwater characteristics and compare the current groundwater flow direction with the historical deep (50-feet) groundwater flow trends. The gauging data is included on Table 1.

The general groundwater flow direction in the deep (50-feet) aquifer has been in a west to north-west direction, as documented in previous reports and field data. Based on the June 6, 2006 gauging event, the groundwater flow in the deep aquifer is generally towards the west (see Figure 3).

2.3 GROUNDWATER FIELD MEASUREMENTS AND LABORATORY SAMPLING

In order to evaluate the suitability of natural attenuation of dissolved MTBE contamination, groundwater field measurements and samples were collected from three deep (50-feet) Type III monitoring wells (MW-09, MW-17 and MW-32) in accordance with CATLIN Standard Methods of Investigation (see Appendix D). These monitoring wells were sampled for analysis of geochemical parameters applicable for evaluating natural attenuation. Monitoring well MW-32 was included to provide a representative "clean" or "background" well while monitoring wells MW-09 and MW-17 were representative samples from within the dissolved contaminant plume.

Field measurements collected during the June 2006 gauging event include the following:

- pH
- Temperature
- Redox Potential
- Dissolved Oxygen
- Depth to Groundwater

Groundwater samples collected for laboratory analysis were analyzed for the following parameters:

- Iron
- Nitrates
- Sulfates
- Alkalinity
- Manganese
- Phosphorous
- Total Plate Count
- Calcium Hardness
- Total Organic Carbon

Results from the June 2006 field measurements and laboratory analysis are summarized in Table 2 and Table 3. Laboratory reports are included in Appendix A.

2.4 GROUNDWATER RESULTS – JUNE 2006

Total Plate Count

Microorganisms in the soil and groundwater are quantified using the total plate count parameter. Both monitoring wells, MW-09 and MW-17, within the deep (50-feet) dissolved MTBE contaminant plume, indicated total plate count results below quantitation limits (BQLs). Conversely, the total plate count results from monitoring well MW-32, a representative sample outside the dissolved contaminant plume, was 107 CFU/mL.

Total Organic Carbon (TOC)

Microorganisms require carbon as an energy source to sustain their metabolic functions, which include growth and reproduction. Therefore, the amount of TOC is important to sustain an adequate population of microorganisms for the biodegradation of petroleum hydrocarbon compounds.

The TOC concentrations in MW-09, MW-17 and MW-32 were 51.6 mg/L, 29.4 mg/L and 3.9 mg/L, respectively. These results indicate a higher TOC concentration within the deep (50-feet) dissolved contaminant plume.

pH and Temperature

Typically a pH value ranging from 6.0-8.0 (standard units) is optimal for microbial activity related to biodegradation of petroleum hydrocarbon compounds. Monitoring wells MW-09 and MW-17 indicated an average pH value of 2.66 (standard units) while monitoring well MW-32 indicated a more neutral pH average value of 7.43 (standard units).

Temperature is also an important parameter since it affects the solubility of dissolved oxygen and the metabolic activity of microorganisms. The preferred temperature range of 5° C to 25° C since biodegradation rates in groundwater tend to be slow below 5° C and above 25° C. Field measurements from the June 2006 gauging event indicated average temperatures in monitoring wells MW-09, MW-17 and MW-32 of 18.28° C, 17.22 ° C, and 13.31° C, respectively. Thus, indicating a 4-5° C higher groundwater temperature within the dissolved contaminant plume compared to the "clean" representative well, MW-32.

Alkalinity and Calcium Hardness

Alkalinity is important since it reflects the neutral buffering capacity of groundwater as it relates to pH. The transfer of carbon dioxide from aeration points and the respiration of microorganisms can contribute to the presence of hydroxides, carbonates and bicarbonates of calcium, magnesium, sodium, potassium and ammonia. This has a direct affect on the alkalinity of the

groundwater. Alkalinity results were consistent with the pH values detected during the June 2006 gauging event. Both monitoring wells MW-09 and MW017 indicated alkalinity levels BQL while monitoring well MW-32 indicated alkalinity level of 64 mg/L. Consequently, both monitoring wells within the dissolved contaminant plume had higher levels of calcium hardness compared to the representative "clean" monitoring well. Results of calcium hardness for MW-09, MW17 and MW-32 were 232 mg/L, 314 mg/L and 71.1 mg/L, respectively.

Dissolved Oxygen

Normally, dissolved oxygen concentrations above 2.0 mg/L indicate the presence of aerobic respiration; whereas, lower concentrations are indicative of anaerobic respiration. The range of dissolved oxygen levels within the dissolved contaminant plume (MW-09 and MW-17) were 4.0 mg/L to 2.03 mg/L while the dissolved oxygen levels from monitoring well MW-32 ranged from 4.35 mg/L to 0.24 mg/L.

Sulfate, Manganese and Iron

If dissolved oxygen has been depleted within the contaminant plume, sulfates, manganese, iron, nitrates and carbon dioxide may be used as electron acceptors for anaerobic decay. Sulfate levels in monitoring well MW-09, MW-17 and MW-32 in June 2006 were 1,694 mg/L, 3,167 mg/L and 18 mg/L, respectively. Manganese levels in monitoring well MW-09, MW-17 and MW-32 in June 2006 were 15.4 mg/L, 15.8 mg/L and 0.00553 mg/L, respectively. And Iron (ferrous) levels in monitoring well MW-09, MW-17 and MW-32 were 6.0 mg/L, 27.9 mg/L and1.18 mg/L, respectively.

Nitrate and Phosphorous

Nitrate levels from the June 2006 sampling event were BQL in all monitoring wells; MW-09, MW-17 and MW-32.

Phosphorous levels within the deep (50-feet) dissolved MTBE contaminant plume were 21.7 mg/L in monitoring well MW-09 and 2.12 mg/L in monitoring well MW-17. A concentration of 0.84 mg/L of phosphorous was detected in monitoring well MW-32, a representative sample outside the dissolved contaminant plume.

3.0 ANALYTICAL TRANSPORT MODEL, *BIOSCREEN™ 1.4*

3.1 MODEL DESCRIPTION

Bioscreen™ 1.4 is an analytical solute transport model based on the Dominenico model for multidimensional transport of a decaying contaminant species. The model has the ability to simulate advection, dispersion, adsorption, and aerobic decay, as well as anaerobic reactions. *Bioscreen™ 1.4* is programmed as a Microsoft Excel Spreadsheet Macro. The model

was developed for the Environmental Protection Agency (EPA) by the Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division at Brooks Air Force Base by Groundwater Services, Inc., Houston, Texas.

Bioscreen™ 1.4 has three contaminant simulation options: No Degradation Model, 1st Order Decay Model, and Instantaneous Reaction Model. A brief description of each simulation option is described as follows:

No Degradation Model

No Degradation Model is appropriate for predicting the movement of non-degrading solutes such as chloride and/or MTBE. The attenuation mechanisms within the No Degradation Model simulation option are dispersion in the longitudinal, transverse and vertical directions. Adsorption of contaminants to the soil matrix is also incorporated in the No Degradation Model simulation option.

1st Order Decay Model

The solute degradation rate in the 1st Order Decay Model is considered proportional to the solute concentration. The 1st Order Decay Model does not account for site-specific information such as the availability of electron acceptors. Also, no biodegradation of dissolved contaminants in the source zone are assumed. Thus, the 1st Order Decay Model assumes that biodegradation starts immediately down gradient of the source zone and that it does not depress the concentrations of dissolved organics in the source zone itself.

Instantaneous Reaction Model

The basis of the Instantaneous Reaction Model is to incorporate the biodegradation of organic contaminants in groundwater immediately in the source zone, unlike the 1st Order Decay Model. To incorporate this instantaneous reaction, a superposition method is used. With the superposition method, contaminant mass concentrations at any location and time within the flow field are corrected by subtracting 1 mg/L organic mass for each mg/L of biodegradation capacity provided by all of the available electron acceptors.

3.2 MODEL ASSUMPTIONS

The assumptions for the *Bioscreen™ 1.4* model include:

1. The aquifer and flow fields are homogeneous and isotropic.
2. The groundwater is fast enough that molecular diffusion in the dispersion terms can be ignored.
3. Simple groundwater flow conditions exist.

4. The contaminant source is infinite.
5. The model assumes a vertical plume source with constant concentration.
6. Adsorption is a reversible process represented by a linear isotherm.

3.3 MODEL EXECUTION

The objective of the model was to examine and predict the dissolved MTBE contaminant plume size, concentration and migratory progress within the deep (50-feet) aquifer over time. As an initial step, for each scenario described below, the model was calibrated for a run time of 15-years (approximate time since the initial release) to represent current conditions. Once current conditions, based on most recent groundwater analytical data, was established by the model, the model was then run for at a 17-year (future 2 years), a 20-year (future 5 years) and a 25-year (future 10 year) simulation.

3.3.1 SCENARIO – I (R=1.0)

For the first model simulation, in the adsorption section of *Bioscreen™ 1.4*, a Retardation Factor of 1.0 was used which indicates no degradation over time. This was due to the fact that MTBE does not readily adhere to soil particles within the aquifer matrix and therefore, a Retardation Factor of 1.0 indicates the subject contaminant is very mobile. Although all model run options were simulated and observed the No Degradation Model option was specifically important, due to the nature of MTBE not readily decaying.

3.3.2 SCENARIO – II (R=1.6)

For the second model simulation, a Retardation Factor of 1.6 was calculated by Bioscreen™ 1.4 and used for analysis. Although MTBE does not readily adhere to soil particles within the aquifer matrix, a Retardation Factor of 1.6 assumes some sorption of MTBE is occurring. It should be noted that by using a Retardation value of 1.6 vs. 1.0, as simulated in Scenario I, the model had to be recalibrated to existing conditions.

3.4 MODEL RESULTS

As previously mentioned, the model was first calibrated to existing conditions utilizing a 15-year simulation time (approximate time since the initial release). Once current conditions, based on most recent groundwater analytical data, were established by the model, the model was then run for a 17-year (future 2 years), a 20-year (future 5 years) and a 25-year (future 10 year) simulation times.

3.4.1 SCENARIO – I (R=1.0)

MAXIUM DISTANCE OF DISSOLVED MTBE CONTAMINATION EXCEEDING 2L GWQS (0.2 mg/L)

TYPE OF MODEL	FUTURE 2-YEAR	FUTURE 5-YEAR	FUTURE 10-YEAR
No Degradation	645 ft.	730 ft.	895 ft.
1st Order Decay	643 ft.	725 ft.	890 ft.
Instantaneous Reaction	350 ft.	430 ft.	500 ft.

NOTE: Currently, the dissolved MTBE contamination exceeding 2LGWQS has migrated approximately 400 ft. from the source location (UST Basin) as indicated in Figure 2.

3.4.2 SCENARIO – II (R=1.6)

MAXIUM DISTANCE OF DISSOLVED MTBE CONTAMINATION EXCEEDING 2L GWQS (0.2 mg/L)

TYPE OF MODEL	FUTURE 2-YEAR	FUTURE 5-YEAR	FUTURE 10-YEAR
No Degradation	430 ft.	495 ft.	610 ft
1st Order Decay	430 ft.	490 ft.	600 ft
Instantaneous Reaction	240 ft.	256 ft.	344 ft.

NOTE: Currently, the dissolved MTBE contamination exceeding 2LGWQS has migrated approximately 400 ft. from the source location (UST Basin) as indicated in Figure 2.

4.0 CONCLUSIONS

The following conclusions were made based current and historical data collected in addition to the *Bioscreen™ 1.4* model output.

Based on analysis of dissolved contaminant concentrations overtime, the deep (50-feet) contaminant plume has migrated away from the source in a west-northwest direction. It is also important to recognize that the migration of the deep (50-feet) contamination is consistent with the general groundwater flow trends in the deep (50-feet) aquifer at the building 820 project site.

The field data collected in June 2006 indicates a microbial population deficiency within the area of deep (50-feet) dissolved contamination. This is supported by the

total plate count parameter, a quantitative measurement of microorganisms present. Since both monitoring wells within the deep (50-feet) dissolved contaminant plume indicated total plate count results below BQL, it is unlikely that there are microorganisms degrading the dissolved plume within the areas sampled. Monitoring well MW-32, a representative sample outside the dissolved MTBE contaminant plume, indicated a total plate count result of 107 CFU/mL.

Typically a pH value ranging from 6.0-8.0 (standard units) is optimal for microbial activity related to biodegradation of petroleum hydrocarbon compounds. As previously mentioned, the recently collected field data indicates extensive pH ranges within the dissolved contaminant plume compared to pH outside the contaminant plume. The very acidic conditions within the deep (50-feet) contaminate plume could explain the lack of microbial presence since such extreme pH values (less than 5 or greater than 10) are generally unfavorable for microbial activity.

Normally, dissolved oxygen concentrations above 2.0 mg/L indicate the presence of aerobic respiration; whereas, lower concentrations are indicative of anaerobic respiration. The range of dissolved oxygen within the dissolved MTBE contaminant plume were 4.0 mg/L to 2.03 mg/L while the dissolved oxygen levels from monitoring well MW-32 ranged from 4.35 mg/L to 0.24 mg/L, with a downward trend over time. Therefore, it could be stated that the environment within the deep (50-feet) contaminant plume is close to an aerobic environment and the "clean" representative sample (MW-32) is indicative of anaerobic environment. The higher DO values within wells MW-9 and MW-17 may be influenced by the existing air sparge system at the site.

The sulfate, manganese, nitrate, and iron levels can then be explained by the two different environments in the deep (50-feet) groundwater. As previously mentioned, if dissolved oxygen has been depleted, sulfates, manganese, iron, nitrates and carbon dioxide may be used as electron acceptors for anaerobic decay. Recall the sulfates, manganese and iron levels were all higher in the deep contaminant plume when compared to the representative "clean" sample (MW-32). The fact that the sampling data from June 2006 indicated an anaerobic environment with a microbial population in monitoring well MW-32 supports the fact that there would be depleted levels of sulfates, manganese, iron and nitrates in this area of the deep (50-feet) aquifer.

The results from *Bioscreen™ 1.4* have indicated a maximum migration distance of dissolved MTBE contamination in excess of 2L GWQS to be approximately 900 feet from the source area. Due to the fact that MTBE does not readily adhere to soil particles within the aquifer matrix and does not readily decay, it is important to consider Scenario-I (R=1.0) and the No Degradation simulation model of *Bioscreen™ 1.4.* Although a second scenario was conducted using a Retardation factor of 1.6, the maximum potential migration of the dissolved MTBE contaminant plume was established during Scenario-I simulations. Also, due to the general west-northwest flow direction of the deep (50-feet) aquifer and dissolved contaminant plume water supply well 623 (north-northeast of the subject site) and Wallace Creek (southeast of the subject site) do not appear to have the potential of

being impacted. The north-northwestern migration of the dissolved contaminant plume could potentially lead to the plume migrating under the athletic fields associated with the middle school. The athletic fields are located approximately 500 feet to the northwest of the building 820 project site but due to the depth of the contamination (50-feet), there appears to be no immediate threat to activities associated with the athletic fields.

In general, all modeling results have simulated the deep (50-feet) dissolved MTBE contamination exceeding 2L GWQS to migrate less than 1,000 feet from the source and do not appear to have the potential for affecting any receptors in the area.

5.0 REFERENCES

CATLIN Engineers and Scientists, *Remedial Action Optimization & Revised Corrective Action Plan Building 820, Marine Corps Base, Camp Lejeune, NC,* February 26, 2004.

CATLIN Engineers and Scientists, *Remedial Action Optimization & Revised Corrective Action Plan Addendum Report Building 820, Marine Corps Base, Camp Lejeune, NC,* March 20, 2006.

Groundwater Services, Inc. and Technology Transfer Division, Air Force Center for Environmental Excellence, *BIOSCREEN, Natural Attenuation Decision Support System, User's Manual Version 1.4.* July 1997.

North Carolina Department of Environment and Natural Resources, Division of Waste Management, UST Section, *Guidelines for Assessment and Corrective Action*, effective July 1, 2001.

U.S. Environmental Protection Agency, *In-Situ Groundwater Remediation, How to Evaluate Alternative Cleanup Technologies for Underground Storage Tanks Sites: A Guide for Corrective Action Plan Reviewers.* (EPA 510-B-95-007). Accessed: July 20, 2006.

TABLES

TABLE 1

WELL CONSTRUCTION DATA AND GROUNDWATER ELEVATIONS

BUILDING 820
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

WELL I.D.	DATE GAUGED	DATE CONSTRUCTED	DTW (Feet)	TOP OF CASING (Feet)	DIAMETER (Inches)	TOTAL DEPTH (Feet Below TOC)	CASING INTERVAL (Feet Below TOC)	SCREEN INTERVAL (Feet Below TOC)	ELEVATION
50-FEET TYPE III MONITORING WELLS									
MW-7	6/6/2006	NA	12.18	27.18	NA	51.8	0-46.8	46.8-51.8	15.00
MW-9	6/6/2006	NA	17.88	31.95	2	51.5	0-46.5	46.5-51.5	14.07
MW-17	6/6/2006	4/1/1994	19.01	32.58	2	49.5	0-44.5	44.5-49.5	13.57
MW-19	6/6/2006	4/1/1994	NM	31.73	2	49.5	0-44.5	44.5-49.5	NA
MW-21	6/6/2006	3/31/1994	17.94	31.80	2	49.5	0-44.5	44.5-49.5	13.86
MW-23	6/6/2006	3/30/1994	17.28	31.2	2	49.5	0-44.5	44.5-49.5	13.92
MW-25	6/6/2006	3/30/1994	14.66	28.51	2	48.5	0-43.5	43.5-48.5	13.85
MW-28	6/6/2006	4/21/2005	15.51	28.85	2	50	0-45	45-50	13.34
MW-29	6/6/2006	4/22/2005	12.79	26.17	2	50	0-45	45-50	13.38
MW-30	6/6/2006	11/30/2005	15.90	30.39	2	50	0-45	45-50	14.49
MW-31	6/6/2006	11/30/2005	15.85	30.16	2	50	0-45	45-50	14.31
MW-32	6/6/2006	11/30/2005	15.32	29.57	2	50	0-45	45-50	14.25
MW-33	6/6/2006	11/30/2005	17.70	31.7	2	50	0-45	45-50	14.00
100-FEET TYPE III MONITORING WELLS									
MW-9D	6/6/2006	9/20/2001	14.18	32.54	2	98	+2-93	93-98	18.36
MW-34	6/6/2006	1/9/2006	15.05	27.77	2	100	0-95	95-100	12.72

1. Casing and screen intervals are assumed to be based on measurements from Top of Casing.
2. Total depth based on maximum depth of screen interval.
3. Top of casing provided by SHAW ENVIRONMENTAL, INC. 2002 Annual Monitoring Report.
4. Data for casing and screen intervals obtained from various OHM/SHAW Monitoring Reports.
5. NA = not available
6. NM = not measured

TABLE 1

SUMMARY OF CURRENT GROUNDWATER FIELD MEASUREMENTS
NATURAL ATTENUATION PARAMETERS

BUILDING 820
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

WELL I.D.	DATE MEASURED	TIME OF MEASUREMENT	pH (Standard Units)	SPECIFIC CONDUCTIVITY (µs/cm)*	TEMPERATURE (°C)	IRON (mg/L)	OXIDATION REDUCTION POTENTIAL (mV)	DISSOLVED OXYGEN (mg/L)
UST820-MW32	6/6/2006	12:15	9.83	0.273	13.28	NM	14.7	4.35
		12:20	8.40	0.226	13.28	NM	-61.1	1.00
		12:25	7.90	0.218	13.31	NM	-71.5	0.69
		12:30	7.04	0.208	13.30	NM	-44.0	0.62
		12:35	6.74	0.202	13.32	NM	-39.6	0.46
		12:40	6.60	0.196	13.34	NM	-38.2	0.35
		12:45	6.46	0.188	13.32	NM	-32.1	0.26
		12:50	6.43	0.185	13.34	1.0	-30.3	0.24
UST820-MW17	6/6/2006	13:15	2.33	8.377	16.40	NM	451.2	2.97
		13:20	2.33	8.400	17.17	NM	437.1	2.70
		13:30	2.34	8.393	17.09	NM	431.0	2.80
		13:35	2.36	8.300	17.28	NM	425.2	2.95
		13:40	2.36	8.278	17.34	NM	423.5	3.28
		13:45	2.37	8.276	17.39	NM	419.1	3.42
		13:50	2.36	8.711	17.38	NM	413.1	3.40
		13:55	2.38	8.325	17.40	NM	415.8	3.22
		14:00	2.39	8.287	17.55	3.6	413.8	3.11
UST820-MW09	6/6/2006	14:20	2.73	6.750	18.11	NM	379.0	2.03
		14:25	2.79	6.701	18.34	NM	368.0	2.79
		14:30	2.93	6.578	18.27	NM	346.0	4.00
		14:40	3.06	6.548	18.29	NM	320.0	2.35
		14:45	3.10	6.522	18.29	NM	317.0	2.32
		14:50	3.12	6.492	18.31	NM	315.0	2.30
		14:55	3.13	6.471	18.31	NM	315.0	2.33
		15:00	3.13	6.470	18.32	5.0	314.0	2.32

NOTES:
°C = Degrees in Celsius
µs/cm = Microsiemens per Centimeter
mg/L = Milligram per Liter
mV = Millivolt

