Final Report:
Technical Assistance for the Kearsarge Metallurgical Corporation Superfund Site
Conway, New Hampshire
EPA Region 1

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ABBREVIATIONS

1,1,1-TCA	1,1,1-trichloroethane
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
AFCEE	Air Force Center for Engineering and the Environment
AMSL	above mean sea level
AR	area ratio
ARAR	applicable or relevant and appropriate requirement
BGS	below ground surface
CES	cost effective sampling
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COC	constituent of concern
CR	concentration ratio
EMS	Environmental Management Support
ESD	explanation of significant difference
FS	feasibility study
GIS	geographic information system
GMZ	groundwater management zone
IC	institutional control
LTM	long-term monitoring
LTMO	long-term monitoring optimization
MAROS	Monitoring and Remediation Optimization Software
MCES	modified cost effective sampling
MCL	Maximum Contaminant Level
MK	Mann-Kendall

MNA	monitored natural attenuation
NPL	National Priorities List
O&M	operation and maintenance
PLSF	preliminary location sampling frequency
POC	point of compliance
P&T	pump and treat
RA	remedial action
RAO	remedial action objective
RI	remedial investigation
ROD	record of decision
SF	slope factor
TCE	trichloroethene
UCL	upper confidence limit
USACE	United States Army Corps of Engineers
U.S. EPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

The following report reviews and provides recommendations for a long-term groundwater monitoring network for the Kearsarge Metallurgical Corporation Superfund site (KMC site). The KMC site is a former foundry and metal fabrication facility in Conway, New Hampshire, listed on the National Priorities List (NPL) in 1984. The facility operated between 1964 and 1982, using chlorinated solvents to clean metal surfaces. Waste management practices during this time resulted in a residual groundwater plume in the shallow subsurface. Extensive remedial actions have been implemented, and the site is currently in a long-term operation and maintenance (O&M) phase.

The primary goal of developing an optimized groundwater monitoring strategy at the KMC site is to create a dataset that fully supports site management decisions relating to the long-term remedial strategy and reuse options for the property.

In the following report, the current KMC site groundwater monitoring network has been evaluated using a formal qualitative approach as well as statistical tools found in the Monitoring and Remediation Optimization System software (MAROS). The evaluation of the monitoring system included data collected both prior to and during active groundwater extraction (1983 - 2005) and after cessation of the extraction remedy (2006 - 2009). Network recommendations are made for groundwater sampling frequency and location based on lines of evidence developed from qualitative factors as well as statistical results.

Qualitative considerations for the KMC site include hydrogeologic conditions as described in *Summary/Update Regarding Site Conceptual Model Kearsarge Metallurgical Corporation* (GeoTrans 2009). KMC site hydrogeology is complex, with radial groundwater flow, variable depth to the confining layer, and fluctuating groundwater levels. Additional qualitative factors considered during the analysis include anticipated future property use, source attenuation processes, as well as the long-term monitoring (LTM) goals for the site. Lines of evidence from MAROS statistical results were interpreted along with qualitative factors in order to account for the complexities of the site. The report outlines recommendations based on the formal evaluation, but final determination of sampling locations and frequencies are to be decided by the overseeing regulatory agencies.

Site Groundwater Monitoring Goals and Objectives

A groundwater extraction and treatment system was operated at KMC between 1993 and 2005. In 2003, a large area of residual soil contamination was excavated and disposed offsite. Active groundwater extraction stopped in 2005 in response to contaminant concentrations falling below cleanup levels and due to the low rate of mass extraction relative to the amount of groundwater removed. Since 2005, monitoring data have been collected to evaluate the remaining groundwater plume under ambient conditions. Going forward, primary monitoring goals for the program include: 1) confirming that concentrations of constituents of concern (COCs) are declining; and 2) ensuring that COCs are not migrating horizontally beyond the current extent of affected groundwater.

Project Goals and Objectives

The goal of the long-term monitoring optimization (LTMO) process is to review the current groundwater monitoring program and provide recommendations for improving the efficiency and accuracy of the network in supporting site monitoring objectives. Specifically, the LTMO process provides information on the site characterization, stability of the plume, sufficiency and redundancy of monitoring locations and the appropriate frequency of sampling. The end product of the LTMO process at the KMC site is a recommendation for specific sampling locations and frequencies that best address monitoring goals and support future management and redevelopment decisions (see Figure 9 for the final network recommendations).