TABLE 3

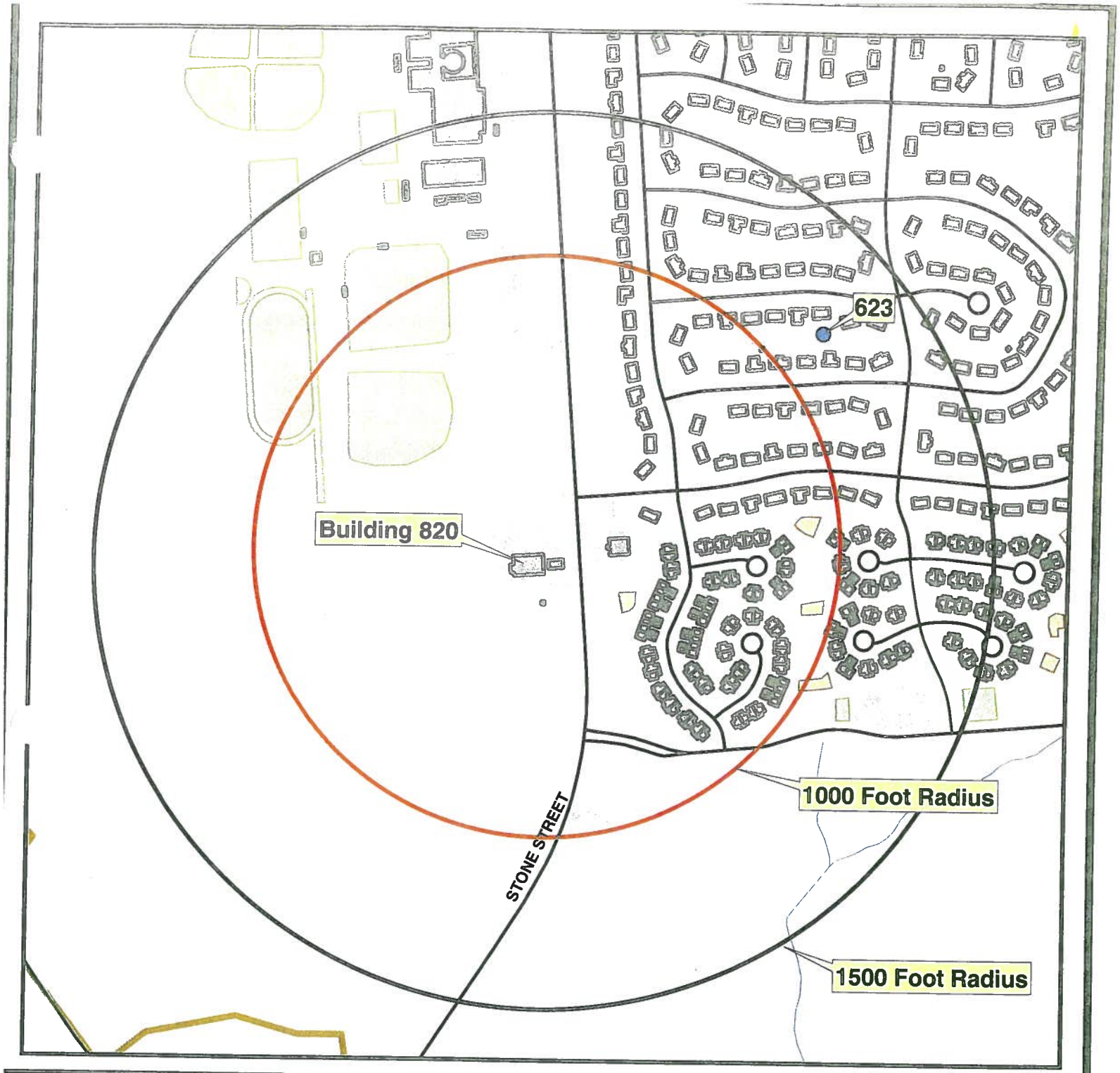
SUMMARY OF GROUNDWATER LABORATORY RESULTS

BUILDING 820
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

CONTAMINANT OF CONCERN →		EPA METHOD 6010B			EPA METHOD SM3500-Fe	EPA METHOD 310.1	EPA METHOD 353.3	EPA METHOD 415.1	EPA METHOD 365.2	EPA METHOD SM9215B	EPA METHOD 375.4
WELL I.D.	DATE COLLECTED	CALCIUM (mg/L)	MANGANESE (mg/L)	HARDNESS (mg/L)	FERROUS IRON (mg/L)	ALKALINITY (mg/L)	NITRATE (mg/L)	TOC (mg/L)	PHOSPHORUS (mg/L)	PLATE COUNT (CFU/mL)	SULFATE (mg/L)
UST820-MW09	6/6/2006	35.2	15.4	232	6.00	<2	<0.025	51.6	21.7	<1	1,694
UST820-MW17	6/6/2006	51.9	15.8	314	27.9	<2	<0.025	29.4	2.12	<1	3,167
UST820-MW32	6/6/2006	27.5	0.00553 J	71.1	1.18	64	<0.025	3.9	0.84	107	18

NOTES:
J = Estimated concentration, below calibration range and above method detection limit.
µg/L = Micrograms per Liter
mg/L = Milligram per Liter
CFU/mL = Colony Forming Units per Milliliter

FIGURES



Water Supply Wells
- ACTIVE
- CLOSED
- INACTIVE
- PENDING

Roads
Railroads
Recreational Horse Trail
Buildings and Structures
Parking Lots
Playgrounds
Driveways
Athletic Fields
Athletic Courts
Surface Water
Creeks
Surface Water

500 0 500 Feet
SCALE

N
W E
S

CATLIN ENGINEERS and SCIENTISTS

DRAWN BY:	CHECK BY:	APPROVED BY:
THW	JC	MEM

CATLIN PROJECT No.: 205-043

SITE VICINITY MAP for BUILDING 820 AREA

BUILDING 820 1500 ft. RADIUS with RECEPTORS

FIGURE 1

ESTIMATED EXTENT OF DEEP (50–FEET) DISSOLVED MTBE CONTAMINATION IN EXCESS OF 2LGWQS

N

MW–31
MW–30
MW–32
MW–28
UST820–MW34
MW–33
MW–29
MW–16
MW–17
MW–9
MW–9D
MW–19
MW–7
MW–8
MW–20
MW–21
MW–23
MW–25

BUILDING 820
PARKING LOT
PUMP ISLAND
CANOPY
SHRUBBERY
DUMPSTER
UST BASIN
EQUIPMENT COMPOUND
PW–1
STONE STREET
TRAIL
WOODS
MW-1 MW-2 MW-3 MW-5 MW-6 MW-10 MW-11 MW-13 MW-14 MW-15 MW-18 MW-22S MW-24S MW-26 MW-27

LEGEND

EXISTING	ACTIVE	DESCRIPTION
▨		BUILDING
⊕		TYPE II MONITORING WELL
⊕		TYPE III MONITORING WELL
◯		PUMPING WELL
■	■	AS/SVE WELL
—F—		FUEL LINE

100 50 0 100
SCALE IN FEET

CATLIN ENGINEERS and SCIENTISTS
WILMINGTON, NORTH CAROLINA

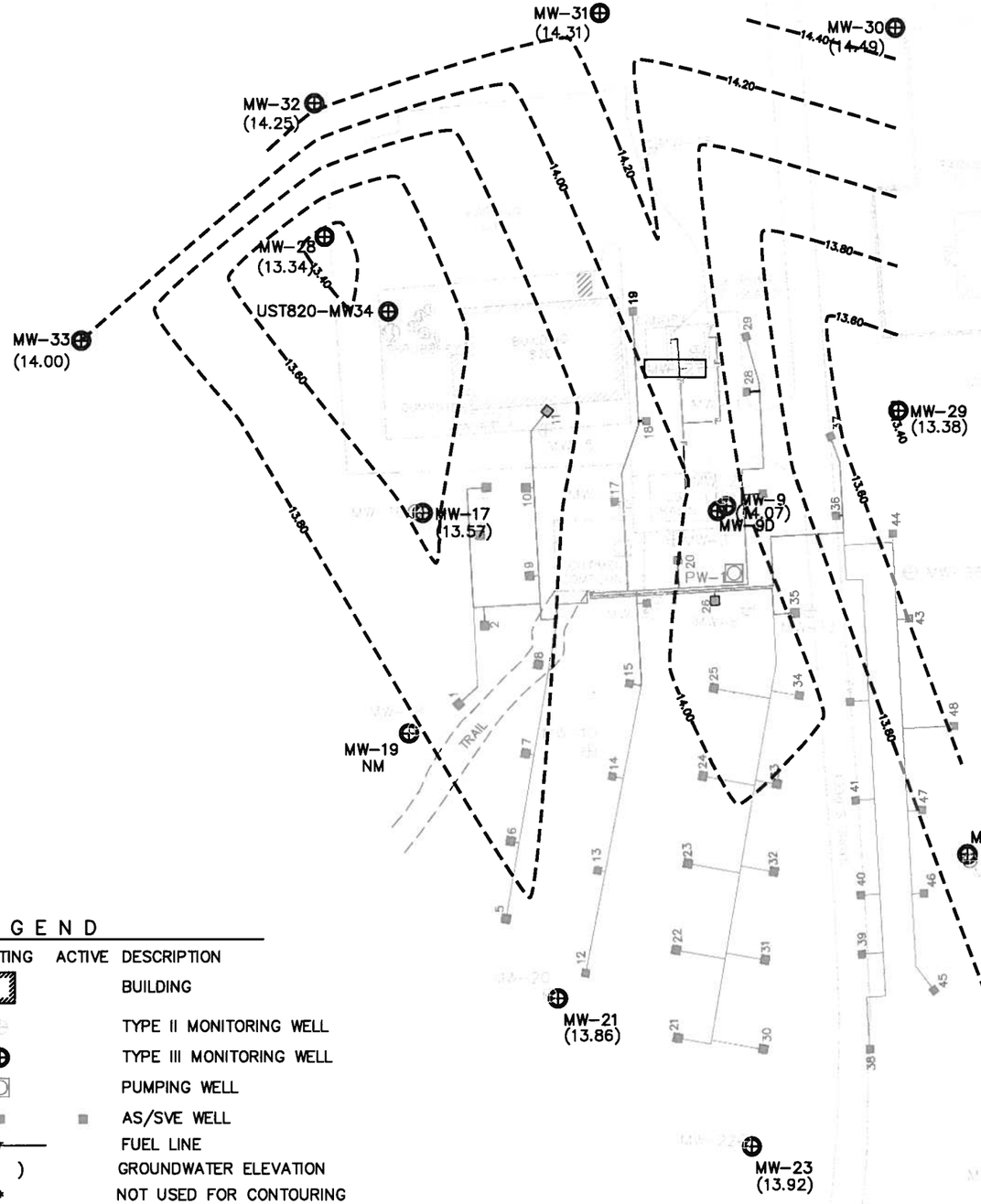
PROJECT: BUILDING 820 -- NATURAL ATTENUATION MODELING MARINE CORPS BASE CAMP LEJEUNE, N.C.
JOB NO. 206–030 | DATE: JULY 2006

TITLE: DEEP (50 – FEET) DISSOLVED MTBE PLUME BOUNDARIES

SCALE: 1'=100' | DRAWN BY: KAWS | CHECKED BY: JPC

FIGURE 2

206030–BLD820–2



N

LEGEND

EXISTING	ACTIVE	DESCRIPTION
		BUILDING
		TYPE II MONITORING WELL
		TYPE III MONITORING WELL
		PUMPING WELL
		AS/SVE WELL
		FUEL LINE
( )		GROUNDWATER ELEVATION
*		NOT USED FOR CONTOURING

100 50 0 100

SCALE IN FEET

CATLIN
ENGINEERS and SCIENTISTS
WILMINGTON, NORTH CAROLINA

PROJECT: BUILDING 820 -- NATURAL ATTENUATION MODELING MARINE CORPS BASE CAMP LEJEUNE, N.C.

TITLE: DEEP (50 – FEET) GROUNDWATER CONTOUR MAP

FIGURE 3

JOB NO. 206-030 | DATE: JULY 2006 | SCALE: 1'=100' | DRAWN BY: KAWS | CHECKED BY: JPC

206030-BLD820-3

APPENDICES

APPENDIX A

GROUNDWATER LABORATORY RESULTS – JUNE 2006

SGS

Mr. Mike E. Mason
Richard Catlin & Associates
P.O. Box 10279
Wilmington NC 28404-0279

Report Number: G128-1778

Client Project: BLDG 820

Dear Mr. Mason:

Enclosed are the results of the analytical services performed under the referenced project. The samples are certified to meet the requirements of the National Environmental Laboratory Accreditation Conference Standards. Copies of this report and supporting data will be retained in our files for a period of five years in the event they are required for future reference. Any samples submitted to our laboratory will will be retained for a maximum of thirty (30) days from the date of this report unless other arrangements are requested.

If there are any questions about the report or the services performed during this project, please call SGS/Paradigm at (910) 350-1903. We will be happy to answer any questions or concerns which you may have.

Thank you for using SGS/Paradigm Analytical Labs for your analytical services. We look forward to working with you again on any additional analytical needs which you may have.

Sincerely,
SGS/Paradigm Analytical Laboratories, Inc.

7/13/2006
Laboratory Director Date
J. Patrick Weaver

SGS

Results for Metals

Client Sample ID:	UST 820-MW 09	Analyzed By:	RML
Client Project ID:	BLDG 820	Date Collected:	6/6/2006 15:00
Lab Sample ID:	G128-1778-1	Date Received:	6/7/06
Lab Project ID:	G128-1778	Matrix:	WATER
Batch ID:	5358		

Metals	Result	RL	MDL	DF	Units	Method	Date Analyzed	Flags
Calcium	**35.2**	0.100	0.0110	1	MG/L	6010B	6/15/06	
Manganese	**15.4**	1.00	0.0410	100	MG/L	6010B	7/11/06	

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor
J = Between MDL and RL
B= Amount in Prep Blank > MDL

Reviewed By: _____
MET_LIMS_4.1

SGS

Results for Metals

Client Sample ID:	UST 820-MW 17	Analyzed By:	RML
Client Project ID:	BLDG 820	Date Collected:	6/6/2006 14:00
Lab Sample ID:	G128-1778-2	Date Received:	6/7/06
Lab Project ID:	G128-1778	Matrix:	WATER
Batch ID:	5358		

Metals	Result	RL	MDL	DF	Units	Method	Date Analyzed	Flags
Calcium	**51.9**	0.100	0.0110	1	MG/L	6010B	6/16/06	
Manganese	**15.8**	1.00	0.0410	100	MG/L	6010B	7/11/06	

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor
J = Between MDL and RL
B= Amount in Prep Blank > MDL

Reviewed By: _____
MET_LIMS_4.1

SGS

Results for Metals

Client Sample ID:	UST 820-MW 32	Analyzed By:	RML
Client Project ID:	BLDG 820	Date Collected:	6/6/2006 12:50
Lab Sample ID:	G128-1778-3	Date Received:	6/7/06
Lab Project ID:	G128-1778	Matrix:	WATER
Batch ID:	5358		

Metals	Result	RL	MDL	DF	Units	Method	Date Analyzed	Flags
Calcium	**27.5**	0.100	0.0110	1	MG/L	6010B	6/16/06	
Manganese	**0.00553**	0.0100	0.000410	1	MG/L	6010B	6/16/06	J

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor
J = Between MDL and RL
B= Amount in Prep Blank > MDL

Reviewed By: _____
MET_LIMS_4.1

SGS

Results for Hardness

Client Sample ID:	UST 820-MW 09	Analyzed By:	RML
Client Project ID:	BLDG 820	Date Collected:	6/6/2006 15:00
Lab Sample ID:	G128-1778-1	Date Received:	6/7/06
Lab Project ID:	G128-1778	Matrix:	WATER
Batch ID:	5358		

Metals	Result	RL	DF	Units	Method	Date Analyzed
Hardness	**232**	0.662	1	MG/L	6010B	6/15/06

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor

Reviewed By: _____
Hardness_LIMS_v0.2

SGS

Results for Hardness

Client Sample ID:	UST 820-MW 17	Analyzed By:	RML
Client Project ID:	BLDG 820	Date Collected:	6/6/2006 14:00
Lab Sample ID:	G128-1778-2	Date Received:	6/7/06
Lab Project ID:	G128-1778	Matrix:	WATER
Batch ID:	5358		

Metals	Result	RL	DF	Units	Method	Date Analyzed
Hardness	**314**	0.662	1	MG/L	6010B	6/16/06

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor

Reviewed By: _____
Hardness_LIMS_v0.2

SGS

Results for Hardness

Client Sample ID:	UST 820-MW 32	Analyzed By:	RML
Client Project ID:	BLDG 820	Date Collected:	6/6/2006 12:50
Lab Sample ID:	G128-1778-3	Date Received:	6/7/06
Lab Project ID:	G128-1778	Matrix:	WATER
Batch ID:	5358		

Metals	Result	RL	DF	Units	Method	Date Analyzed
Hardness	**71.1**	0.662	1	MG/L	6010B	6/16/06

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor

Reviewed By: _____
Hardness_LIMS_v0.2

SGS

Results for Metals

Client Sample ID:	UST 820-MW 09	Analyzed By:	PSW
Client Project ID:	BLDG 820	Date Collected:	6/6/2006 15:00
Lab Sample ID:	G128-1778-1S	Date Received:	6/7/06
Lab Project ID:	G128-1778	Matrix:	Water

Metals	Result	RL	DF	Units	Method	Date Analyzed
Ferrous Iron	**6.00**	2.00	10.00	MG/L	SM3500-Fe	7/13/06

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor

Reviewed By: _____
FE2_LIMS_v0.2

SGS

Results for Metals

Client Sample ID:	UST 820-MW 17	Analyzed By:	PSW
Client Project ID:	BLDG 820	Date Collected:	6/6/2006 14:00
Lab Sample ID:	G128-1778-2O	Date Received:	6/7/06
Lab Project ID:	G128-1778	Matrix:	Water

Metals	Result	RL	DF	Units	Method	Date Analyzed
Ferrous Iron	**27.9**	2.00	10.00	MG/L	SM3500-Fe	7/13/06

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor

Reviewed By: _____
FE2_LIMS_v0.2

SGS

Results for Metals

Client Sample ID:	UST 820-MW 32	Analyzed By:	PSW
Client Project ID:	BLDG 820	Date Collected:	6/6/2006 12:50
Lab Sample ID:	G128-1778-3P	Date Received:	6/7/06
Lab Project ID:	G128-1778	Matrix:	Water

Metals	Result	RL	DF	Units	Method	Date Analyzed
Ferrous Iron	**1.18**	0.200	1.00	MG/L	SM3500-Fe	7/13/06

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor

Reviewed By: _____
FE2_LIMS_v0.2

SGS

Analytical Results

Client Sample ID:	UST 820-MW 09	Date Collected:	6/6/2006
Client Project ID:	BLDG 820	Date Received:	6/7/2006
Lab Sample ID:	G128-1778-1	Matrix:	Water
Lab Project ID:	G128-1778		

Analyte	Result	RL	Units	Method	Date Analyzed	Analyst
Alkalinity	BQL	2	mg/L	EPA310.1	6/12/2006	Envirochem
Nitrate	BQL	0.025	mg/L	EPA353.3	6/9/2006	Envirochem
TOC	**51.6**	0.5	mg/L	EPA415.1	6/16/2006	Envirochem
Phosphorus	**21.7**	0.02	mg/L	EPA365.2	6/9/2006	Envirochem
Plate Count	BQL	1	CFU/mL	SM9215B	6/7/2006	Envirochem
Sulfate	**1694**	5	mg/L	EPA375.4	6/12/2006	Envirochem

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor
RL = Report Limit

Reviewed By: _____
subout_LIMS_v1.2

SGS

Analytical Results

Client Sample ID:	UST 820-MW 17	Date Collected:	6/6/2006
Client Project ID:	BLDG 820	Date Received:	6/7/2006
Lab Sample ID:	G128-1778-2	Matrix:	Water
Lab Project ID:	G128-1778		

Analyte	Result	RL	Units	Method	Date Analyzed	Analyst
Alkalinity	BQL	2	mg/L	EPA310.1	6/12/2006	Envirochem
Nitrate	BQL	0.025	mg/L	EPA353.3	6/9/2006	Envirochem
TOC	**29.4**	0.5	mg/L	EPA415.1	6/16/2006	Envirochem
Phosphorus	**2.12**	0.02	mg/L	EPA365.2	6/9/2006	Envirochem
Plate Count	BQL	1	CFU/mL	SM9215B	6/7/2006	Envirochem
Sulfate	**3167**	5	mg/L	EPA375.4	6/12/2006	Envirochem

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor
RL = Report Limit

Reviewed By: _____
subout_LIMS_v1.2

SGS

Analytical Results

Client Sample ID:	UST 820-MW 32	Date Collected:	6/6/2006
Client Project ID:	BLDG 820	Date Received:	6/7/2006
Lab Sample ID:	G128-1778-3	Matrix:	Water
Lab Project ID:	G128-1778		

Analyte	Result	RL	Units	Method	Date Analyzed	Analyst
Alkalinity	**64**	2	mg/L	EPA310.1	6/12/2006	Envirochem
Nitrate	BQL	0.025	mg/L	EPA353.3	6/9/2006	Envirochem
TOC	**3.9**	0.5	mg/L	EPA415.1	6/16/2006	Envirochem
Phosphorus	**0.84**	0.02	mg/L	EPA365.2	6/9/2006	Envirochem
Plate Count	**107**	1	CFU/mL	SM9215B	6/7/2006	Envirochem
Sulfate	**18**	5	mg/L	EPA375.4	6/12/2006	Envirochem

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor
RL = Report Limit

Reviewed By: _____
subout_LIMS_v1.2

SGS

Results for Organics
by EPA 3810

Client Sample ID: UST 820-MW 09
Client Project ID: BLDG 820
Lab Sample ID: G128-1778-1H
Lab Project ID: G128-1778

Analyzed By: BWS
Date Collected: 06-06-2006 15:00
Date Received: 06-07-2006 10:30
Matrix: Water

Compound	Result ug/L	Quantitation Limit ug/L	Dilution Factor	Date Analyzed
Methane	BQL	7.2	1	06-19-2006
Ethane	BQL	20	1	06-19-2006
Ethene	BQL	20	1	06-19-2006

Reviewed By: _____

METHANE_LIMS_2.1_IP

SGS

Results for Organics
by EPA 3810

Client Sample ID: UST 820-MW 17
Client Project ID: BLDG 820
Lab Sample ID: G128-1778-2H
Lab Project ID: G128-1778

Analyzed By: BWS
Date Collected: 06-06-2006 14:00
Date Received: 06-07-2006 10:30
Matrix: Water

Compound	Result ug/L	Quantitation Limit ug/L	Dilution Factor	Date Analyzed
Methane	BQL	7.2	1	06-19-2006
Ethane	BQL	20	1	06-19-2006
Ethene	BQL	20	1	06-19-2006

Reviewed By: _____

METHANE_LIMS_2.1_IP

SGS

Results for Organics
by EPA 3810

Client Sample ID: UST 820-MW 32
Client Project ID: BLDG 820
Lab Sample ID: G128-1778-3H
Lab Project ID: G128-1778

Analyzed By: BWS
Date Collected: 06-06-2006 12:50
Date Received: 06-07-2006 10:30
Matrix: Water

Compound	Result ug/L	Quantitation Limit ug/L	Dilution Factor	Date Analyzed
Methane	BQL	7.2	1	06-19-2006
Ethane	BQL	20	1	06-19-2006
Ethene	BQL	20	1	06-19-2006

Reviewed By: _____

METHANE_LIMS_2.1_IP

SGS

List of Reporting Abbreviations and Data Qualifiers

B = Compound also detected in batch blank

BQL = Below Quantitation Limit (RL or MDL)

DF = Dilution Factor

Dup = Duplicate

D = Detected, but RPD is > 40% between results in dual column method.

E = Estimated concentration, exceeds calibration range.

J = Estimated concentration, below calibration range and above MDL

LCS(D) = Laboratory Control Spike (Duplicate)

MDL = Method Detection Limit

MS(D) = Matrix Spike (Duplicate)

PQL = Practical Quantitation Limit

RL = Reporting Limit

RPD = Relative Percent Difference

mg/kg = milligram per kilogram, ppm, parts per million

ug/kg = micrograms per kilogram, ppb, parts per billion

mg/L = milligram per liter, ppm, parts per million

ug/L = micrograms per liter, ppb, parts per billion

% Rec = Percent Recovery

% soilds = Percent Solids

Special Notes:

1) Metals and mercury samples are digested with a hot block, see the standard operating procedure document for details.

2) Uncertainty for all reported data is less than or equal to 30 percent.

MI34.030606.3

1 3 2 2 5 1

205-043

SGS

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- West Virginia
- Hawaii
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SGS ENVIRONMENTAL SERVICES, INC.

N.C. CERTIFICATION #481

(1)

CLIENT: CATLIN

CONTACT: MIKE EMASON PHONE NO:(910) 452-5866

PROJECT: BLDG 820 SITE/PWSID#:

REPORTS TO: MEM FAX NO.:( )

INVOICE TO: SHEILA@CATLIN QUOTE # DOD 161

P.O. NUMBER 260607-3

SGS Reference: G128-1778

PAGE 1 OF 1

(2)

LAB NO.	SAMPLE IDENTIFICATION	DATE	TIME	MATRIX	No CONTAINERS	SAMPLE TYPE (C=COMP, G=GRAB)	Preservatives Used	Analysis Required (3) 6010 B (Manganese, Calcium, Iron)	365.2 - Phosphorus	9215B - Total Plate Count	375.4 - Sulfate	353.3 - Nitrates	310.1 - Alkalinity	415.1 TOC	Ferrous Iron	METHANE	REMARKS
	UST 820-MW09	6.6.06	1500	GRND H2O	12	G		✓	✓	✓	✓	✓	✓	✓	✓	✓	
	UST 820-MW17	↓	1400	↓	↓	↓		↓	↓	↓	↓	↓	↓	↓	↓	↓	
	UST 820-MW32	↓	1250	↓	↓	↓		↓	↓	↓	↓	↓	↓	↓	↓	↓	LABELED TIME INCORRECT

(5)

Collected/Relinquished By:(1)	Date	Time	Received By:
	6.7.06	1030	L. Lockamy
Relinquished By: (2)	Date	Time	Received By:
Relinquished By: (3)	Date	Time	Received By:
Relinquished By: (4)	Date	Time	Received By:

(4)

Shipping Carrier:

Shipping Ticket No:

Samples Received Cold? (Circle) YES NO

Temperature ∫C:_____ ĩ_____

Special Deliverable Requirements:

Chain of Custody Seal: (Circle)

INTACT BROKEN ABSENT

Requested Turnaround Time and Special Instructions: STNRD TURN

PLEASE REPORT IN SUMMARY EDD & LEJUNE EDD FORMAT W/ BATCH QC DATA & ANY LOW RUNS

200 W. Potter Drive Anchorage, AK 99518 Tel: (907) 562-2343 Fax: (907) 561-5301
5600 Business Drive Wilmington, NC 28405 Tel: (910) 350-1903 Fax: (910) 350-1557
1258 Greenbrier Street Charleston, WV 25311 Tel: (304) 346-0725 Fax: (304) 346-0761

White - Retained by Lab
Yellow - Returned with Report
Pink - Retained by Sampler

APPENDIX B

HISTORICAL GROUNDWATER LABORATORY RESULTS – DEEP (50-FEET) MONITORING WELLS

DATA POVIDED BY SHAW ENVIRONMENTAL, INC.

CLJ - POL Berkeley Manor
Project #110385

Analytical Data Summary

Type III Well: **MW-7**

Client Sample ID:		143GW027	143GW053	143GW084	143GW108		143GW142	143GW153	143GW163	143GW181	143GW199
Date Sampled:		08/19/97	02/11/98	05/12/98	08/15/98	11/17/98	02/26/99	05/18/99	09/10/99	11/17/99	05/18/00
Analyte (ug/l)	**Action Level**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
EPA 601											
1,2-Dichlorobenzene	620	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,3-Dichlorobenzene	620	<0.8	<0.8	<0.8	<0.8	<1	<1	<1	<1	<1	<1
1,4-Dichlorobenzene	75	<1.5	**0.12 J**	**0.34 J**	**1.2 JB**	**0.82 J**	<1	<1	<1	<1	<1
Dibromochloromethane	0.41	NA	NA	NA	NA	NA	<1	<1	<1	<1	<1
Chloroform	0.19	NA	NA	NA	NA	NA	<1	<1	<1	<1	<1
Chloromethane	2.6	NA	NA	NA	NA	NA	<1	<1	<1	<1	<1
1,2-Dichloroethane	0.38	NA	NA	NA	NA	NA	<1	<1	<1	<1	<1
EPA 602											
Benzene	1	<0.5	**0.1 J**	<0.5	**0.11 J**	<1	**7.5**	**36.6**	**47.9**	**7.1**	**4.7**
Chlorobenzene	50	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<1	<1
Methyl tert-butyl ether	210	**0.82 J**	**0.67 J**	**0.21 J**	**1.8 J**	**1.2 J**	**8.3**	**19**	**4.2**	**8.6**	**91.4**
Ethylbenzene	29	<0.8	**0.15 JB**	<0.8	<0.8	<1	**3.3**	**12.6**	**11.3**	**12.8**	<1
Xylenes (total)	530	<3	**0.95 JB**	**0.26 J**	<3	<3	**7.4**	**51.3**	**43.5**	**77.4**	<3
Toluene	1000	<2	**1.2 JB**	**0.79 JB**	<2	**0.26 J**	**24.9**	**59.6**	**39.5**	**42.8**	<1
Total BTEX			**2.4**	**1.05**	**0.11**	**0.26**	**43.1**	**160.1**	**142.2**	**140.1**	**4.7**
EPA 610											
Chrysene	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	0.05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	280	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	2100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	280	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SW846-3010A											
Lead	15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Bold type indicates detectable concentrations.									
		Shaded area indicates detectable concentrations above the groundwater quality standards.									

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

Printed: 2/27/2006
Samples analyzed by Compuchem, STL, or Accutest

CLJ - POL Berkeley Manor
Project #110385

Analytical Data Summary

Type III Well: **MW-7**

Client Sample ID:		143GW209	143GW220
Date Sampled:		08/29/00	12/13/00
Analyte (ug/l)	**Action Level**	**Result**	**Result**
EPA 601			
1,2-Dichlorobenzene	620	<2	<1
1,3-Dichlorobenzene	620	<2	<1
1,4-Dichlorobenzene	75	<2	<1
Dibromochloromethane	0.41	<2	<1
Chloroform	0.19	<2	<1
Chloromethane	2.6	<2	<1
1,2-Dichloroethane	0.38	<2	<1
EPA 602			
Benzene	1	**46**	**21**
Chlorobenzene	50	<2	<1
Methyl tert-butyl ether	210	**86.9**	**28**
Ethylbenzene	29	**7.8**	**4.9**
Xylenes (total)	530	**14.7**	**13**
Toluene	1000	**25.8**	**15**
Total BTEX		**94.3**	**53.9**
EPA 610			
Chrysene	5	NA	NA
Naphthalene	21	NA	NA
Acenaphthene	80	NA	NA
Acenaphthylene	210	NA	NA
Benzo(a)anthracene	0.05	NA	NA
Pyrene	210	NA	NA
Fluorene	280	NA	NA
Anthracene	2100	NA	NA
Fluoranthene	280	NA	NA
Phenanthrene	210	NA	NA
SW846-3010A			
Lead	15	NA	NA

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

Printed: 2/27/2006
Samples analyzed by Compuchem, STL, or Accutest

CLJ - POL Berkeley Manor
Project #110385

Analytical Data Summary

Type III Well: **MW-7**

Client Sample ID:		CL-143-GW-231	GW-231	UST820-MW07-01C3	UST820-MW07-02B	UST820-MW07-02C	UST820-MW07	UST820-MW07	UST820-MW07	UST820-MW07	UST820-MW07
Date Sampled:		03/19/01	06/26/01	09/27/01	04/26/02	10/30/02	04/18/03	10/23/03	04/20/04	11/20/04	3/1/05
Analyte (ug/l)	**Action Level**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
EPA 601											
1,2-Dichlorobenzene	620	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,3-Dichlorobenzene	620	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	75	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	0.41	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	0.19	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloromethane	2.6	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	0.38	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPA 602											
Benzene	1	**18**	<1.0	<2.0	<1.0	<1.0	<1.0	**5.3**	<1.0	**0.56 J**	<1.0
Chlorobenzene	50	<1	<1.0	<2.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methyl tert-butyl ether	210	**39**	**1.7 J**	<2.0	**48.3**	**14.1**	**2.9**	**1.6**	<1.0	<1.0	<1.0
Ethylbenzene	29	**3.8**	<1.0	<2.0	<1.0	<1.0	<1.0	**1.3**	<1.0	<1.0	<1.0
Xylenes (total)	530	**9.6**	<1.0	<4.0	**1.8 J**	<3.0	<3.0	**9.4**	<3.0	<3.0	<3.0
Toluene	1000	**14**	**0.35 J**	<2.0	**1.8**	<1.0	<1.0	**3.6**	<1.0	<1.0	<1.0
Total BTEX		**45.4**	**0.35**		**3.6**			**19.6**		**0.56**	
EPA 610											
Chrysene	5	NA	<0.10	<0.10	<5.5	<5.3	<5.0	<5.1	<5.3	<4.8	<4.8
Naphthalene	21	NA	<2.0	<2.0	<5.5	<5.3	<5.0	<5.1	<5.3	<4.8	<4.8
Acenaphthene	80	NA	<1.0	<1.0	<5.5	<5.3	<5.0	<5.1	<5.3	<4.8	<4.8
Acenaphthylene	210	NA	<1.0	<1.0	<5.5	<5.3	<5.0	<5.1	<5.3	<4.8	<4.8
Benzo(a)anthracene	0.05	NA	<0.10	<0.10	<5.5	<5.3	<5.0	<5.1	<5.3	<4.8	<4.8
Pyrene	210	NA	<0.10	<0.25	<5.5	<5.3	<5.0	<5.1	<5.3	<4.8	<4.8
Fluorene	280	NA	<2.0	<2.0	<5.5	<5.3	<5.0	<5.1	<5.3	<4.8	<4.8
Anthracene	2100	NA	<1.0	<1.0	<5.5	<5.3	<5.0	<5.1	<5.3	<4.8	<4.8
Fluoranthene	280	NA	<0.20	<0.25	<5.5	<5.3	<5.0	<5.1	<5.3	<4.8	<4.8
Phenanthrene	210	NA	<1.0	<1.0	<5.5	<5.3	<5.0	<5.1	<5.3	<4.8	<4.8
SW846-3010A											
Lead	15	NA	NA	NA	NA	NA	NA	NA	NA	**7.7**	**5.9**
		Bold type indicates detectable concentrations.									
		Shaded area indicates detectable concentrations above the groundwater quality standards.									

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

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CLJ - POL Berkeley Manor
Project #110385

Analytical Data Summary

Type III Well: **MW-7**

Client Sample ID:		UST820-MW07	UST820-MW07
Date Sampled:		5/31/05	8/9/05
Analyte (ug/l)	**Action Level**	**Result**	**Result**
EPA 601			
1,2-Dichlorobenzene	620	NA	<1.0
1,3-Dichlorobenzene	620	NA	<1.0
1,4-Dichlorobenzene	75	NA	<1.0
Dibromochloromethane	0.41	NA	NA
Chloroform	0.19	NA	NA
Chloromethane	2.6	NA	NA
1,2-Dichloroethane	0.38	NA	NA
EPA 602			
Benzene	1	<1.0	<1.0
Chlorobenzene	50	<1.0	<1.0
Methyl tert-butyl ether	210	<1.0	<1.0
Ethylbenzene	29	<1.0	<1.0
Xylenes (total)	530	<3.0	<3.0
Toluene	1000	<1.0	<1.0
Total BTEX			
EPA 610			
Chrysene	5	<4.8	<1.9
Naphthalene	21	<4.8	<1.9
Acenaphthene	80	<4.8	<3.8
Acenaphthylene	210	<4.8	<3.8
Benzo(a)anthracene	0.05	<4.8	<0.19
Pyrene	210	<4.8	<1.9
Fluorene	280	<4.8	<1.9
Anthracene	2100	<4.8	<1.9
Fluoranthene	280	<4.8	<1.9
Phenanthrene	210	<4.8	<1.9
SW846-3010A			
Lead	15	**6.3**	**9.0**

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

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Samples analyzed by Compuchem, STL, or Accutest

CLJ - POL Berkeley Manor
Project #110385

Analytical Data Summary

Type III Well: **MW-9**

Client Sample ID:		143GW021	143GW048	143GW078			143GW135	143GW146	143GW161	143GW175	143GW197
Date Sampled:		08/19/97	02/11/98	05/12/98	08/15/98	11/17/98	02/26/99	05/18/99	09/10/99	11/17/99	05/18/00
Analyte (ug/l)	**Action Level**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
EPA 601											
1,2-Dichlorobenzene	620	<2000	<1	<500	<10	<380	<10	<200	<10	<50	<5
1,3-Dichlorobenzene	620	<1500	<0.8	<380	<7.5	<290	<10	<200	<10	<50	<5
1,4-Dichlorobenzene	75	**740 J**	<1.5	<750	**2.6 JB**	<580	<10	<200	<10	<50	<5
Dibromochloromethane	0.41	NA	NA	NA	NA	NA	<10	<200	<10	<50	<5
Chloroform	0.19	NA	NA	NA	NA	NA	<10	<200	<10	<50	<5
Chloromethane	2.6	NA	NA	NA	NA	NA	<10	<200	<10	<50	<5
1,2-Dichloroethane	0.38	NA	NA	NA	NA	NA	<10	<200	<10	<50	<5
EPA 602											
Benzene	1	**8500**	**0.45 J**	**4400 P**	**3300**	**5000**	**4140**	**5620**	**6170**	**1190**	**2580**
Chlorobenzene	50	<1000	<0.5	<250	<5	<190	<10	<200	<10	<50	<5
Methyl tert-butyl ether	210	<10000	**31**	<2500	**1300 J**	**14000**	**11600**	**14000**	**16700**	**55.2**	**7150**
Ethylbenzene	29	**2800**	**0.19 JP**	**740**	**600 J**	**480**	**368**	**411**	**1030**	**736**	**217**
Xylenes (total)	530	**13300**	**1.21 JBP**	**2010 B**	**1780 J**	**1120 J**	**785**	**917**	**2760**	**5990**	**507**
Toluene	1000	**32000**	**0.82 JBP**	**4700 B**	**2500 B**	**1200**	**959**	**1340**	**1760**	**5480**	**747**
Total BTEX		**56600**	**2.67**	**11850**	**8180**	**7800**	**6252**	**8288**	**11720**	**13396**	**4051**
EPA 610											
Chrysene	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	0.05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	280	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	2100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	280	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SW846-3010A											
Lead	15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Bold type indicates detectable concentrations.									
		Shaded area indicates detectable concentrations above the groundwater quality standards.									

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

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Analytical Data Summary

Type III Well: **MW-9**

Client Sample ID:		143GW207
Date Sampled:		08/29/00
Analyte (ug/l)	**Action Level**	**Result**
EPA 601		
1,2-Dichlorobenzene	620	<2
1,3-Dichlorobenzene	620	<2
1,4-Dichlorobenzene	75	<2
Dibromochloromethane	0.41	<2
Chloroform	0.19	<2
Chloromethane	2.6	<2
1,2-Dichloroethane	0.38	<2
EPA 602		
Benzene	1	**3390**
Chlorobenzene	50	<2
Methyl tert-butyl ether	210	**9260**
Ethylbenzene	29	**291**
Xylenes (total)	530	**735**
Toluene	1000	**1060**
Total BTEX		**5476**
EPA 610		
Chrysene	5	NA
Naphthalene	21	NA
Acenaphthene	80	NA
Acenaphthylene	210	NA
Benzo(a)anthracene	0.05	NA
Pyrene	210	NA
Fluorene	280	NA
Anthracene	2100	NA
Fluoranthene	280	NA
Phenanthrene	210	NA
SW846-3010A		
Lead	15	NA

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P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

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Analytical Data Summary

Type III Well: **MW-9**

Client Sample ID:		143GW218	CL-143-GW-229	GW-239	UST820-MW09-01C3	UST820-MW09-02B	UST820-MW09-02C	UST820-MW09	UST820-MW09	UST820-MW09	UST820-MW09
Date Sampled:		12/13/00	03/19/01	06/21/01	10/01/01	04/24/02	10/28/02	04/16/03	10/21/03	04/14/04	11/3/04
Analyte (ug/l)	**Action Level**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
EPA 601											
1,2-Dichlorobenzene	620	<1	<50	NA	NA	NA	NA	NA	NA	NA	NA
1,3-Dichlorobenzene	620	<1	<50	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	75	<1	<50	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	0.41	<1	<50	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	0.19	<1	<50	NA	NA	NA	NA	NA	NA	NA	NA
Chloromethane	2.6	<1	<50	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	0.38	<1	<50	NA	NA	NA	NA	NA	NA	NA	NA
EPA 602											
Benzene	1	**2900**	**2000**	**2700**	**2600**	**1770**	**1450**	**2340**	**1960**	**1170**	**2360**
Chlorobenzene	50	<50	<50	<80	<200	<50	<50	<1.0	<50	<20	<5.0
Methyl tert-butyl ether	210	**7700**	**5100**	**6400**	**7000**	**4070**	**4200**	**4530**	**4110**	**2620**	**3930**
Ethylbenzene	29	**280**	**180**	**300**	**250**	**159**	**125**	**241**	**155**	**225**	**222**
Xylenes (total)	530	**740**	**490**	**820**	**690**	**447**	**348**	**556**	**389**	**532**	**495**
Toluene	1000	**990**	**710**	**1200 B**	**1100**	**645**	**488**	**466**	**416**	**375**	**428**
Total BTEX		**4910**	**3380**	**5020**	**4640**	**3021**	**2411**	**3603**	**2920**	**2302**	**3505**
EPA 610											
Chrysene	5	NA	NA	<0.10	<0.10	<5.0	<5.2	<5.1	<5.1	<5.4	<4.8
Naphthalene	21	NA	NA	**25**	**24**	**9.6**	**15.6**	**24.4**	**15.9**	**14.8**	**16.8**
Acenaphthene	80	NA	NA	<1.0	<1.0	<5.0	<5.2	<5.1	<5.1	<5.4	<4.8
Acenaphthylene	210	NA	NA	<1.0	<1.0	<5.0	<5.2	<5.1	<5.1	<5.4	<4.8
Benzo(a)anthracene	0.05	NA	NA	<0.10	<0.10	<5.0	<5.2	<5.1	<5.1	<5.4	<4.8
Pyrene	210	NA	NA	<0.10	<0.25	<5.0	<5.2	<5.1	<5.1	<5.4	<4.8
Fluorene	280	NA	NA	<2.0	<2.0	<5.0	<5.2	<5.1	<5.1	<5.4	<4.8
Anthracene	2100	NA	NA	<1.0	<1.0	<5.0	<5.2	<5.1	<5.1	<5.4	<4.8
Fluoranthene	280	NA	NA	<0.20	<0.25	<5.0	<5.2	<5.1	<5.1	<5.4	<4.8
Phenanthrene	210	NA	NA	<1.0	<1.0	<5.0	<5.2	<5.1	<5.1	<5.4	<4.8
SW846-3010A											
Lead	15	NA	NA	NA	NA	NA	NA	NA	NA	NA	<5.0
		Bold type indicates detectable concentrations.									
		Shaded area indicates detectable concentrations above the groundwater quality standards.									