Results

Statistical analysis and qualitative review of KMC site analytical data have been conducted and the following general conclusions have been developed based on the results of these analyses:

- *Historical remedial activities have diminished the size of the plume*. In the years since discontinuation of extraction remedy, the majority of monitoring locations show either no detections of contaminants of concern (COCs) or show low or decreasing concentrations of COCs.
- *Biotic and abiotic degradation pathways are active at the site.* Historically, biological degradation of 1,1,1-trichloroethane (1,1,1-TCA) to 1,1-dichloroethane (1,1-DCA) and chloroethane has been active in the eastern area of the site. Currently, abiotic degradation of 1,1,1-TCA, producing 1,1-dichloroethene (1,1-DCE), is the dominant degradation process at the site, especially in the western area of the plume. Due to its relatively low cleanup level (7 µg/L, the U.S. EPA MCL), 1,1-DCE is the priority groundwater contaminant at the site.
- *Two areas of the plume show increasing concentration trends.* The area around well MW-3008 near the drainage culvert shows a strongly increasing trend for 1,1-DCE. The area in the vicinity of MW-3003 shows increasing trends for 1,1,1-TCA and 1,1-DCE. These two areas are priorities for the monitoring effort. Areas of the plume north and south of the source excavation show largely decreasing trends and very low concentrations, and are of lower monitoring priority.
- *Monitoring Well Redundancy/Sufficiency*: Spatial analysis indicates that there is monitoring well redundancy on the edges of the plume and in the Hobbs Street Area. No excess concentration uncertainty requiring new monitoring locations was found in the aerial extent of the plume.
- *Reduced Sampling Frequency:* The statistical sampling frequency analysis along with a qualitative review indicated that a reduced sampling frequency may be appropriate for many wells in the network. With the exception of MW-3003 and MW-3008; MW-3009 concentrations are changing very slowly and frequent monitoring does not provide unique information.
- *Statistically "clean" locations:* The following locations have adequate analytical data to confirm that groundwater in the area has attained the cleanup goals for all

constituents: EW-01, EW-02, EW-06, MW-202A, MW-211, MW-3004, MW-3005, MW-3007, MW-9, and PZ-4004.

Recommendations

The following recommendations are made based on the results of the qualitative and quantitative review of data received, with findings summarized above and in Sections 2 and 3 below.

- *Eliminate Wells from Monitoring Program:* Eliminate ten wells from routine monitoring: EW-01, EW-10, MW-203A, MW-205, MW-211; MW-3007, MW-5001; MW-8, MW-9 and PZ-4003. These locations provide redundant information for the routine monitoring program. The recommendation is not to plug and abandon the wells, as they may provide useful hydrogeologic data. These wells may be included in the future network if they address specific regulatory requirements related to monitoring the boundary of the groundwater management zone. No additional new wells are recommended.
- *Reduce Sampling Frequency:* Annual sampling is recommended for the majority of the monitoring locations, and is recommended for wells that delineate or serve as point of compliance (POC) locations. Five locations are recommended for semiannual sampling: MW-3006, MW-3003, MW-3008, MW-3009 and MW-3010. Semiannual sampling is recommended for wells that indicate residual source strength and to develop a statistically significant dataset (MW-3006), to track historic high concentrations (MW-3008 and MW-3010) and to monitor increasing concentration trends (MW-3003, MW-3008 and MW-3009).
- *Areas of concern:* Groundwater in the area of MW-3003 shows increasing concentration trends and flow in this region is to the west.
- *Source, Sentry and Compliance Monitoring Locations*: Wells recommended to evaluate continued attenuation of the source include: MW-3003; MW-3006; MW-3008, MW-3009 and MW-3010. Wells recommended as sentry points, to indicate a potentially expanding plume or threats to downgradient receptors, include MW-5003, PZ-4002, EW-09; MW-3004, MW-3011, and MW-3004. Concentration trend analysis is an appropriate analytical technique for interpreting data from both source and sentry monitoring locations. Wells recommended to delineate the plume or to demonstrate compliance with regulatory cleanup goals include: EW-02, EW-03, EW-06, MW-202A, MW-206, MW-5002, MW-3004, MW-213, MW-3005, and EW-13B. Delineation wells show no recent detections of site contaminants or intermittent detections below cleanup goals.
- *Surface water monitoring:* The area between MW-3008 and the drainage culvert shows a strongly increasing trend for 1,1-DCE. The drainage culvert may receive discharge from shallow groundwater and appears to be a flow barrier for eastward migration of the plume. Discharge to the drainage culvert should be monitored in the region of MW-3008 in order to confirm that concentrations of contaminants above surface water quality standards are not being released. Locations CB 7-8, CB 6-7 and CB 5-6 should be monitored annually as POC locations to confirm that excess concentrations of 1,1-DCE are not affecting surface water.