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

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Samples analyzed by Compuchem, STL, or Accutest

Analytical Data Summary

Type III Well: **MW-9**

Client Sample ID:		UST820-MW09
Date Sampled:		8/6/05
Analyte (ug/l)	**Action Level**	**Result**
EPA 601		
1,2-Dichlorobenzene	620	**4.8**
1,3-Dichlorobenzene	620	<1.0
1,4-Dichlorobenzene	75	<1.0
Dibromochloromethane	0.41	NA
Chloroform	0.19	NA
Chloromethane	2.6	NA
1,2-Dichloroethane	0.38	NA
EPA 602		
Benzene	1	**1820**
Chlorobenzene	50	<1.0
Methyl tert-butyl ether	210	**2410**
Ethylbenzene	29	**168**
Xylenes (total)	530	**297**
Toluene	1000	**224**
Total BTEX		**2509**
EPA 610		
Chrysene	5	<2.0
Naphthalene	21	**13.9**
Acenaphthene	80	<3.9
Acenaphthylene	210	<3.9
Benzo(a)anthracene	0.05	<0.2
Pyrene	210	<2.0
Fluorene	280	<2.0
Anthracene	2100	<2.0
Fluoranthene	280	<2.0
Phenanthrene	210	<2.0
SW846-3010A		
Lead	15	<20

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

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Analytical Data Summary

Type III Well: **MW-17**

Client Sample ID:		GW-240	UST820-MW17-01C3	UST820-MW17-02B	UST820-MW17-02C	UST820-MW17	UST820-MW17	UST820-MW17	UST820-MW17	UST820-MW17
Date Sampled:		06/22/01	09/27/01	04/25/02	10/29/02	04/18/03	10/07/03	04/15/04	11/20/04	8/8/05
Analyte (ug/l)	**Action Level**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
EPA 602										
Benzene	1	**19**	**18**	**17.4**	<1.0	**45.8**	**364**	**181**	**242**	**552**
Chlorobenzene	50	<1.0	<2.0	<1.0	<1.0	<1.0	<1.0	<10	<1.0	<1.0
Methyl tert-butyl ether	210	**56**	<2.0	**61**	**12.4**	**148**	**1860**	**1500**	**1760**	**4250**
Ethylbenzene	29	**2.2**	<2.0	<1.0	<1.0	<1.0	<1.0	<10	<1.0	**1.2**
Xylenes (total)	530	**10**	<4.0	<3.0	<3.0	**1.9 J**	**3.3**	<30	**2.3 J**	**5.1**
Toluene	1000	**12 B**	<2.0	<1.0	<1.0	<1.0	<1.0	<10	<1.0	<1.0
Total BTEX		**43.2**	**18**	**17.4**		**47.7**	**367.3**	**181**	**244.3**	**558.3**
EPA 610										
Chrysene	5	<0.10	<0.10	<5.5	<5.1	<5.1	<5.2	<5.1	<4.8	<1.9
Naphthalene	21	<2.0	<2.0	<5.5	<5.1	<5.1	<5.2	<5.1	<4.8	<1.9
Acenaphthene	80	<1.0	<1.0	<5.5	<5.1	<5.1	<5.2	<5.1	<4.8	<3.8
Acenaphthylene	210	<1.0	<1.0	<5.5	<5.1	<5.1	<5.2	<5.1	<4.8	<3.8
Benzo(a)anthracene	0.05	<0.10	<0.10	<5.5	<5.1	<5.1	<5.2	<5.1	<4.8	<0.19
Pyrene	210	<0.10	<0.25	<5.5	<5.1	<5.1	<5.2	<5.1	<4.8	<1.9
Fluorene	280	<2.0	<2.0	<5.5	<5.1	<5.1	<5.2	<5.1	<4.8	<1.9
Anthracene	2100	<1.0	<1.0	<5.5	<5.1	<5.1	<5.2	<5.1	<4.8	<1.9
Fluoranthene	280	<0.20	<0.25	<5.5	<5.1	<5.1	<5.2	<5.1	<4.8	<1.9
Phenanthrene	210	<1.0	<1.0	<5.5	<5.1	<5.1	<5.2	<5.1	<4.8	<1.9
SW846-3010A										
Lead	15	NA	NA	NA	NA	NA	NA	NA	<15	<20
Bold type indicates detectable concentrations.										
Shaded area indicates detectable concentrations above the groundwater quality standards.										

J= estimated
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B= detected in blank
NA= not analyzed

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Project #110385

Analytical Data Summary

Type III Well: **MW-19**

Client Sample ID:		GW-229	UST820-MW19-01C3	UST820-MW19-02B	UST820-MW19-02C	UST820-MW19	UST820-MW19	UST820-MW19	UST820-MW19	UST820-MW19	UST820-MW19
Date Sampled:		06/22/01	09/26/01	04/24/02	10/30/02	04/14/03	10/07/03	04/16/04	11/20/04	2/26/05	5/31/05
Analyte (ug/l)	**Action Level**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
EPA 602											
Benzene	1	**1.5**	<1.0	**1.4**	<1.0	**0.87 J**	**0.76 J**	**0.79 J**	**0.57 J**	**4.1**	**0.75 J**
Chlorobenzene	50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methyl tert-butyl ether	210	**12**	<10	**8.2**	**5.1**	**4.4**	**3.0**	**4.5**	**4.7**	**8.0**	**9.0**
Ethylbenzene	29	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<3.0	**8.3**	**0.6 J**
Xylenes (total)	530	**0.56 J**	<2.0	<3.0	<3.0	<3.0	<3.0	**1.8 J**	<1.0	**21.8**	<3.0
Toluene	1000	**0.66 J**	<1.0	**0.75 J**	<1.0	<1.0	<1.0	**1.3**	<1.0	**23.1**	**1.0**
Total BTEX		**2.72**		**2.15**		**0.87**	**0.76**	**3.89**	**0.57**	**57.3**	**2.35**
EPA 610											
Chrysene	5	<0.10	<0.10	<5.5	<5.3	<5.1	<5.4	<5.3	<4.8	<4.8	<4.8
Naphthalene	21	<2.0	<2.0	<5.5	<5.3	<5.1	<5.4	<5.3	<4.8	**1.5 J**	<4.8
Acenaphthene	80	<1.0	<1.0	<5.5	<5.3	<5.1	<5.4	<5.3	<4.8	<4.8	<4.8
Acenaphthylene	210	<1.0	<1.0	<5.5	<5.3	<5.1	<5.4	<5.3	<4.8	<4.8	<4.8
Benzo(a)anthracene	0.05	<0.10	<0.10	<5.5	<5.3	<5.1	<5.4	<5.3	<4.8	<4.8	<4.8
Pyrene	210	<0.10	<0.25	<5.5	<5.3	<5.1	<5.4	<5.3	<4.8	<4.8	<4.8
Fluorene	280	<2.0	<2.0	<5.5	<5.3	<5.1	<5.4	<5.3	<4.8	<4.8	<4.8
Anthracene	2100	<1.0	<1.0	<5.5	<5.3	<5.1	<5.4	<5.3	<4.8	<4.8	<4.8
Fluoranthene	280	<0.20	<0.25	<5.5	<5.3	<5.1	<5.4	<5.3	<4.8	<4.8	<4.8
Phenanthrene	210	<1.0	<1.0	<5.5	<5.3	<5.1	<5.4	<5.3	<4.8	<4.8	<4.8
SW846-3010A											
Lead	15	NA	NA	NA	NA	NA	NA	NA	<5.0	<5.0	**19.9**
Bold type indicates detectable concentrations.											
Shaded area indicates detectable concentrations above he groundwater quality standards.											

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

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Analytical Data Summary

Type III Well: **MW-19**

Client Sample ID:		UST820-MW19
Date Sampled:		8/8/05
Analyte (ug/l)	**Action Level**	**Result**
EPA 602		
Benzene	1	<1.0
Chlorobenzene	50	<1.0
Methyl tert-butyl ether	210	**8.0**
Ethylbenzene	29	<1.0
Xylenes (total)	530	<3.0
Toluene	1000	<1.0
Total BTEX		
EPA 610		
Chrysene	5	<1.9
Naphthalene	21	<1.9
Acenaphthene	80	<3.8
Acenaphthylene	210	<3.8
Benzo(a)anthracene	0.05	<0.19
Pyrene	210	<1.9
Fluorene	280	<1.9
Anthracene	2100	<1.9
Fluoranthene	280	<1.9
Phenanthrene	210	<1.9
SW846-3010A		
Lead	15	<100
Bold type indicates detectable concentration:		
Shaded area indicates detectable concentrati		

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

Printed: 2/27/2006
Samples analyzed by Compuchem, STL, or Accutest

CLJ - POL Berkeley Manor
Project #110385

Analytical Data Summary

Type III Well: **MW-21**

Client Sample ID:		143GW026	143GW052	143GW082	143GW114		143GW138	143GW149	143GW159	143GW171	143GW195
Date Sampled:		08/19/97	02/11/98	05/12/98	08/15/98	11/17/98	02/27/99	05/18/99	09/10/99	11/17/99	05/18/00
Analyte (ug/l)	**Action Level**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
EPA 601											
1,2-Dichlorobenzene	620	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,3-Dichlorobenzene	620	<0.8	<0.8	<0.8	<0.8	<1	<1	<1	<1	<1	<1
1,4-Dichlorobenzene	75	<1.5	<1.5	<1.5	**0.56 JB**	**0.44 J**	<1	<1	<1	<1	<1
Dibromochloromethane	0.41	NA	NA	NA	NA	NA	<1	<1	<1	<1	<1
Chloroform	0.19	NA	NA	NA	NA	NA	<1	<1	<1	<1	<1
Chloromethane	2.6	NA	NA	NA	NA	NA	<1	<1	<1	<1	<1
1,2-Dichloroethane	0.38	NA	NA	NA	NA	NA	<1	<1	<1	<1	<1
EPA 602											
Benzene	1	<0.5	<0.5	<0.5	**0.49 J**	<1	**3.8**	**50.4**	**2.2**	**1.9**	<1
Chlorobenzene	50	<0.5	**0.085 J**	<0.5	<0.5	<1	<1	<1	<1	<1	<1
Methyl tert-butyl ether	210	<5	**1.3 J**	<5	<5	**8.3**	**0.86 J**	**3.6**	<1	<1	<1
Ethylbenzene	29	<0.8	<0.8	**0.42 J**	**0.29 J**	<1	<1	**8.8**	**4.5**	**5.5**	<1
Xylenes (total)	530	<3	**0.51 JB**	**1.48 J**	**0.95 J**	<3	<3	**20**	**44**	**24.9**	<3
Toluene	1000	<2	**0.23 JB**	**1.9 J**	<2	<1	**1.4**	**26**	**36.7**	**10.8**	<1
Total BTEX			**0.74**	**3.8**	**1.73**		**5.2**	**105.2**	**87.4**	**43.1**	
EPA 610											
Chrysene	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	0.05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	280	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	2100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	280	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SW846-3010A											
Lead	15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Bold type indicates detectable concentrations.									
		Shaded area indicates detectable concentrations above the groundwater quality standards.									

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

Printed: 2/27/2006
Samples analyzed by Compuchem, STL, or Accutest

CLJ - POL Berkeley Manor
Project #110385

Analytical Data Summary

Type III Well: **MW-21**

Client Sample ID:		143GW203	143GW214
Date Sampled:		08/29/00	12/13/00
Analyte (ug/l)	**Action Level**	**Result**	**Result**
EPA 601			
1,2-Dichlorobenzene	620	<2	<1
1,3-Dichlorobenzene	620	<2	<1
1,4-Dichlorobenzene	75	<2	<1
Dibromochloromethane	0.41	<2	<1
Chloroform	0.19	<2	<1
Chloromethane	2.6	<2	<1
1,2-Dichloroethane	0.38	<2	<1
EPA 602			
Benzene	1	<1	<1
Chlorobenzene	50	<2	<1
Methyl tert-butyl ether	210	<2	<5
Ethylbenzene	29	<2	<1
Xylenes (total)	530	<6	<1
Toluene	1000	<2	<1
Total BTEX			
EPA 610			
Chrysene	5	NA	NA
Naphthalene	21	NA	NA
Acenaphthene	80	NA	NA
Acenaphthylene	210	NA	NA
Benzo(a)anthracene	0.05	NA	NA
Pyrene	210	NA	NA
Fluorene	280	NA	NA
Anthracene	2100	NA	NA
Fluoranthene	280	NA	NA
Phenanthrene	210	NA	NA
SW846-3010A			
Lead	15	NA	NA

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

Printed: 2/27/2006
Samples analyzed by Compuchem, STL, or Accutest

CLJ - POL Berkeley Manor
Project #110385

Analytical Data Summary

Type III Well: MW-21

Client Sample ID:		CL-143-GW-225	GW-225	UST820-MW21-01C3	UST820-MW21-02B	UST820-MW21-02C	UST820-MW21	UST820-MW21	UST820-MW21	UST820-MW21	UST820-MW21
Date Sampled:		03/19/01	06/22/01	09/26/01	04/24/02	10/30/02	04/14/03	10/07/03	04/16/04	11/20/04	3/1/05
Analyte (ug/l)	**Action Level**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
EPA 601											
1,2-Dichlorobenzene	620	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,3-Dichlorobenzene	620	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	75	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	0.41	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	0.19	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloromethane	2.6	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	0.38	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPA 602											
Benzene	1	**0.17 J**	**0.19 J**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**2.8**
Chlorobenzene	50	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methyl tert-butyl ether	210	**2 J**	<5.0	<10	<1.0	<1.0	<1.0	<1.0	**0.51 J**	**0.84 J**	**0.85 J**
Ethylbenzene	29	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**5**
Xylenes (total)	530	<1	**0.55 J**	<2.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	**12.5**
Toluene	1000	**0.24 J**	**0.56 J**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**11.7**
Total BTEX		**0.41**	**1.3**								**32**
EPA 610											
Chrysene	5	NA	<0.10	<0.10	<5.5	<5.0	<5.1	<5.6	<5.2	<4.8	<4.8
Naphthalene	21	NA	<2.0	<2.0	<5.5	<5.0	<5.1	<5.6	<5.2	<4.8	<4.8
Acenaphthene	80	NA	<1.0	<1.0	<5.5	<5.0	<5.1	<5.6	<5.2	<4.8	<4.8
Acenaphthylene	210	NA	<1.0	<1.0	<5.5	<5.0	<5.1	<5.6	<5.2	<4.8	<4.8
Benzo(a)anthracene	0.05	NA	<0.10	<0.10	<5.5	<5.0	<5.1	<5.6	<5.2	<4.8	<4.8
Pyrene	210	NA	<0.10	<0.25	<5.5	<5.0	<5.1	<5.6	<5.2	<4.8	<4.8
Fluorene	280	NA	<2.0	<2.0	<5.5	<5.0	<5.1	<5.6	<5.2	<4.8	<4.8
Anthracene	2100	NA	<1.0	<1.0	<5.5	<5.0	<5.1	<5.6	<5.2	<4.8	<4.8
Fluoranthene	280	NA	<0.20	<0.25	<5.5	<5.0	<5.1	<5.6	<5.2	<4.8	<4.8
Phenanthrene	210	NA	<1.0	<1.0	<5.5	<5.0	<5.1	<5.6	<5.2	<4.8	<4.8
SW846-3010A											
Lead	15	NA	NA	NA	NA	NA	NA	NA	NA	<5.0	<5.0
		Bold type indicates detectable concentrations.									
		Shaded area indicates detectable concentrations above the groundwater quality standards.									

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

Printed: 2/27/2006
Samples analyzed by Compuchem, STL, or Accutest

CLJ - POL Berkeley Manor
Project #110385

Analytical Data Summary

Type III Well: **MW-21**

Client Sample ID:		UST820-MW21	UST820-MW21
Date Sampled:		5/31/05	8/9/05
Analyte (ug/l)	**Action Level**	**Result**	**Result**
EPA 601			
1,2-Dichlorobenzene	620	NA	<1.0
1,3-Dichlorobenzene	620	NA	<1.0
1,4-Dichlorobenzene	75	NA	<1.0
Dibromochloromethane	0.41	NA	NA
Chloroform	0.19	NA	NA
Chloromethane	2.6	NA	NA
1,2-Dichloroethane	0.38	NA	NA
EPA 602			
Benzene	1	<1.0	<1.0
Chlorobenzene	50	<1.0	<1.0
Methyl tert-butyl ether	210	**0.87 J**	**0.85 J**
Ethylbenzene	29	<1.0	<1.0
Xylenes (total)	530	<3.0	<3.0
Toluene	1000	<1.0	<1.0
Total BTEX			
EPA 610			
Chrysene	5	<4.8	<1.9
Naphthalene	21	<4.8	<1.9
Acenaphthene	80	<4.8	<3.9
Acenaphthylene	210	<4.8	<3.9
Benzo(a)anthracene	0.05	<4.8	<0.19
Pyrene	210	<4.8	<1.9
Fluorene	280	<4.8	<1.9
Anthracene	2100	<4.8	<1.9
Fluoranthene	280	<4.8	<1.9
Phenanthrene	210	<4.8	<1.9
SW846-3010A			
Lead	15	<5.0	<10

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

Printed: 2/27/2006
Samples analyzed by Compuchem, STL, or Accutest

Analytical Data Summary

Typelll Well: **MW-23**

Client Sample ID:		UST820-MW23	UST820-MW23	UST820-MW23	UST820-MW23
Date Sampled:		11/30/04	3/1/05	5/31/05	8/10/05
Analyte (ug/l)	**Action Level**	**Result**	**Result**	**Result**	**Result**
EPA 602					
Benzene	1	<1.0	<1.0	<1.0	<1.0
Chlorobenzene	50	<1.0	<1.0	<1.0	<1.0
Methyl tert-butyl ether	210	<1.0	**2.2**	**2.9**	**2.7**
Ethylbenzene	29	<1.0	<1.0	<1.0	<1.0
Xylenes (total)	530	<3.0	<3.0	<3.0	<3.0
Toluene	1000	<1.0	<1.0	<1.0	<1.0
Total BTEX					
EPA 610					
Chrysene	5	<4.8	<4.8	<4.9	<1.9
Naphthalene	21	<4.8	<4.8	<4.9	<1.9
Acenaphthene	80	<4.8	<4.8	<4.9	<3.8
Acenaphthylene	210	<4.8	<4.8	<4.9	<3.8
Benzo(a)anthracene	0.05	<4.8	<4.8	<4.9	<0.19
Pyrene	210	<4.8	<4.8	<4.9	<1.9
Fluorene	280	<4.8	<4.8	<4.9	<1.9
Anthracene	2100	<4.8	<4.8	<4.9	<1.9
Fluoranthene	280	<4.8	<4.8	<4.9	<1.9
Phenanthrene	210	<4.8	<4.8	<4.9	<1.9
SW846-3010A					
Lead	15	**5.4**	<5.0	<5.0	**8.2**
Bold type indicates detectable concentrations.					
Shaded area indicates detectable concentrations above the groundwater quality standards.					

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

Printed: 2/27/2006
Samples analyzed by Compuchem, STL, or Accutest

CLJ - POL Berkeley Manor
Project #110385

Analytical Data Summary

Typefll Well: **MW-25**

Client Sample ID:		UST820-MW25	UST820-MW25	UST820-MW25	UST820-MW25
Date Sampled:		11/30/04	2/26/05	5/27/05	8/8/05
Analyte (ug/l)	**Action Level**	**Result**	**Result**	**Result**	**Result**
EPA 602					
Benzene	1	<1.0	**4.2**	<1.0	<1.0
Chlorobenzene	50	<1.0	<1.0	<1.0	<1.0
Methyl tert-butyl ether	210	**1.5**	<1.0	**0.65 J**	<1.0
Ethylbenzene	29	<1.0	**9.2**	<1.0	<1.0
Xylenes (total)	530	<3.0	**23.8**	<3.0	<3.0
Toluene	1000	<1.0	**26.2**	<1.0	<1.0
Total BTEX			**63.4**		
EPA 610					
Chrysene	5	<4.8	<4.8	<4.8	<1.9
Naphthalene	21	<4.8	**1.6 J**	<4.8	<1.9
Acenaphthene	80	<4.8	<4.8	<4.8	<3.8
Acenaphthylene	210	<4.8	<4.8	<4.8	<3.8
Benzo(a)anthracene	0.05	<4.8	<4.8	<4.8	<0.19
Pyrene	210	<4.8	<4.8	<4.8	<1.9
Fluorene	280	<4.8	<4.8	<4.8	<1.9
Anthracene	2100	<4.8	<4.8	<4.8	<1.9
Fluoranthene	280	<4.8	<4.8	<4.8	<1.9
Phenanthrene	210	<4.8	<4.8	<4.8	<1.9
SW846-3010A					
Lead	15	<5.0	<5.0	<5.0	<5.0
Bold type indicates detectable concentrations.					
Shaded area indicates detectable concentrations above the groundwater quality standards.					

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

Printed: 2/27/2006
Samples analyzed by Compuchem, STL, or Accutest

CLJ - POL Berkeley Manor
Project #110385

Analytical Data Summary

Type III Well: **MW-28**

Client Sample ID:		UST820-MW28	UST820-MW28
Date Sampled:		5/25/05	8/9/05
Analyte (ug/l)	**Action Level**	**Result**	**Result**
EPA 602			
Benzene	1	**1110**	**1130**
Chlorobenzene	50	<50	<1.0
Methyl tert-butyl ether	210	**3350**	**2430**
Ethylbenzene	29	<50	<1.0
Xylenes (total)	530	<150	<3.0
Toluene	1000	<50	<1.0
Total BTEX		**1110**	**1130**
EPA 610			
Chrysene	5	<4.8	<1.9
Naphthalene	21	<4.8	<1.9
Acenaphthene	80	<4.8	<3.8
Acenaphthylene	210	<4.8	<3.8
Benzo(a)anthracene	0.05	<4.8	<0.19
Pyrene	210	<4.8	<1.9
Fluorene	280	<4.8	<1.9
Anthracene	2100	<4.8	<1.9
Fluoranthene	280	<4.8	<1.9
Phenanthrene	210	<4.8	<1.9
Bold type indicates detectable concentrations.			
Shaded area indicates detectable concentrations above the groundwater quality standards.			

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

Printed: 2/27/2006
Samples analyzed by Accutest

CLJ - POL Berkeley Manor
Project #110385

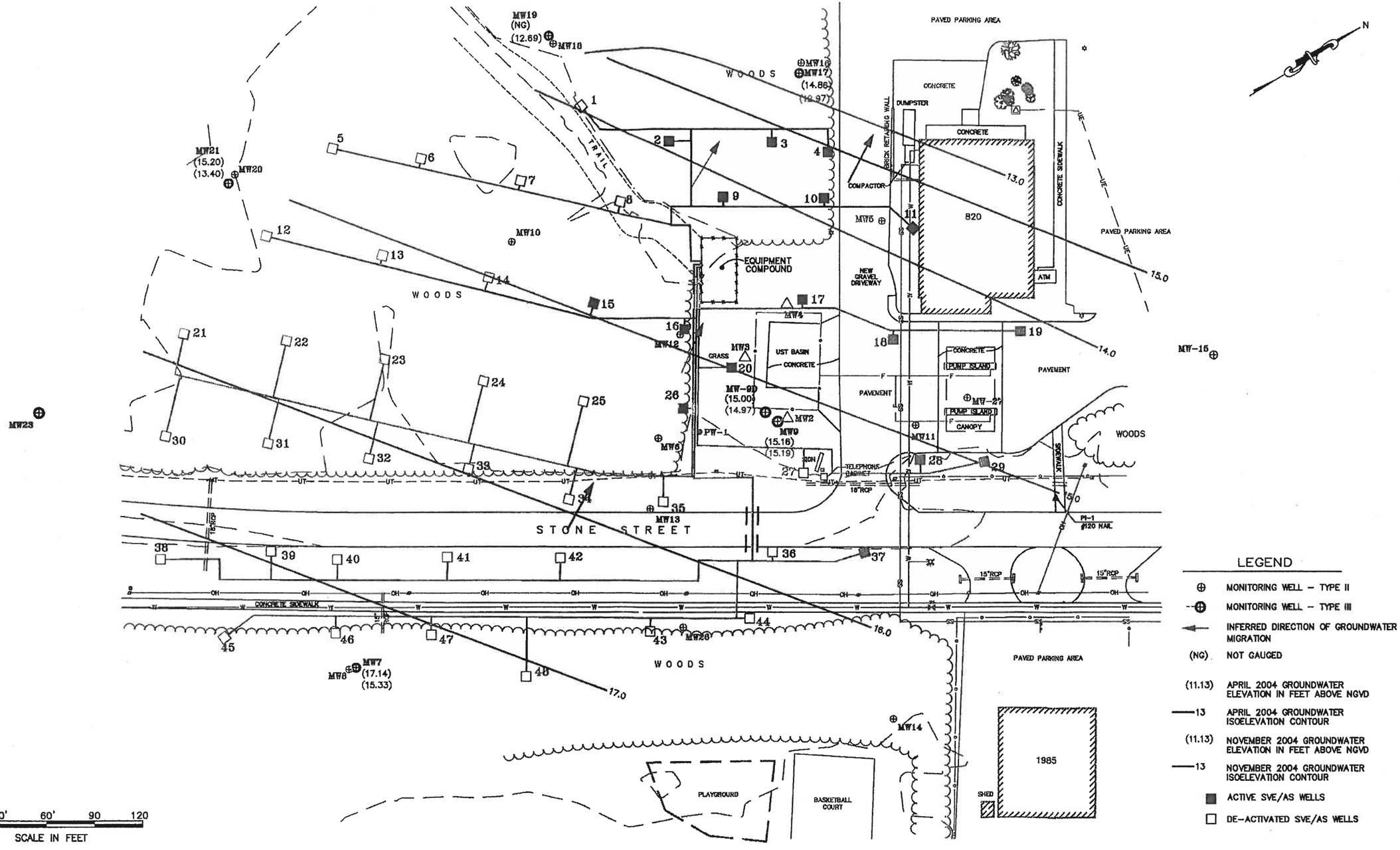
Analytical Data Summary

Type III Well: **MW-29**

Client Sample ID:		UST820-MW29	UST820-MW29
Date Sampled:		5/25/05	8/9/05
Analyte (ug/l)	**Action Level**	**Result**	**Result**
EPA 602			
Benzene	1	**29.6**	**10.7**
Chlorobenzene	50	<1.0	<1.0
Methyl tert-butyl ether	210	**31.8**	**23.2**
Ethylbenzene	29	<1.0	<1.0
Xylenes (total)	530	<3.0	<3.0
Toluene	1000	<1.0	<1.0
Total BTEX		**29.6**	**10.7**
EPA 610			
Chrysene	5	<4.8	<1.9
Naphthalene	21	<4.8	<1.9
Acenaphthene	80	<4.8	<3.8
Acenaphthylene	210	<4.8	<3.8
Benzo(a)anthracene	0.05	<4.8	<0.19
Pyrene	210	<4.8	<1.9
Fluorene	280	<4.8	<1.9
Anthracene	2100	<4.8	<1.9
Fluoranthene	280	<4.8	<1.9
Phenanthrene	210	<4.8	<1.9
Bold type indicates detectable concentrations.			
Shaded area indicates detectable concentrations above the groundwater quality standards.			

J= estimated
P= >25% difference between column quantitation
B= detected in blank
NA= not analyzed

Printed: 2/27/2006
Samples analyzed by Accutest



Shaw
Shaw Environmental, Inc.

SUBMITTED: _____ PROJECT MANAGER DATE: _____
APPROVED: _____ SR. PROJECT ENGINEER DATE: _____
APPROVED: _____ DEPT. MANAGER DATE: _____

CADD FILE: _____
DRAWN: J. LANGE
DESIGNED: B. BROWN
CHECKED: R. KENYON
CHECKED: _____

REVISIONS

ZONE	REV.	DESCRIPTION	BY	DATE	APP.

DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
NAVAL STATION NORFOLK, VIRGINIA
MARINE CORPS BASE, CAMP LEJEUNE, N.C.

FIGURE 4.2
ANNUAL REPORT 2004
GROUNDWATER ELEVATION CONTOUR MAP
TYPE III WELLS
BERKELEY MANOR 820

NAVFAC DRAWING NO.
SHEET NUMBER: of
DATE: 3/24/05

DATA PROVIDED BY CATLIN ENGINEERS AND SCIENTISTS

TABLE 4A SUMMARY OF GROUNDWATER LABORATORY RESULTS

EPA Method 602 for December 2005 and January 2006

Well ID	Contaminant of Concern → Sample ID	Date Collected	Ethylbenzene	Methyl-tert butyl ether (MTBE)	Total Xylenes	All Other 602 Analytes
GCL (ug/L)			84,500	200,000	87,500	Varies
2L GWQS (ug/L)			550	200	530	Varies
UST820-MW30	820MW30	12/8/2005	<0.299	1.03 J	<1.24	BQL
UST820-MW31	820MW31	12/8/2005	<0.299	<0.588	1.50 J	BQL
UST820-MW32	820MW32	12/8/2005	<0.299	<0.588	<1.24	BQL
UST820-MW33	820MW33	12/8/2005	<0.299	<0.588	4.21	BQL
UST820-MW34	820MW34	1/11/2006	0.428	<2.00	1.31	BQL

All results in ug/L

BQL = Below Quantitation Limits

J = Estimated concentration, below calibration range and above MDL

TABLE 4B SUMMARY OF GROUNDWATER LABORATORY RESULTS

EPA Method 625 for December 2005 and January 2006

Well ID	Contaminant of Concern → Sample ID	Date Collected	Bis(2-ethylhexyl)phthalate	All Other 625 Analytes
GCL (ug/L)			2,500	Varies
2L GWQS (ug/L)			2.5	Varies
UST820-MW30	820MW30	12/8/2005	<1.33	BQL
UST820-MW31	820MW31	12/8/2005	<1.33	BQL
UST820-MW32	820MW32	12/8/2005	<1.33	BQL
UST820-MW33	820MW33	12/8/2005	<1.33	BQL
UST820-MW34	820MW34	1/11/2006	4.40	BQL

All results in ug/L

BQL = Below Quantitation Limits

J = Estimated concentration, below calibration range and above MDL

Shaded concentrations exceed the lowest applicable standard

TABLE 4C SUMMARY OF GROUNDWATER LABORATORY RESULTS

MADEP VPH/EPH As Compared to NCDENR 2L GWQS for December 2005 and January 2006

Sample ID / Contaminant of Concern →	Date Collected	C5-C8 Aliphatics	C9-C18 Aliphatics	C19-C36 Aliphatics	C9-C22 Aromatics
GCL (µg/L) 2L GWQS (µg/L)		NE 420	NE 4,200	NE 42,000	NE 210
820-MW30	12/8/2005	<100	<200	<100	<200
820-MW31	12/8/2005	<100	<200	<100	<240*
820-MW32	12/8/2005	<100	<200	<100	<210*
820-MW33	12/8/2005	<100	<200	<100	<200
820-MW34	1/11/2006	<100	<200	<100	<200

All results in µg/L
NE = None Established
* - The result is the sum of the reported quantitation limit of one fraction and the detected concentration of the other fraction.

EPA Method 6020 for December 2005 and January 2006

Well ID	Contaminant of Concern →		Lead
	Sample ID	Date Collected	
GCL (ug/L)			15,000
2L GWQS (ug/L)			15
UST820-MW30	820MW30	12/8/2005	<0.470
UST820-MW31	820MW31	12/8/2005	<0.470
UST820-MW32	820MW32	12/8/2005	<0.470
UST820-MW33	820MW33	12/8/2005	<0.470
UST820-MW34	820MW34	1/11/2006	1.82

All results in ug/L

BQL = Below Quantitation Limits

J = Estimated concentration, below calibration range and above MDL

Shaded concentrations exceed the lowest applicable standard

APPENDIX C

BIOSCREEN™ 1.4 MODEL OUTPUT

CALIBRATED MODEL

SCENARIO-I

(RETARDATION FACTOR (R) = 1.0)

Assumptions for *Bioscreen* ™ Natural Attenuation Support System
Scenario-I

Building 820
Marine Corps Base
Camp Lejeune, North Carolina

Parameters	Values	Comments
HYDROLOGY		
Seepage Velocity (Vs)	27.2 ft/yr	Calculated by model
Hydrualic Conductivity (K)	2.5E-04 cm/sec	Assumed value
Hydrualic Gradient (I)	0.02 ft/ft	Calculated from field data
Effective Porosity (n_e)	0.19	Value for fine soils
DISPERSION		
Longitudinal Dispersivity (ax)	16.1 ft	Calculated by model
Transverse Dispersivity (ay)	1.6 ft	Calculated by model
Vertical Dispersivity (az)	0 ft	Calculated by model
ADSORPTION		
Retardation Factor (R)	1	Manually input
Soil Bulk Density (rho)	1.7 kg/l	Assumed value from literature
Partition Coeffcient (Koc)	12.7 L/kg	Default for MTBE
Fractional Organic Carbon (foc)	5.00E-03	Default for foc
BIODEGRADATION		
1st Order Decay Coeffcient (lambda)	6.9E-3 per year	Calculated by model
Delta Oxygen	0.1 mg/L	From field data
Delta Nitrate	0 mg/L	From field data
Delta Ferrous Iron	10.5 mg/L	From field data
Delta Sulfate	68 mg/L	From field data
Delta Methane	0 mg/L	From field data
GENERAL		
Model Area Length	900-1000 ft	-
Model Area Width	400 ft	-
Estimated Plume Length	400 ft	From field data
Source Thickness	10 ft.	Assumed value

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Keesler AFB
SWMU 66
Run Name

Data Input Instructions:

115
or
0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	27.2	(ft/yr)
or		or	
Hydraulic Conductivity	K	2.5E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Porosity	n	0.19	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	16.1	(ft)
Transverse Dispersivity*	alpha y	1.6	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	400	(ft)

3. ADSORPTION

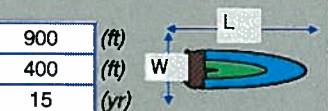
Retardation Factor*	R	1.0	(-)
or		or	
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	12.7	(L/kg)
FractionOrganicCarbon	foc	5.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-3	(per yr)
or		or	
Solute Half-Life	t-half	100.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0.1	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	10.5	(mg/L)
Delta Sulfate*	SO4	68	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	900	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	15	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

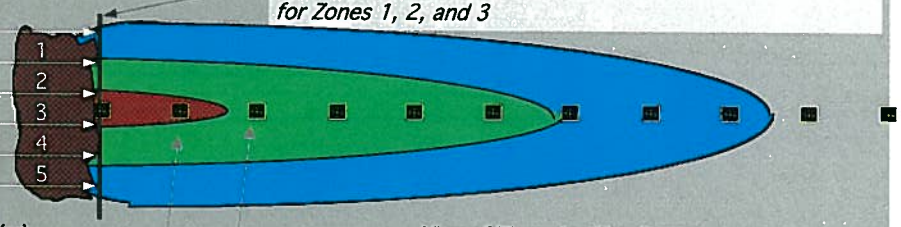
Width* (ft)	Conc. (mg/L)*
25	1
25	6
25	2.5
25	6
25	1

Source Halflife (see Help):

200	>1000	(yr)
Inst. React.	1st Order	

Soluble Mass 1000 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	2.4
90	
180	4.0
270	
360	2.4
450	
540	
630	
720	
810	
900	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

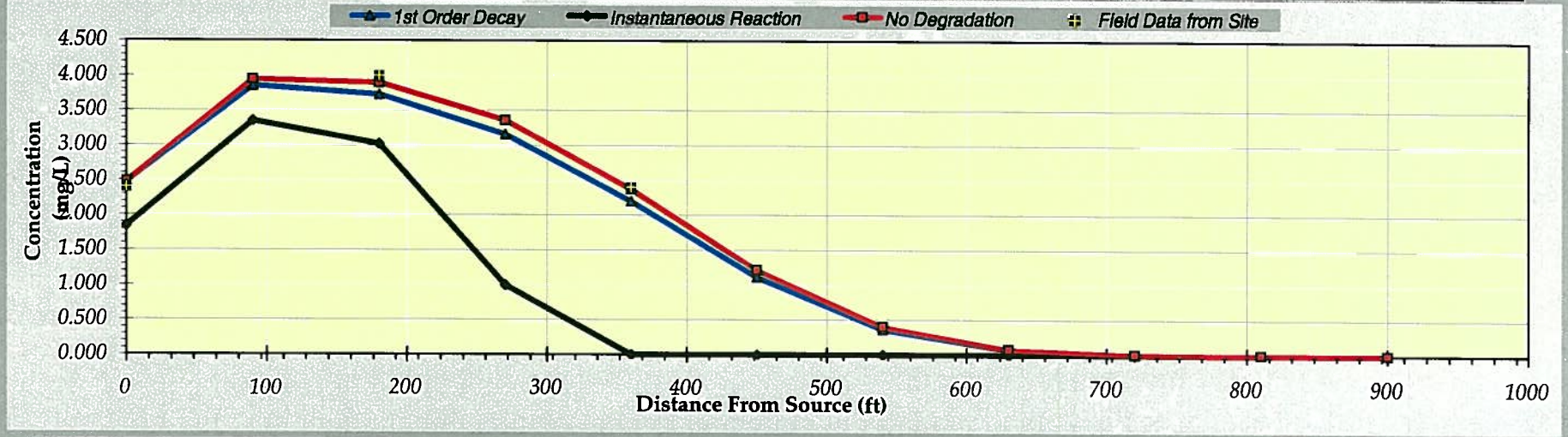
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	90	180	270	360	450	540	630	720	810	900
No Degradation	2.477	3.942	3.895	3.359	2.373	1.210	0.401	0.081	0.009	0.001	0.000
1st Order Decay	2.477	3.854	3.727	3.156	2.200	1.113	0.367	0.074	0.009	0.001	0.000
Inst. Reaction	1.844	3.352	3.020	0.996	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	2.400		4.000		2.400						



Calculate Animation

Time: 15 Years

Return to Input

Recalculate This Sheet

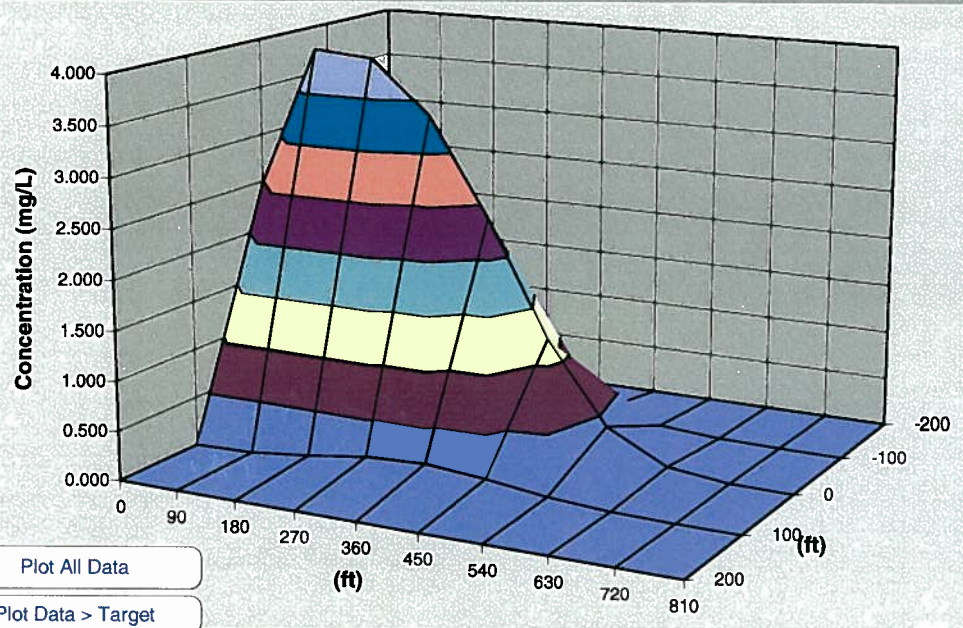
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) \ Distance from Source (ft)	0	90	180	270	360	450	540	630	720	810	900
200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
100	0.000	0.014	0.080	0.160	0.188	0.136	0.058	0.014	0.002	0.000	0.000
0	2.477	3.942	3.895	3.359	2.373	1.210	0.401	0.081	0.009	0.001	0.000
-100	0.000	0.014	0.080	0.160	0.188	0.136	0.058	0.014	0.002	0.000	0.000
-200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	1.7E+3	1.6E+3	1.6E+3	1.5E+3	1.1E+3	5.9E+2	2.1E+2	4.4E+1	5.4E+0	3.8E-1	1.5E-2

Time: 15 Years Target Level: 0.200 mg/L Displayed Model: No Degradation

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	9.0	(Kg)
- Actual Plume Mass	9.0	(Kg)
= Plume Mass Removed by Biodeg	0.0	(Kg)
	0 %	

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	1000.0	(Kg)
Contam. Mass in Source Now (t=15Years)	991.0	(Kg)
Current Volume of Groundwater in Plume	9.0	(ac-ft)
Flowrate of Water Through Source Zone	0.148	(ac-ft/yr)

Mass HELP

Recalculate

FUTURE 2-YEAR SIMULATION

SCENARIO-I

(RETARDATION FACTOR (R) = 1.0)

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Keesler AFB
SWMU 66
Run Name

Data Input Instructions:

115
or
0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	27.2	(ft/yr)
or		or	
Hydraulic Conductivity	K	2.5E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Porosity	n	0.19	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	16.1	(ft)
Transverse Dispersivity*	alpha y	1.6	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	400	(ft)