- *Future reductions in monitoring effort* may be possible after a larger dataset has been collected and increasing trends at MW-3003 and MW-3008 have stabilized or begin to decline.

1.0 INTRODUCTION

The Kearsarge Metallurgical Corporation Superfund site (KMC site) is a National Priorities Listed (NPL) site in Conway, New Hampshire. The site comprises a four-acre former industrial property and an adjacent five-acre wetland. Historical metal casting and foundry activities have resulted in residual groundwater contamination related to releases of chlorinated solvents to a septic system. The site is bounded to the south by Pequawket Pond which ultimately discharges to the Saco River. The site is bounded to the north by industrial/commercial property, with Hobbs Street to the west/northwest and other industrial properties to the north. A drainage culvert runs along the eastern side of the property, discharging to Pequawket Pond. Wooded wetland property lies to the east of the culvert (see Figure1).

KMC has undergone significant remedial activities since approval of the record of decision (ROD) in 1990. A groundwater extraction and treatment system (pump and treat [P&T]) was operated at the site between 1993 and 2005. In December 2005, the P&T system was discontinued because groundwater concentrations of priority contaminants dropped below cleanup goals, and the mass of contaminants being removed relative to the volume of water pumped was very low (United States Army Corps of Engineers [USACE] 2008).

At the KMC site, monitoring goals define why data are collected and how data will be used to support site management decisions. Currently, groundwater monitoring efforts are underway to evaluate ambient conditions after the cessation of active P&T. Groundwater monitoring data will be used to evaluate whether monitored natural attenuation (MNA) is an appropriate long-term remedy for residual contamination. Therefore, current monitoring goals for the site include: 1) confirming that concentrations of constituents of concern (COCs) remain below cleanup levels; 2) documenting changes to the groundwater plume after excavation of a source area and cessation of the P&T system; and 3) ensuring that COCs are not migrating horizontally beyond the current extent of affected groundwater or beyond boundaries of the institutional control.

U.S. EPA Region 1 has requested GSI Environmental (GSI) under contract to EMS to review the KMC site groundwater monitoring network *and provide recommendations for improving the efficiency and accuracy of the network for supporting site management decisions during aquifer restoration.* To this end, the following tasks have been performed:

- Review monitoring objectives and overall remedial goals, and qualitatively evaluate the ability of the monitoring network to achieve goals and objectives.
- Evaluate individual well concentration trends over time;
- Evaluate overall “plume stability” through concentration trend and moment analysis;
- Develop sampling location recommendations based on a calculation of spatial concentration uncertainty as well as a review of hydrogeologic features;
- Develop sampling frequency recommendations based on both qualitative and quantitative statistical analysis results; and

- Evaluate individual well analytical data for statistical sufficiency and identify locations that have achieved clean-up goals.

1.1 SITE BACKGROUND

Between 1900 and 1964, the KMC property was the site of a saw mill operation. In 1964, the property was converted to a foundry for the manufacture of precision stainless steel castings operated by KMC. During this time, chlorinated solvents such as 1,1,1-trichloroethane (1,1,1-TCA) were used to clean metal surfaces, and waste solvents were discharged to a septic system. In addition to chlorinated solvents, several types of waste were generated at the site including ceramic materials, metal grindings, spent acids, and caustic soda (U.S. EPA 1990). Chemical wastes were disposed of through the septic system on the east side of the main KMC building. The septic system discharged to the ground via a lower leach field oriented toward the current storm drainage system known as the "Culvert Area." Liquid wastes also were discharged toward the west, on property owned by Carroll Reed Industries.

In the late 1970s KMC was directed by the State of New Hampshire to discontinue disposal of wastes through the septic system. In 1982, the state began a hydrologic investigation of the site. Groundwater monitoring wells were installed with sampling results indicating significant quantities of dissolved chlorinated solvents in shallow groundwater. KMC ceased foundry operations in 1982 and the site was added to the NPL in 1984. A remedial investigation (RI) began in 1985 and the ROD was published in September of 1990.

The KMC site conceptual model has been reviewed and summarized by GeoTrans in a memorandum dated 15 May, 2009 (GeoTrans 2009). The memorandum identifies the key aspects of site hydrogeology and how they impact the distribution of residual groundwater contaminants. The most significant feature of site hydrogeology is a low permeability, fine-grained silt layer that underlies the upper transmissive sand layer. The depth to the fine-grained silt varies greatly across the site, causing variations in groundwater flow and velocity. The silt layer lies near the surface on the east side of the property and drops off sharply to the west of the site buildings. Variability in infiltration caused by paved areas, along with the high rate of recharge to the shallow eastern area also impact groundwater flow, resulting in a radial flow regime.