3. ADSORPTION

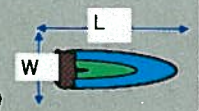
Retardation Factor*	R	1.0	(-)
or		or	
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	12.7	(L/kg)
FractionOrganicCarbon	foc	5.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-3	(per yr)
or		or	
Solute Half-Life	t-half	100.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0.1	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	10.5	(mg/L)
Delta Sulfate*	SO4	68	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	900	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	17	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

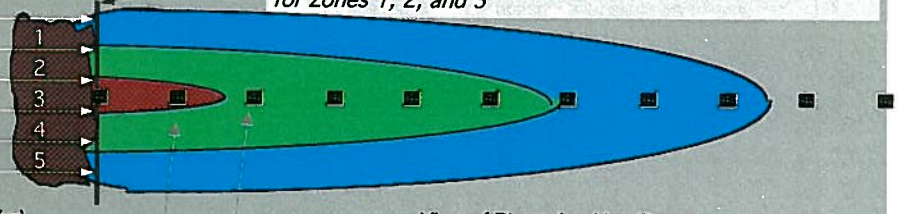
Width* (ft)	Conc. (mg/L)*
25	1
25	6
25	2.5
25	6
25	1

Source Halflife (see Help):

200	>1000	(yr)
Inst. React.	1st Order	

Soluble Mass 1000 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	2.4
90	
180	4.0
270	
360	2.4
450	
540	
630	
720	
810	
900	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

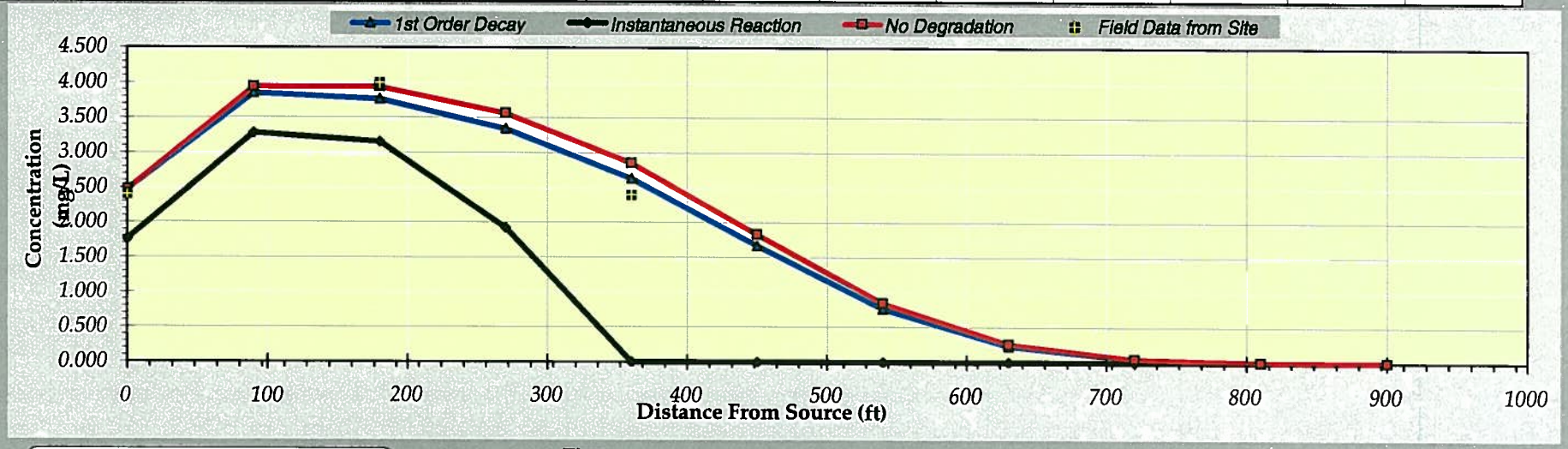
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	90	180	270	360	450	540	630	720	810	900
No Degradation	2.474	3.943	3.942	3.569	2.859	1.830	0.844	0.260	0.051	0.006	0.000
1st Order Decay	2.474	3.855	3.769	3.345	2.637	1.670	0.764	0.234	0.046	0.006	0.000
Inst. Reaction	1.759	3.285	3.160	1.923	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	2.400		4.000		2.400						



Calculate Animation

Time: 17 Years

Return to Input

Recalculate This Sheet

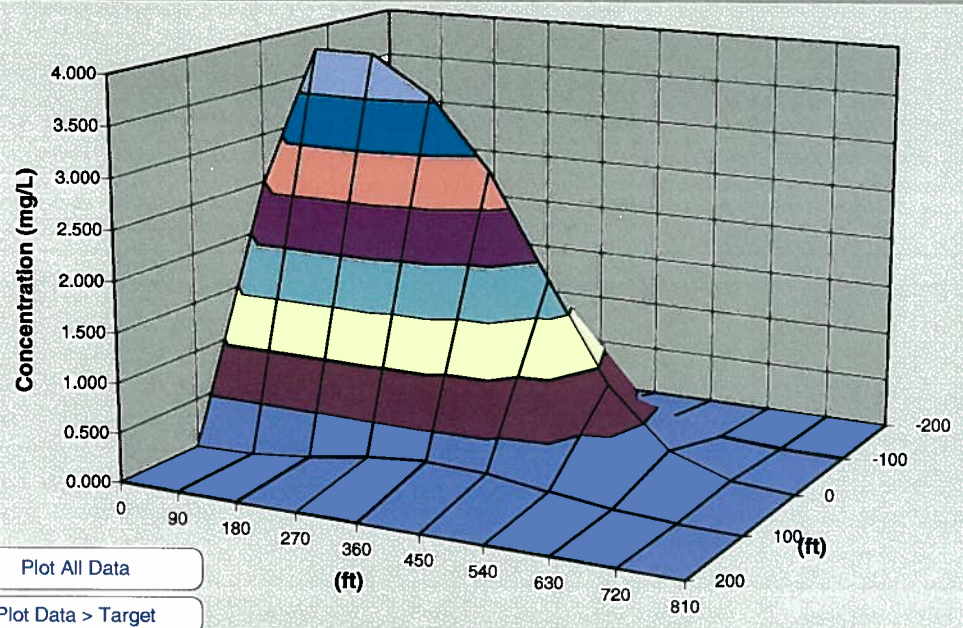
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) / Distance from Source (ft)	0	90	180	270	360	450	540	630	720	810	900
200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
100	0.000	0.014	0.081	0.170	0.227	0.206	0.123	0.046	0.011	0.001	0.000
0	2.474	3.943	3.942	3.569	2.859	1.830	0.844	0.260	0.051	0.006	0.000
-100	0.000	0.014	0.081	0.170	0.227	0.206	0.123	0.046	0.011	0.001	0.000
-200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	1.7E+3	1.6E+3	1.6E+3	1.6E+3	1.3E+3	9.0E+2	4.4E+2	1.4E+2	2.9E+1	3.7E+0	2.8E-1

Time: **17 Years** Target Level: **0.200** mg/L Displayed Model: **No Degradation**

Model to Display:

- *No Degradation Model*
- *1st Order Decay Model*
- *Instantaneous Reaction Model*



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	10.2	*(Kg)*
- Actual Plume Mass	10.2	*(Kg)*
= Plume Mass Removed by Biodeg	**0.0**	*(Kg)*
	0 %	

Change in Electron Acceptor/Byproduct Masses:

Oxygen	*Nitrate*	*Iron II*	*Sulfate*	*Methane*	
na	na	na	na	na	*(Kg)*

Contam. Mass in Source (t=0 Years)	1000.0	*(Kg)*
Contam. Mass in Source Now (t=17Years)	989.8	*(Kg)*
Current Volume of Groundwater in Plume	10.2	*(ac-ft)*
Flowrate of Water Through Source Zone	0.148	*(ac-ft/yr)*

Mass HELP

Recalculate

FUTURE 5-YEAR SIMULATION

SCENARIO-I

(RETARDATION FACTOR (R) = 1.0)

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Keesler AFB
SWMU 66
Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	27.2	(ft/yr)
or		or	
Hydraulic Conductivity	K	2.5E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Porosity	n	0.19	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	16.1	(ft)
Transverse Dispersivity*	alpha y	1.6	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	400	(ft)

3. ADSORPTION

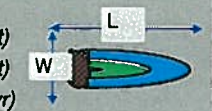
Retardation Factor*	R	1.0	(-)
or		or	
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	12.7	(L/kg)
FractionOrganicCarbon	foc	5.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-3	(per yr)
or		or	
Solute Half-Life	t-half	100.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0.1	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	10.5	(mg/L)
Delta Sulfate*	SO4	68	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	900	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	20	(yr)



115 or 0.02

Variable* 20

6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

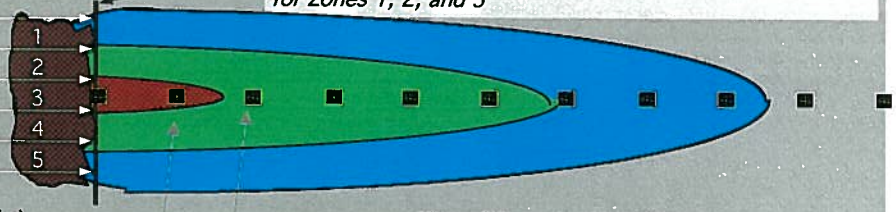
Width* (ft)	Conc. (mg/L)*
25	1
25	6
25	2.5
25	6
25	1

Source Halflife (see Help):

200	>1000	(yr)
Inst. React.	1st Order	

Soluble Mass in Source NAPL, Soil: 1000 (Kg)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	2.4
90	
180	4.0
270	
360	2.4
450	
540	
630	
720	
810	
900	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

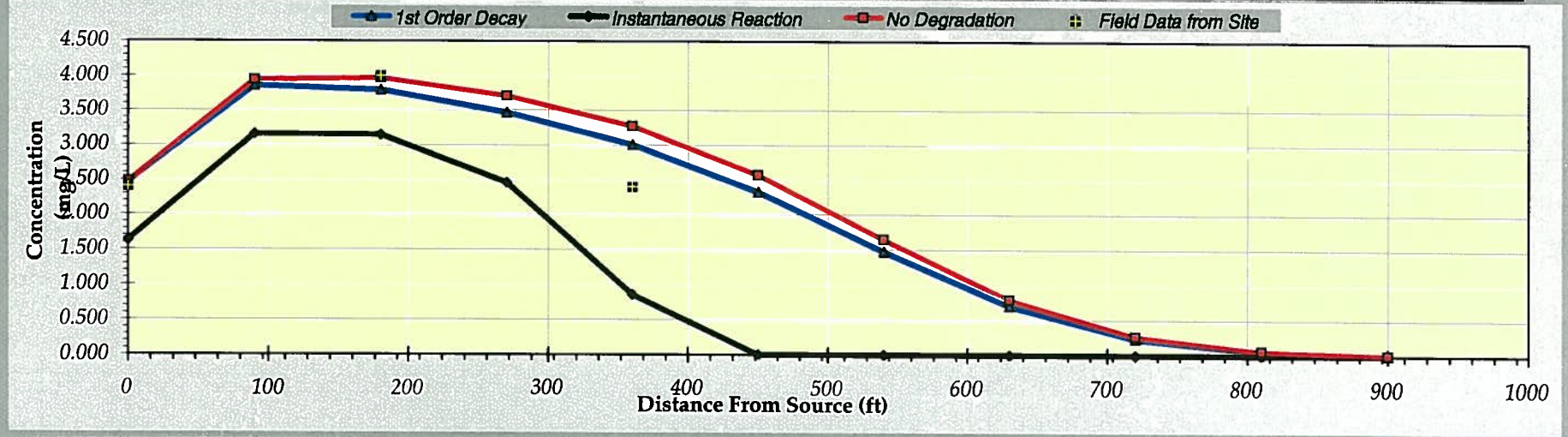
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	90	180	270	360	450	540	630	720	810	900
No Degradation	2.470	3.939	3.963	3.706	3.274	2.571	1.644	0.789	0.269	0.062	0.010
1st Order Decay	2.470	3.851	3.788	3.466	3.005	2.324	1.471	0.701	0.238	0.055	0.009
Inst. Reaction	1.632	3.157	3.146	2.459	0.857	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	2.400		4.000		2.400						



Calculate Animation

Time: 20 Years

Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) \ Distance from Source (ft)	0	90	180	270	360	450	540	630	720	810	900
200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
100	0.000	0.014	0.081	0.177	0.260	0.289	0.239	0.140	0.056	0.015	0.003
0	2.470	3.939	3.963	3.706	3.274	2.571	1.644	0.789	0.269	0.062	0.010
-100	0.000	0.014	0.081	0.177	0.260	0.289	0.239	0.140	0.056	0.015	0.003
-200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	1.7E+3	1.6E+3	1.7E+3	1.6E+3	1.5E+3	1.3E+3	8.5E+2	4.3E+2	1.5E+2	3.7E+1	6.0E+0

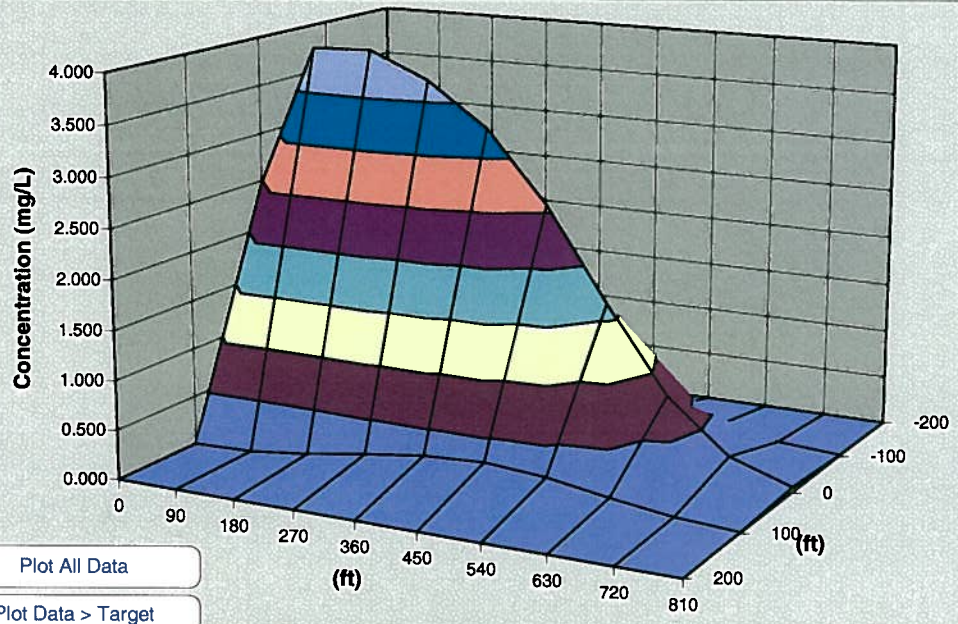
Time: 20 Years

Target Level: 0.200 mg/L

Displayed Model: No Degradation

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	12.0	(Kg)
- Actual Plume Mass	12.0	(Kg)
= Plume Mass Removed by Biodeg	0.0	(Kg)
	0 %	

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	1000.0	(Kg)
Contam. Mass in Source Now (t=20Years)	988.0	(Kg)
Current Volume of Groundwater in Plume	11.4	(ac-ft)
Flowrate of Water Through Source Zone	0.148	(ac-ft/yr)

Mass HELP

Recalculate

FUTURE 10-YEAR SIMULATION

SCENARIO-I

(RETARDATION FACTOR (R) = 1.0)

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

Keesler AFB
SWMU 66
Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	27.2	(ft/yr)
or		or	
Hydraulic Conductivity	K	2.5E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Porosity	n	0.19	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	16.1	(ft)
Transverse Dispersivity*	alpha y	1.6	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	400	(ft)

3. ADSORPTION

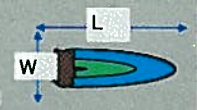
Retardation Factor*	R	1.0	(-)
or		or	
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	12.7	(L/kg)
FractionOrganicCarbon	foc	5.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-3	(per yr)
or		or	
Solute Half-Life	t-half	100.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0.1	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	10.5	(mg/L)
Delta Sulfate*	SO4	68	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	900	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	25	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

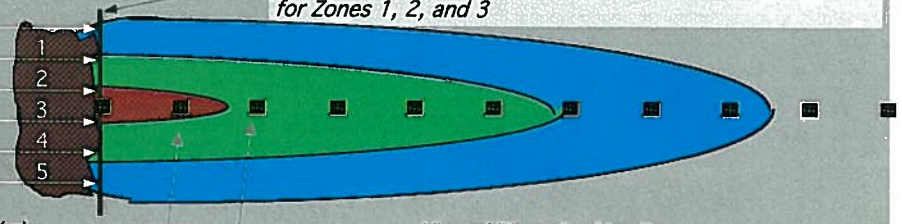
Width* (ft)	Conc. (mg/L)*
25	1
25	6
25	2.5
25	6
25	1

Source Halflife (see Help):

200	>1000	(yr)
Inst. React.	1st Order	

Soluble Mass 1000 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	2.4
90	
180	4.0
270	
360	2.4
450	
540	
630	
720	
810	
900	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

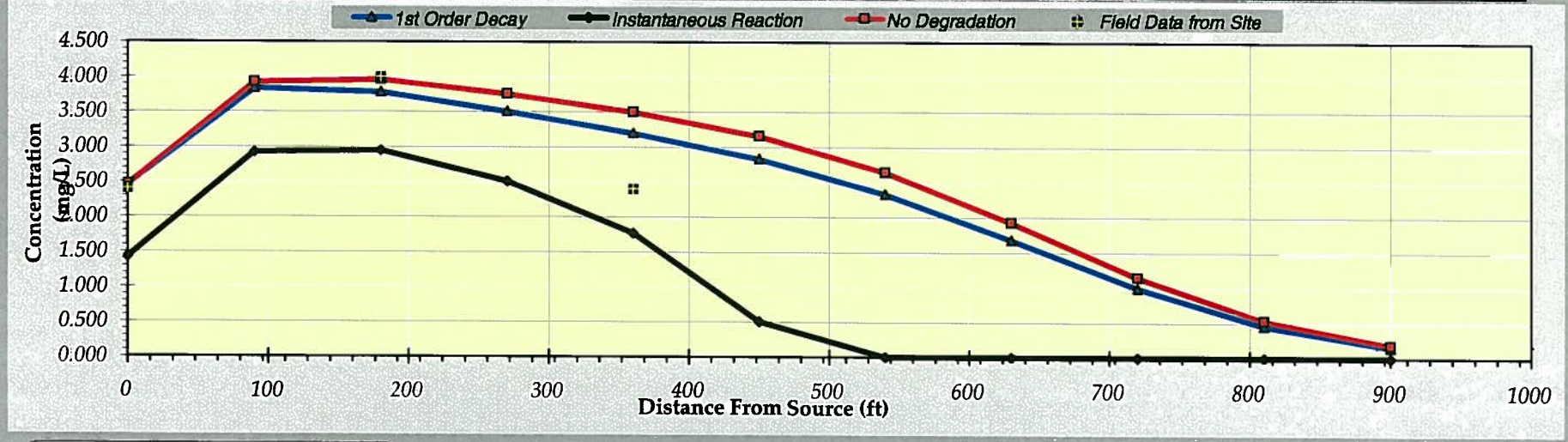
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	90	180	270	360	450	540	630	720	810	900
No Degradation	2.463	3.929	3.962	3.756	3.500	3.161	2.646	1.930	1.150	0.533	0.185
1st Order Decay	2.463	3.840	3.785	3.509	3.199	2.833	2.334	1.681	0.994	0.458	0.158
Inst. Reaction	1.424	2.926	2.950	2.506	1.769	0.504	0.000	0.000	0.000	0.000	0.000
Field Data from Site	2.400		4.000		2.400						



Calculate Animation

Time:
25 Years

Return to Input

Recalculate This Sheet

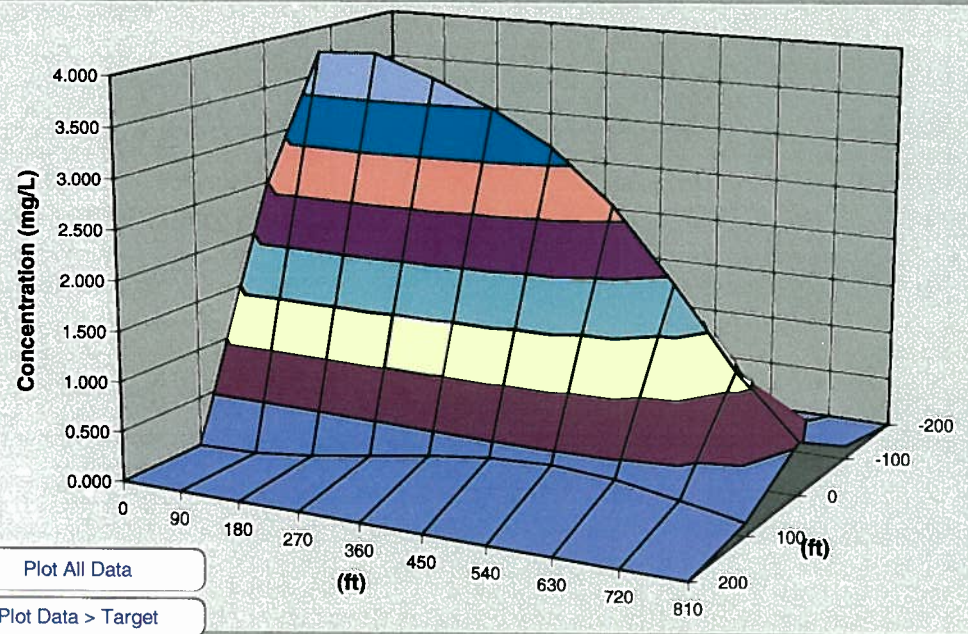
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) \ Distance from Source (ft)	0	90	180	270	360	450	540	630	720	810	900
200	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001
100	0.000	0.014	0.081	0.179	0.278	0.355	0.384	0.342	0.239	0.126	0.049
0	2.463	3.929	3.962	3.756	3.500	3.161	2.646	1.930	1.150	0.533	0.185
-100	0.000	0.014	0.081	0.179	0.278	0.355	0.384	0.342	0.239	0.126	0.049
-200	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001
MASS FLUX (mg/day)	1.7E+3	1.6E+3	1.7E+3	1.7E+3	1.6E+3	1.6E+3	1.4E+3	1.0E+3	6.5E+2	3.2E+2	1.1E+2

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model

Time: **25 Years** Target Level: **0.200** mg/L Displayed Model: **No Degradation**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	15.0	(Kg)
- Actual Plume Mass	15.0	(Kg)
= Plume Mass Removed by Biodeg	0.0	(Kg)
	0 %	

Change in Electron Acceptor/Byproduct Masses:

Oxygen	*Nitrate*	*Iron II*	*Sulfate*	*Methane*	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	1000.0	(Kg)
Contam. Mass in Source Now (t=25Years)	985.0	(Kg)
Current Volume of Groundwater in Plume	12.2	(ac-ft)
Flowrate of Water Through Source Zone	0.148	(ac-ft/yr)

Mass HELP

Recalculate

CALIBRATED MODEL

SCENARIO-II

(RETARDATION FACTOR (R) = 1.6)

Assumptions for *Bioscreen* ™ Natural Attenuation Support System
Scenario-II

Building 820
Marine Corps Base
Camp Lejeune, North Carolina

Parameters	Values	Comments
HYDROLOGY		
Seepage Velocity (Vs)	27.2 ft/yr	Calculated by model
Hydrualic Conductivity (K)	2.5E-04 cm/sec	Assumed value
Hydrualic Gradient (I)	0.02 ft/ft	Calculated from field data
Effective Porosity (n_e)	0.19	Value for fine soils
DISPERSION		
Longitudinal Dispersivity (ax)	16.1 ft	Calculated by model
Transverse Dispersivity (ay)	1.6 ft	Calculated by model
Vertical Dispersivity (az)	0 ft	Calculated by model
ADSORPTION		
Retardation Factor (R)	1	Manually input
Soil Bulk Density (rho)	1.7 kg/l	Assumed value from literature
Partition Coeffcient (Koc)	12.7 L/kg	Default for MTBE
Fractional Organic Carbon (foc)	5.00E-03	Default for foc
BIODEGRADATION		
1st Order Decay Coeffcient (lambda)	6.9E-3 per year	Calculated by model
Delta Oxygen	0.1 mg/L	From field data
Delta Nitrate	0 mg/L	From field data
Delta Ferrous Iron	10.5 mg/L	From field data
Delta Sulfate	68 mg/L	From field data
Delta Methane	0 mg/L	From field data
GENERAL		
Model Area Length	900-1000 ft	-
Model Area Width	400 ft	-
Estimated Plume Length	400 ft	From field data
Source Thickness	10 ft.	Assumed value

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Keesler AFB

SWMU 66

Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.

Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	27.2	(ft/yr)
or		or	
Hydraulic Conductivity	K	2.5E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Porosity	n	0.19	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	16.1	(ft)
Transverse Dispersivity*	alpha y	1.6	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	400	(ft)

3. ADSORPTION

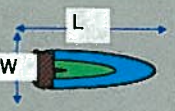
Retardation Factor*	R	1.6	(-)
or		or	
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	12.7	(L/kg)
FractionOrganicCarbon	foc	5.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-3	(per yr)
or		or	
Solute Half-Life	t-half	100.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0.1	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	10.5	(mg/L)
Delta Sulfate*	SO4	68	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	900	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	15	(yr)



115 or 0.02

Variable* 20

6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

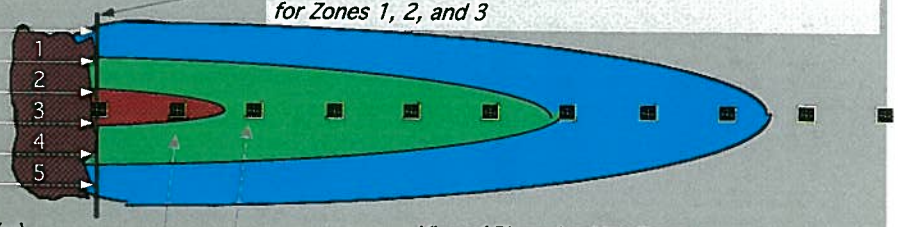
Width* (ft)	Conc. (mg/L)*
25	1
25	6
25	2.5
25	6
25	1

Source Halflife (see Help):

200	>1000	(yr)
Inst. React.	1st Order	

Soluble Mass in Source NAPL, Soil: 1000 (Kg)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	0	90	180	270	360	450	540	630	720	810	900
Concentration (mg/L)											

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

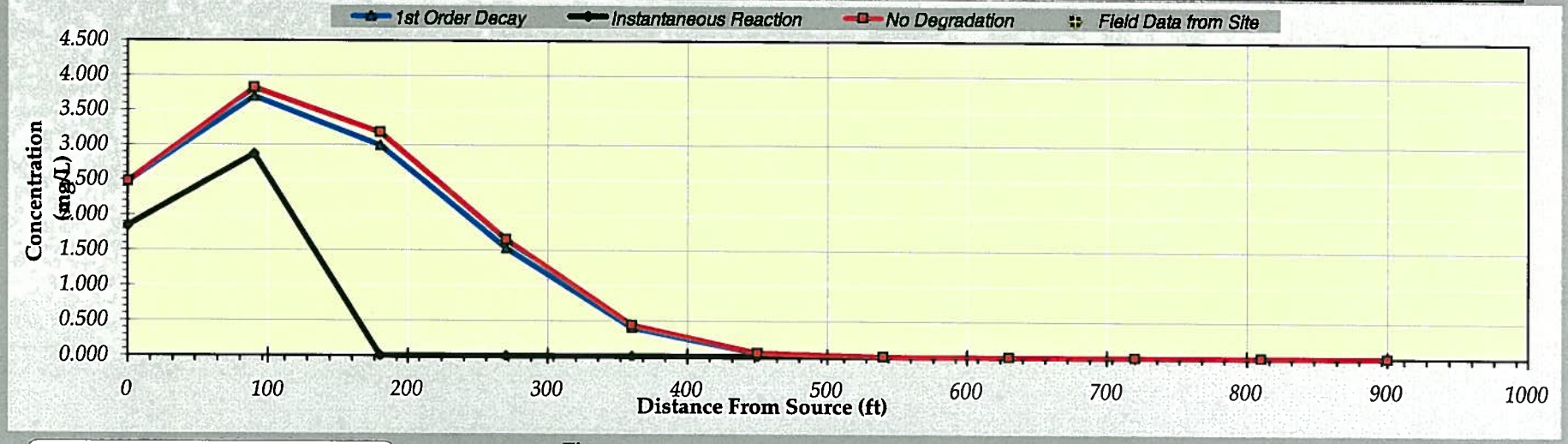
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	90	180	270	360	450	540	630	720	810	900
No Degradation	2.477	3.823	3.185	1.655	0.443	0.053	0.003	0.000	0.000	0.000	0.000
1st Order Decay	2.477	3.696	3.000	1.533	0.406	0.049	0.002	0.000	0.000	0.000	0.000
Inst. Reaction	1.844	2.869	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:
15 Years

Return to Input

Recalculate This Sheet

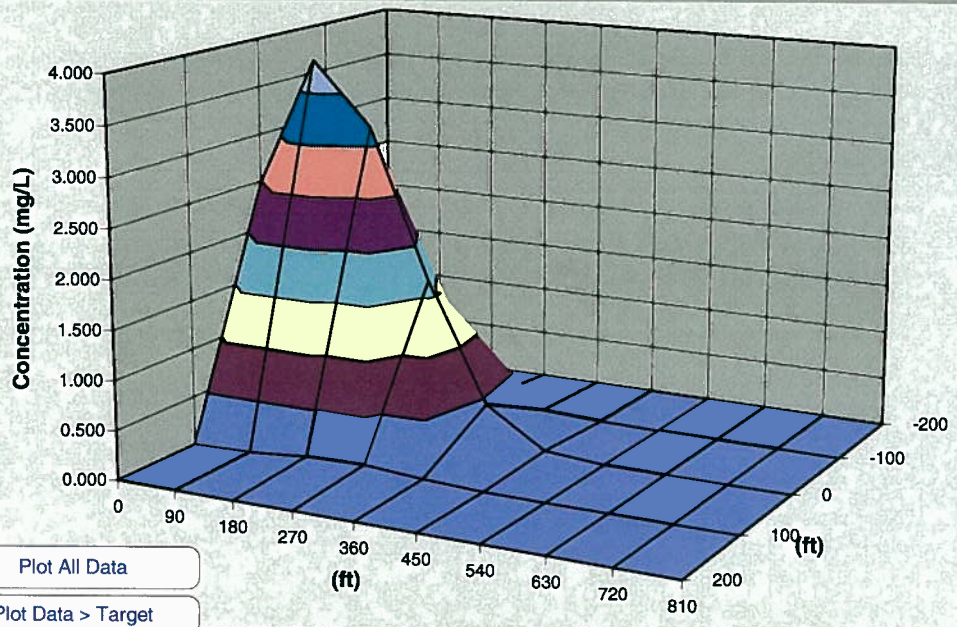
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft)	Distance from Source (ft)										
	0	90	180	270	360	450	540	630	720	810	900
200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
100	0.000	0.014	0.065	0.079	0.035	0.006	0.000	0.000	0.000	0.000	0.000
0	2.477	3.823	3.185	1.655	0.443	0.053	0.003	0.000	0.000	0.000	0.000
-100	0.000	0.014	0.065	0.079	0.035	0.006	0.000	0.000	0.000	0.000	0.000
-200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	1.7E+3	1.5E+3	1.3E+3	7.3E+2	2.1E+2	2.6E+1	1.4E+0	2.9E-2	2.4E-4	7.5E-7	9.0E-10

Time: 15 Years Target Level: 0.200 mg/L Displayed Model: No Degradation

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	9.0	(Kg)
- Actual Plume Mass	9.0	(Kg)
= Plume Mass Removed by Biodeg	0.0	(Kg)
	0 %	

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	1000.0	(Kg)
Contam. Mass in Source Now (t=15Years)	991.0	(Kg)
Current Volume of Groundwater in Plume	6.3	(ac-ft)
Flowrate of Water Through Source Zone	0.148	(ac-ft/yr)

Mass HELP

Recalculate

FUTURE 2-YEAR SIMULATION

SCENARIO-II

(RETARDATION FACTOR (R) = 1.6)

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Keesler AFB
SWMU 66
Run Name

Data Input Instructions:

115
↑ or
0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	27.2	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	2.5E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Porosity	n	0.19	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	16.1	(ft)
Transverse Dispersivity*	alpha y	1.6	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		↑ or	
Estimated Plume Length	Lp	400	(ft)

3. ADSORPTION

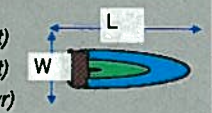
Retardation Factor*	R	1.6	(-)
or		↑ or	
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	12.7	(L/kg)
FractionOrganicCarbon	foc	5.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-3	(per yr)
or		↑ or	
Solute Half-Life	t-half	100.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0.1	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	10.5	(mg/L)
Delta Sulfate*	SO4	68	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	900	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	17	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

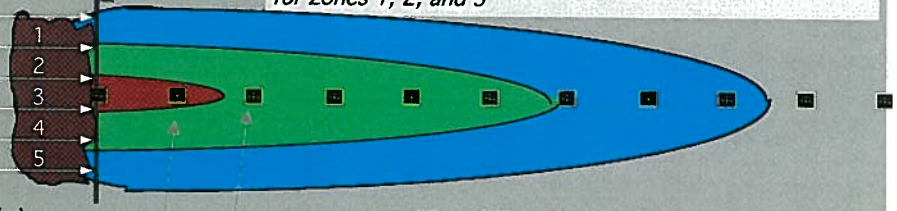
Width* (ft)	Conc. (mg/L)*
25	1
25	6
25	2.5
25	6
25	1

Source Halflife (see Help):

200	>1000	(yr)
Inst. React. ↑	↑ 1st Order	

Soluble Mass in Source NAPL, Soil: 1000 (Kg)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	
90	
180	
270	
360	
450	
540	
630	
720	
810	
900	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

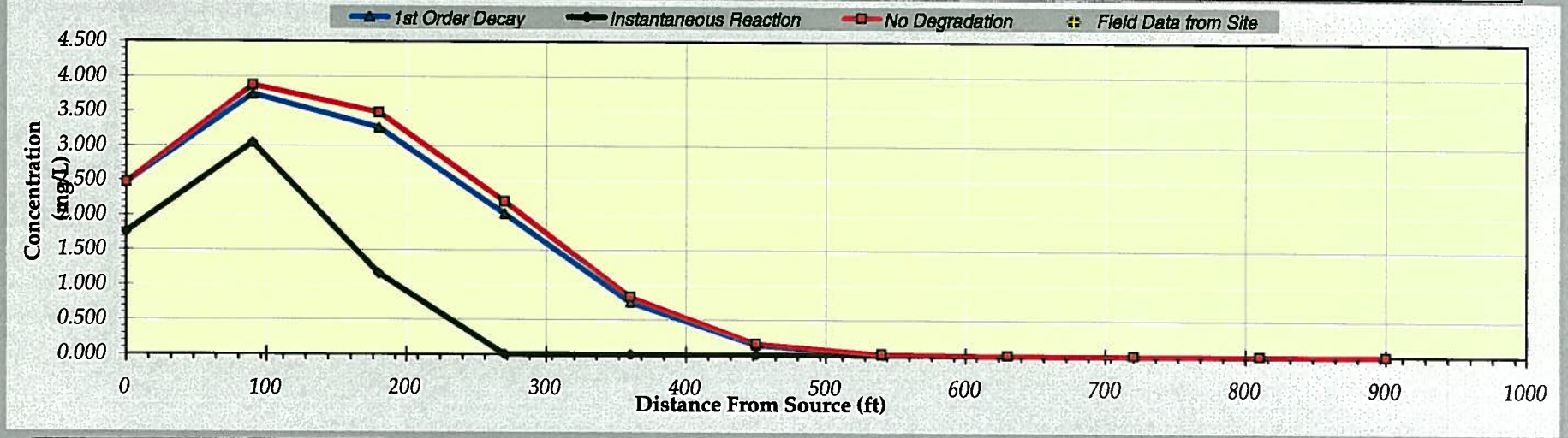
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	90	180	270	360	450	540	630	720	810	900
No Degradation	2.474	3.876	3.479	2.200	0.829	0.161	0.015	0.001	0.000	0.000	0.000
1st Order Decay	2.474	3.744	3.264	2.024	0.754	0.146	0.013	0.001	0.000	0.000	0.000
Inst. Reaction	1.759	3.045	1.163	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time: 17 Years

Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft)	Distance from Source (ft) 0	90	180	270	360	450	540	630	720	810	900
200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
100	0.000	0.014	0.072	0.105	0.066	0.018	0.002	0.000	0.000	0.000	0.000
0	2.474	3.876	3.479	2.200	0.829	0.161	0.015	0.001	0.000	0.000	0.000
-100	0.000	0.014	0.072	0.105	0.066	0.018	0.002	0.000	0.000	0.000	0.000
-200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	1.7E+3	1.6E+3	1.5E+3	9.7E+2	3.9E+2	7.9E+1	7.7E+0	3.4E-1	6.6E-3	5.5E-5	2.0E-7

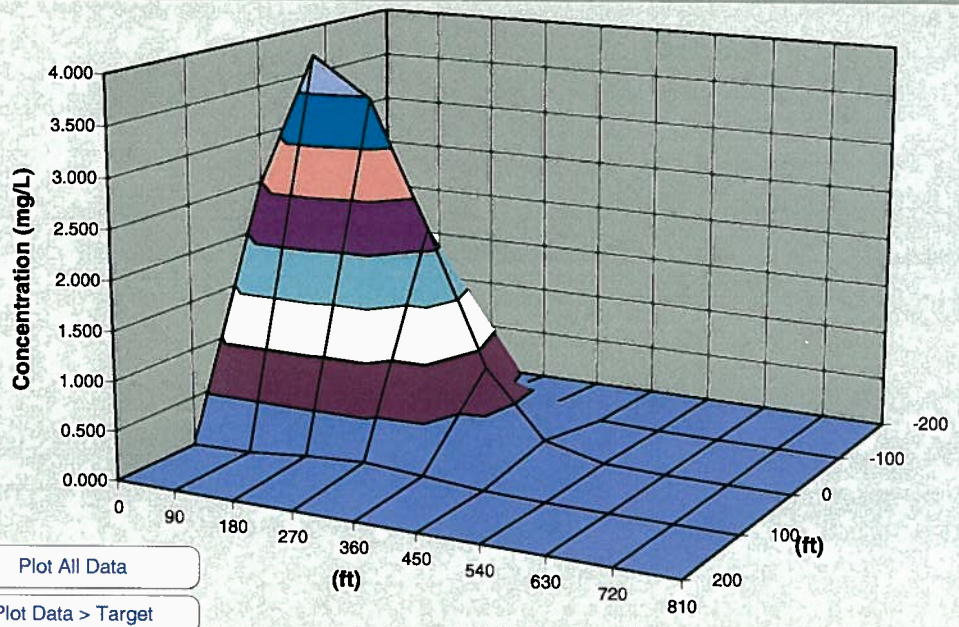
Time: 17 Years

Target Level: 0.200 mg/L

Displayed Model: No Degradation

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	10.2	(Kg)
- Actual Plume Mass	10.2	(Kg)
= Plume Mass Removed by Biodeg	0.0	(Kg)
	0 %	

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	1000.0	(Kg)
Contam. Mass in Source Now (t=17Years)	989.8	(Kg)
Current Volume of Groundwater in Plume	6.7	(ac-ft)
Flowrate of Water Through Source Zone	0.148	(ac-ft/yr)

Mass HELP

Recalculate

FUTURE 5-YEAR SIMULATION

SCENARIO-II

(RETARDATION FACTOR (R) = 1.6)

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Keesler AFB

SWMU 66

Run Name

Data Input Instructions:

115 or 0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.