The shallow subsurface layer consists of sandy fill with residual saw dust from the mill overlying a fine, silty sand with gravel. Under ambient conditions, groundwater flow in the transmissive zone is radial, roughly outward from the former manufacturing and waste release area. A groundwater mound currently exists between wells EW-13B and PZ-4002. During the 1993 to 2005 time frame, groundwater flow was altered, inward toward the extraction wells. Underlying the sand layer, the upper silt zone is composed of a series of undulating layers including a thin, discontinuous, gray, silty fine sand, and a tan clayey sand or silt layer of varying thickness (usually 2 to 4 feet in depth) (Weston 2008). Underlying these layers is the gray silt/clay aquitard. Variability in the thickness of the thin upper layers of the silt may be responsible for some of the variability in distribution of residual contamination.

Based on the depth to the fine-grained zone, the site can be divided conceptually into the eastern Culvert Area and the western Hobbs Street Area. In the Culvert Area, the upper transmissive zone extends 8 to 14 feet below ground surface (bgs), and groundwater flows to the east. The hydraulic gradient in the upper sandy zone of the Culvert Area is high, and groundwater velocity fast relative to flow to the west.

The drainage culvert is most likely a flow barrier to the spread of the plume to the east. Groundwater appears to discharge to the culvert, but measured concentrations of contaminants are low in water leading to Pequawket Pond located to the south. Low concentrations in groundwater discharge are attributed to evaporation of constituents. Groundwater discharge to the culvert is sampled at several points (CB5-6, CB6-7, CB7-8, CB8-9, and CB10+) along the culvert. Water levels in Pequawket Pond are managed seasonally, and can impact the potentiometric surface across the site.

Toward the west of the site, the surface sandy layer becomes deeper and coarser, extending more than 40 ft in depth near Hobbs Street. The hydraulic gradient flattens as a result of the increase in saturated thickness. Groundwater flow in this area is largely to the north/northwest.

1.2 REGULATORY STATUS AND REMEDY

Initial groundwater sampling during the 1980s at KMC indicated the presence of volatile organic compounds including 1,1,1-TCA and its daughter products 1,1-dichloroethene (1,1-DCE) and 1,1-dichloroethane (1,1-DCA), as well as trichloroethene (TCE), chloroform and some metals. Aqueous samples taken from the septic tank in 1989 indicated the presence of high concentrations of the 1,1,1-TCA anaerobic degradation product 1,1-DCA.

Shallow groundwater at the site is classified as IIB, and is deemed to be suitable for drinking water. Therefore, federal Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLG) were established by the 1990 ROD as cleanup levels for groundwater. The ROD identified cleanup levels for 1,1,1-TCA, 1,1-DCE, 1,1-DCA TCE, 1,2-dichloroethane (1,2-DCA), chloroform, nickel and chromium. An explanation of significant differences (ESD) (U.S. EPA 2003) published in 2003 adjusted the cleanup goal for 1,1-DCA from 4 μg/L to 3650 μg/L. Current cleanup goals for site COCs are listed in Table 2.

The ROD identified remedial action objectives (RAOs) for groundwater that include minimizing further horizontal and vertical migration of contaminated groundwater, minimizing any negative impact on Pequawket Pond resulting from discharge of affected groundwater, and preventing the migration of contaminants from the septic system and associated soils that could further degrade groundwater quality. The remedy chosen to address the RAOs was designed to include source control, plume migration control and long-term groundwater monitoring to evaluate progress toward attainment of cleanup goals.

The chosen remedy included removal, treatment and disposal of surface waste piles, and excavation of the septic tank and leach field as source control mechanisms. A groundwater P&T system was installed in 1993 to remove contaminants and control migration of the plume. The P&T system included groundwater extraction wells along Hobbs Street and a small extraction trench and wells in the Culvert Area. The 2003 ESD identified an area of low permeability soils downgradient of the former leach field in the Culvert Area as a continuing source of contaminants. The ESD authorized excavation and offsite disposal of the affected soils. As a result of excavation activities, the Culvert Area P&T system was reconfigured in 2004 with one large extraction trench and a single new extraction well (EW-13B) (see Figure 1). In 2004, the Hobbs Street P&T system was discontinued as a result of groundwater having met cleanup goals. In 2005, the P&T system in the Culvert Area was also discontinued.

Since 2005, groundwater at KMC has been monitored to evaluate any changes resulting from cessation of active P&T. The site is in the process of being evaluated for an MNA remedy to address both migration control and residual contaminant treatment.