20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	27.2	(ft/yr)
or		or	
Hydraulic Conductivity	K	2.5E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Porosity	n	0.19	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	16.1	(ft)
Transverse Dispersivity*	alpha y	1.6	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	400	(ft)

3. ADSORPTION

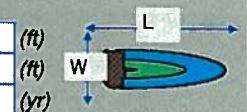
Retardation Factor*	R	1.6	(-)
or		or	
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	12.7	(L/kg)
FractionOrganicCarbon	foc	5.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-3	(per yr)
or		or	
Solute Half-Life	t-half	100.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0.1	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	10.5	(mg/L)
Delta Sulfate*	SO4	68	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	900	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	20	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
25	1
25	6
25	2.5
25	6
25	1

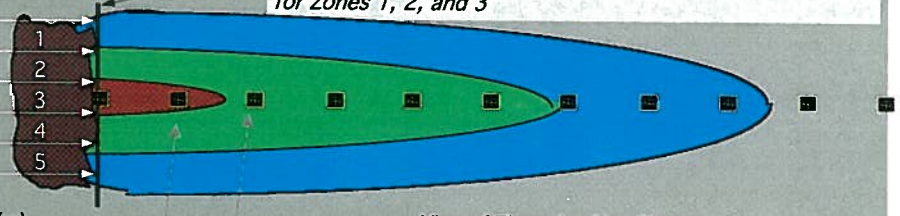
Source Halflife (see Help):

200	>1000	(yr)
Inst. React.	1st Order	

Soluble Mass 1000 (Kg)

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	0	90	180	270	360	450	540	630	720	810	900
Concentration (mg/L)											

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

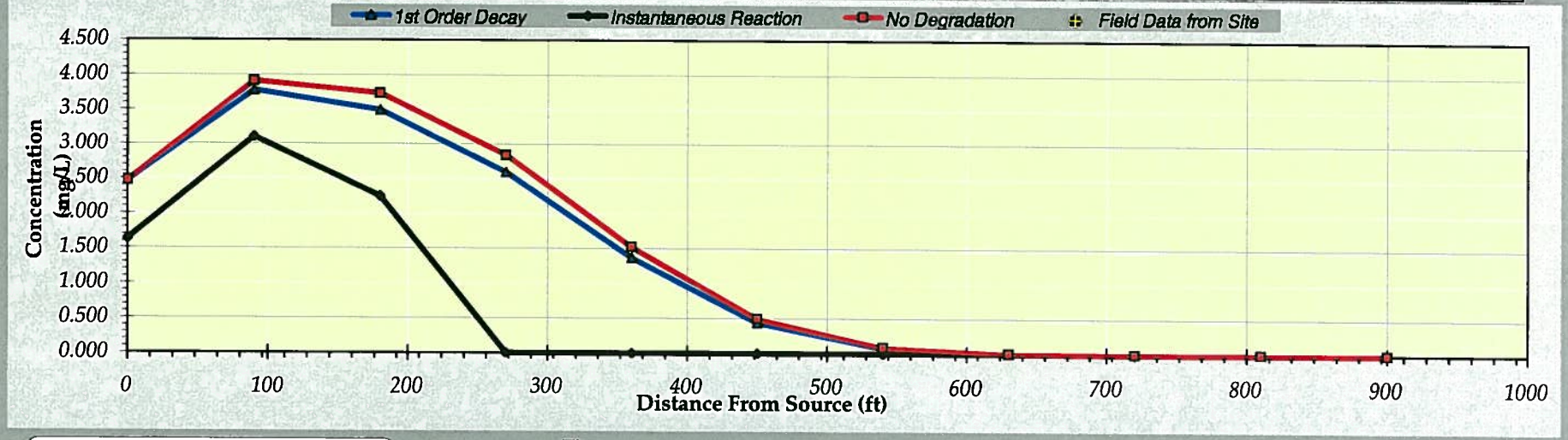
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	90	180	270	360	450	540	630	720	810	900
No Degradation	2.470	3.913	3.735	2.841	1.523	0.497	0.090	0.009	0.000	0.000	0.000
1st Order Decay	2.470	3.776	3.492	2.592	1.368	0.442	0.080	0.008	0.000	0.000	0.000
Inst. Reaction	1.632	3.105	2.244	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time: 20 Years

Return to Input

Recalculate This Sheet

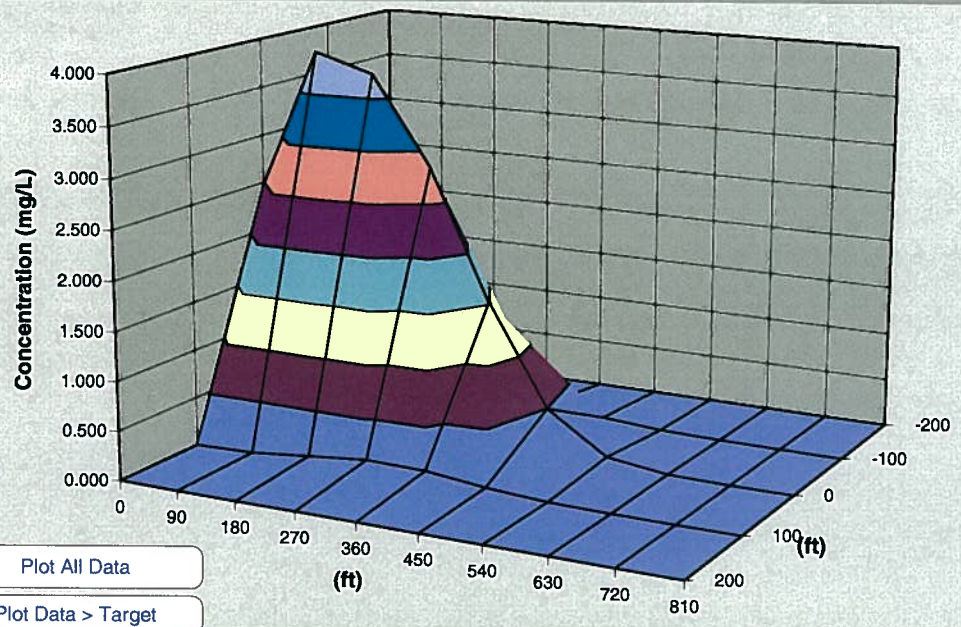
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	90	180	270	360	450	540	630	720	810	900
200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
100	0.000	0.014	0.077	0.135	0.121	0.056	0.013	0.002	0.000	0.000	0.000
0	2.470	3.913	3.735	2.841	1.523	0.497	0.090	0.009	0.000	0.000	0.000
-100	0.000	0.014	0.077	0.135	0.121	0.056	0.013	0.002	0.000	0.000	0.000
-200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	1.7E+3	1.6E+3	1.6E+3	1.2E+3	7.1E+2	2.4E+2	4.7E+1	4.6E+0	2.3E-1	5.9E-3	7.2E-5

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model

Time: **20 Years** Target Level: **0.200** mg/L Displayed Model: **No Degradation**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	12.0	(Kg)
- Actual Plume Mass	12.0	(Kg)
= Plume Mass Removed by Biodeg	0.0	(Kg)
	0 %	

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	1000.0	(Kg)
Contam. Mass in Source Now (t=20Years)	988.0	(Kg)
Current Volume of Groundwater in Plume	7.9	(ac-ft)
Flowrate of Water Through Source Zone	0.148	(ac-ft/yr)

Mass HELP

Recalculate

FUTURE 10-YEAR SIMULATION

SCENARIO-II

(RETARDATION FACTOR (R) = 1.6

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Keesler AFB
SWMU 66
Run Name

Data Input Instructions:

115 or 0.02
1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* 20
Data used directly in model.
Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	27.2	(ft/yr)
or		or	
Hydraulic Conductivity	K	2.5E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Porosity	n	0.19	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	16.1	(ft)
Transverse Dispersivity*	alpha y	1.6	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	400	(ft)

3. ADSORPTION

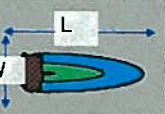
Retardation Factor*	R	1.6	(-)
or		or	
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	12.7	(L/kg)
FractionOrganicCarbon	foc	5.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-3	(per yr)
or		or	
Solute Half-Life	t-half	100.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0.1	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	10.5	(mg/L)
Delta Sulfate*	SO4	68	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	900	(ft)
Modeled Area Width*	400	(ft)
Simulation Time*	25	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

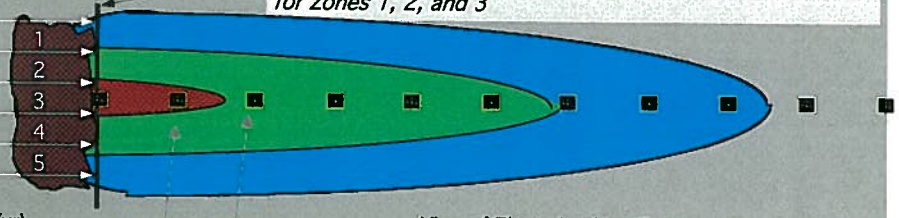
Width* (ft)	Conc. (mg/L)*
25	1
25	6
25	2.5
25	6
25	1

Source Halflife (see Help):

200 (Inst. React.) | >1000 (1st Order) (yr)

Soluble Mass 1000 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	0	90	180	270	360	450	540	630	720	810	900
Concentration (mg/L)											

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

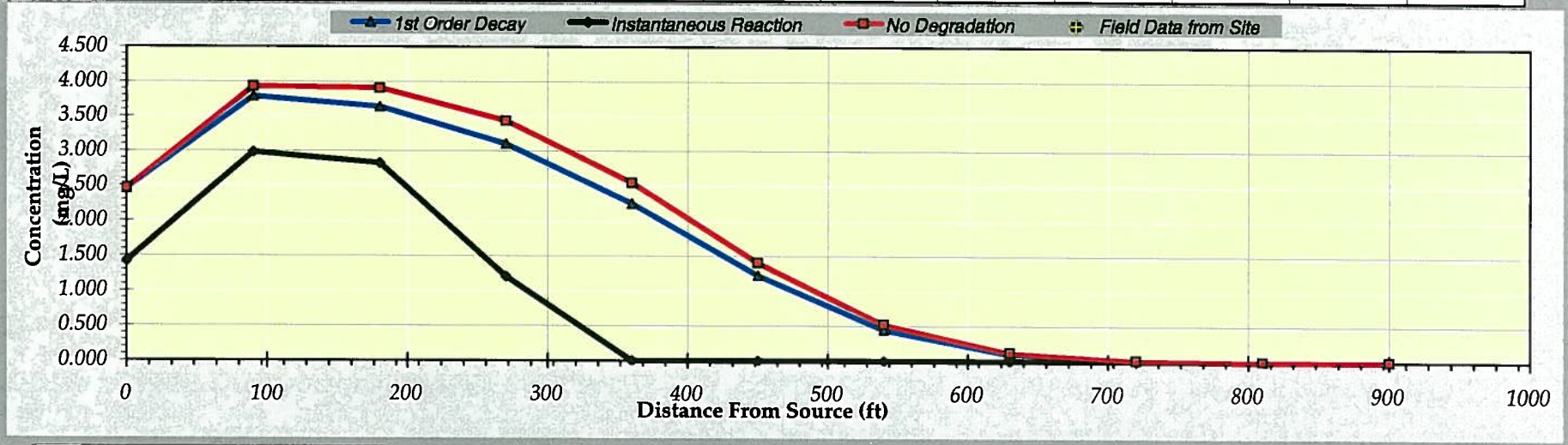
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	90	180	270	360	450	540	630	720	810	900
No Degradation	2.463	3.925	3.901	3.433	2.543	1.408	0.524	0.122	0.017	0.001	0.000
1st Order Decay	2.463	3.786	3.635	3.103	2.247	1.226	0.452	0.105	0.015	0.001	0.000
Inst. Reaction	1.424	2.983	2.824	1.205	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:
25 Years

Return to Input

Recalculate This Sheet

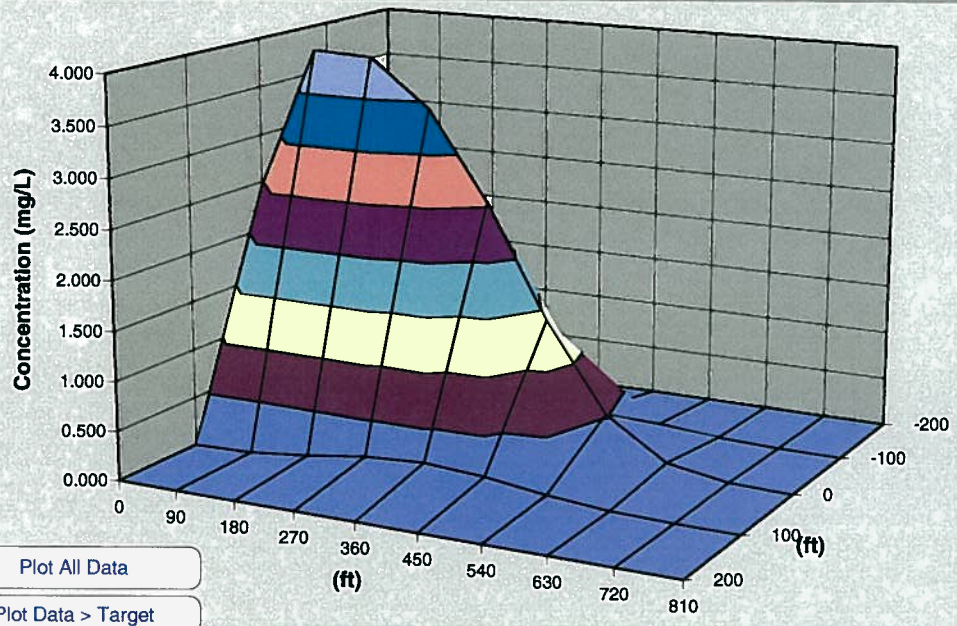
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) \ Distance from Source (ft)	0	90	180	270	360	450	540	630	720	810	900
200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
100	0.000	0.014	0.080	0.164	0.202	0.158	0.076	0.022	0.004	0.000	0.000
0	2.463	3.925	3.901	3.433	2.543	1.408	0.524	0.122	0.017	0.001	0.000
-100	0.000	0.014	0.080	0.164	0.202	0.158	0.076	0.022	0.004	0.000	0.000
-200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	1.7E+3	1.6E+3	1.6E+3	1.5E+3	1.2E+3	6.9E+2	2.7E+2	6.6E+1	9.7E+0	8.3E-1	4.1E-2

Time: 25 Years Target Level: 0.200 mg/L Displayed Model: No Degradation

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	15.0	(Kg)
- Actual Plume Mass	15.0	(Kg)
= Plume Mass Removed by Biodeg	0.0	(Kg)
	0 %	

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	1000.0	(Kg)
Contam. Mass in Source Now (t=25Years)	985.0	(Kg)
Current Volume of Groundwater in Plume	9.0	(ac-ft)
Flowrate of Water Through Source Zone	0.148	(ac-ft/yr)

Mass HELP

Recalculate

APPENDIX D

CATLIN STANDARD METHODS OF INVESTIGATION

1.0 DATA COLLECTION

1.1 BACKGROUND DATA

Background data and history information relevant to the site investigation is generated through numerous sources. These sources may include, but are not limited to, the following:

- Conversations with the client and regulatory officials involved with the incident.
- Review of pertinent regulatory correspondence.
- Review of previous and existing reports and other technical data.
- Review of available historical records.

1.2 SURVEYS AND POTENTIAL RECEPTOR DATA

Physical survey and potential receptor data is collected in accordance with the intended level of investigation. In general, the purpose is to collect sufficient information for site assessment and corrective action planning.

Individual receptors are identified and evaluated in the context of their potential for contaminant impact. Potential receptors of contamination can include surface water bodies, groundwater supply wells, wellhead protection areas, and subsurface building structures.

1.2.1 Horizontal Survey

Horizontal survey data is generated using either accepted general field surveying techniques, or existing survey maps; or by using a combination of existing data and field generated information. The survey area generally extends to a point at least 50 feet beyond suspected plume boundaries. A receptor scale survey of a larger area surrounding a site will be made if appropriate and necessary.

1.2.2 Vertical Survey

A vertical survey is conducted at the site typically within an accuracy of 0.01 foot. The datum plane is generally assumed unless otherwise noted. Assumed temporary benchmarks (TBM) are selected near ground level. The vertical survey includes such points as top of all well casings, selected ground shots, important utility inverts, utility fluid levels, important surface water levels, and other items determined to be significant.

1.3 DRILLING AND MONITORING WELL/PIEZOMETER INSTALLATION

Necessary permits are applied for and obtained in accordance with federal, state, and local requirements prior to drilling or well construction activities. Additionally, the well locations are scanned for underground utilities prior to conducting intrusive subsurface activities. Wells are installed under applicable licensing requirements, and are designed and constructed in accordance with accepted standards and practices. Any wells purposely installed at off-site locations are permitted through appropriate right-of-entry agreements with all necessary property owners and/or their agents.

1.3.1 Drilling Methods and Subsurface Data Collection

Drilling is accomplished utilizing one or more of the following methods:

Auger Drilling

Auger drilling is the preferred, most often used method of subsurface investigation and is accomplished using a vehicle or trailer mounted drill rig. Continuous flight auger types used vary upon the site and situation; ranging from the 4-inch outside diameter solid stem to the 12-inch outside diameter hollow stem. Auger type is selected based upon appropriateness and/or site-specific requirements.

Hand Augering

Hand augering is utilized when economically and scientifically feasible, or when no other method is suitable. Hand augers typically produce three-inch diameter holes and are generally limited to depths of less than 15 feet.

Direct Push

Direct push methods of subsurface investigation are used generally for soil screening purposes or collection of groundwater samples where permanent wells are not viable.

Other Methods

Other drilling methods, such as mud and air rotary, rock coring, cable tool, and large bucket augering are used when site conditions or project requirements dictate.

Regardless of the drilling method used, the drill rig(s) and all drilling tools are thoroughly cleaned between boreholes to prevent cross introduction of contaminants. Split spoon samples are collected and field-described at intervals of five feet or less, and cuttings are continuously monitored for organic vapors. Drill cuttings are containerized for off-site disposal or are spread on the ground surface in proximity to the well or boring in accordance with North Carolina Department of Environment and Natural Resources (NCDENR) requirements. A geologist or engineer, trained in using visual/manual techniques, is always present during drilling and is responsible for subsurface contaminant and geologic data collection. Soils are classified in general agreement with the Unified Soils Classification System (USCS).

1.3.2 Hydropunch Installation

Hydropunch penetrometers (Hydropunches) are used to delineate the spatial extent of dissolved and free phase plumes. Soil borings are advanced to the appropriate depth and then the Hydropunch is advanced through the soil boring into undisturbed material. Groundwater samples are collected by pulling back on the body of the Hydropunch and allowing the groundwater to enter the screened portion of the sample chamber. Samples are retrieved using a decontaminated Teflon bailer or peristaltic pump.

1.3.3 Well Installation

Wells are typically constructed of threaded PVC casing and screen. No glues or cements are used in joining PVC components. Well diameter, slot sizes, and protective covers vary depending upon site-specific conditions or situation-specific requirements.

1.3.4 Well Development

Wells are developed by over-pumping or surging using appropriate pumps, blocks, or bailers. Through development, unwanted fine materials are removed from the natural formation surrounding the well. Well development will be performed no sooner than 24-hours after grouting is completed for the Type III wells. Water generated during development is containerized and properly disposed or is discharged onto the ground in proximity of the well in accordance with NCDENR requirements.

1.4 *HYDROGEOLOGIC DATA COLLECTION*

Data used to help characterize hydrogeologic conditions at a site are obtained through various procedures including, but not necessarily limited to, those described below:

1.4.1 Regional Geology

Information pertaining to the regional geologic framework is compiled from existing publications, maps, and scientific papers.

1.4.2 Site Geology

Shallow site geology is generally determined from field descriptions and borehole samples. Interpretations with regard to hydrogeologically important contacts, zones, fractures, faults, cleavage, and face changes are made when possible.

1.4.3 Groundwater Occurrence and Characteristics

Groundwater data is obtained utilizing a number of methods and procedures, not limited to the general list below:

Well Water Levels

After well development, wells are allowed to stabilize for a minimum of 24 hours prior to measuring. Water level and free product thickness (where applicable) measurements are performed using an electronic interface probe or steel tape with water/product finding pastes.

The specific gravity of any accumulated product is determined and used to calculate true hydraulic grade from measured water levels. This information is combined with vertical survey data to determine relative potentiometric surface elevations for all wells.

Aquifer Testing

Various aquifer tests may be used to make determinations of hydraulic conductivity. Slug or pumping tests are often used to characterize site hydrogeologic conditions and to develop remedial action alternatives utilizing appropriate pumping technologies.

Other Methods

Other methods may be deemed appropriate for determining various groundwater characteristics. These other methods may include nested well configurations and/or clustered piezometer installations; sieve or pipette analysis; fracture trace analysis; computer modeling; and geophysical logging.

1.5 PETROLEUM HYDROCARBON DATA COLLECTION

1.5.1 Collection Methods

Petroleum hydrocarbon data is obtained through various methods including, but not limited to, the following:

Field Analysis

- Direct thickness measurement of phase separated components using tapes and/or probes.
- Manual vapor analysis using a photoionization detector (PID) or flame ionization detector (FID).
- Detectable odor and visual observation.

Laboratory Analysis

- Laboratory analysis of phase-separated products.
- Laboratory vapor, soil, and groundwater analysis using appropriate EPA Methods.

1.5.2 Field Sampling

Field sampling procedures are performed in accordance with recommended protocol, accepted industry standards, and under appropriate chain-of-custody procedures. Generally, sampling procedures are as follows:

Product Samples

Product samples are obtained using clean equipment and containers. Each is shipped to the analytical laboratory in protective containers.

Vapor Samples

PID/FID readings are measured from soil sample headspace using containerized samples that have been brought to ambient temperature.

Carbon tubes are utilized in conjunction with a laboratory calibrated vacuum pump to obtain vapor samples. The carbon tubes are sealed and refrigerated for shipment to the analytical laboratory (This method is known as the Carbon Adsorption Method).

Soil Samples

Soil samples are immediately packed into clean containers, and refrigerated for shipment to the analytical laboratory.

Groundwater Samples

Groundwater samples are collected in accordance with the following procedures:

- Creeks/Lakes/Etc.

  Grab samples are obtained.

- Domestic Wells

  Wells are pumped for a time sufficient to completely purge the well and any pressure or holding tanks prior to sampling.

- Monitoring Wells

  Water level measurements are made and well volumes calculated for each well.

  Three well volumes are removed from each well using a thoroughly cleaned Teflon bailer or appropriate purging pump. If it is not possible to remove three volumes, due to very low yields, a minimum of one volume is removed prior to obtaining a sample.

  Where analysis for metals is required, wells are typically sampled utilizing low flow techniques, which reduce turbidity and the potential for matrix interference.

Samples are collected and containerized in a manner that minimizes agitation and contact with the air.

Sampling records are field prepared.

Samples are labeled and proper chains of custody documents are maintained.

Samples are promptly protectively packed, refrigerated, and shipped to the analytical laboratory for analysis.

2.0 DATA EVALUATION

Data obtained as a result of the site investigation is compiled and evaluated and a report is prepared for client review and distribution to the appropriate agencies. Generally, specific data is evaluated as follows:

- Background data is evaluated in context with the suspected or confirmed problem.
- Survey data is utilized to develop site maps and to evaluate contaminant receptors.
- Well construction records are compiled and presented as part of the report. As-built information is used in combination with other data to evaluate subsurface conditions and monitoring well screen settings as they relate to the investigation.
- Subsurface drilling logs are used to develop geologic cross-sections, fence diagrams, isopachs, structure contours, or other constructions. Regional geologic data are used to obtain an overall framework.
- Hydrogeologic data is used to develop contour maps, flow nets and other constructions. The data is also used to calculate various hydrogeologic parameters that describe aquifer characteristics.
- Hydrocarbon data is utilized to develop various plume geometry and isoconcentration maps.
- All data is compiled and utilized for making specific recommendations with regard to remedial action alternatives.