Institutional controls (ICs) have been proposed for the site to prevent exposure of possible receptors to affected groundwater. ICs will consist of fencing and other physical barriers as well as a groundwater management zone (GMZ) established by judicial enactment that would prevent drilling into groundwater zones affected by contaminants. Designation of the boundaries of the GMZ is ongoing.

1.3 KEARSARGE SITE MONITORING OBJECTIVES

Monitoring objectives for the KMC site are not explicitly listed in site documents. However, based on the site history and overall goals of the Superfund program, the following monitoring objectives have been proposed for the KMC site:

- Delineate the extent of groundwater affected above cleanup goals;
- Monitor possible exposure pathways such as discharge to surface water bodies (Pequawket Pond);
- Monitor the boundaries of the site (IC or GMZ boundaries) to ensure that concentrations do not exceed regulatory limits in offsite locations;
- Monitor historical source areas to confirm attenuation of constituents and to anticipate future source strength; and
- Monitor locations that may indicate plume migration or an impending exceedance of regulatory levels at compliance or exposure points.

Recommendations developed in the following report for the KMC monitoring network are designed to address the objectives listed above. Wells addressing objectives above can be summarized into three basic categorizes: delineation or point of compliance (POC) wells, source monitoring wells and flow path monitoring or sentry wells. Each well recommended for the final monitoring network (see Table 7) has been identified as addressing one or more of the monitoring objectives above. Because the GMZ has yet to be recorded, the locations that address regulatory requirements related to monitoring the GMZ are estimated.

2.0 QUALITATIVE REVIEW OF CONTAMINANT CHEMISTRY

1,1,1-TCA is the primary parent chlorinated solvent remaining in KMC site groundwater. 1,1,1-TCA is unique in that both biodegradation and abiotic chemical degradation pathways determine its fate in the groundwater (Figure 2). Each pathway produces different primary byproducts with very different cleanup standards. Microbial degradation of 1,1,1-TCA generates 1,1-DCA (cleanup goal = 3650 µg/L) while spontaneous abiotic degradation produces 1,1-DCE (cleanup goal = 7 µg/L) and acetic acid (no drinking water standard). By assessing the relative strength of each of these pathways in various parts of the plume, the persistence and future footprint of the plume can be estimated.

1,1,1-TCA is degraded under anaerobic conditions by microorganisms through reductive dechlorination. The primary product of biological degradation is 1,1-DCA (Vogel and McCarty 1987). 1,1-DCA is further degraded to chloroethane by reductive dechlorination. However, the second reaction is somewhat slower than 1,1,1-TCA degradation as 1,1-DCA is more stable and less oxidized than its parent compound. Chloroethane degrades quickly in the subsurface under both aerobic and anaerobic conditions. The presence of 1,1-DCA and chloroethane in various locations within the KMC plume is an indication of a history of active anaerobic degradation processes. More labile contaminants (i.e., benzene), sewage, or residual organic matter from the sawmill operation may have contributed organic matter to induce anaerobic conditions in the shallow subsurface of the Culvert Area. At the KMC site, 1,1-DCA and chloroethane are found frequently at locations MW-3008, MW-3010, and MW-203A. Anaerobic degradation processes appear more active in the shallow groundwater of the Culvert Area than in groundwater in the Hobbs Street plume.

Because the cleanup goal for 1,1-DCA is relatively high, the anaerobic transformation of 1,1,1-TCA represents a reduction in risk, a reduction in plume size and significant progress toward site cleanup goals.

1,1,1-TCA also undergoes significant spontaneous abiotic degradation in water. Two mechanisms dominate abiotic transformation (degradation) of 1,1,1-TCA: 1) β-elimination or dehydrohalogenation; and 2) hydrolysis by nucleophilic addition. The β-elimination reaction generates 1,1-DCE and accounts for approximately 20% of the transformation product yield (Vogel and McCarty 1987). Nucleophilic substitution generates acetic acid with approximately 80% yield, representing a significant destructive mechanism for 1,1,1-TCA. Acetic acid is degraded very rapidly by microorganisms in the subsurface, so is seldom detected. 1,1-DCE is degraded by reductive dechlorination to vinyl chloride (Vogel and McCarty 1987), but the process is slow, and no vinyl chloride has been detected at the site. Consequently, the formation of 1,1-DCE represents a more recalcitrant compound with a lower cleanup standard, that may affect the ultimate size and persistence of the groundwater plume.

The abiotic degradation process is not influenced by geochemical conditions such as the presence or absence of oxygen (Vogel and McCarty 1987; Haag and Mill 1988; Jeffers, Ward et al. 1989); therefore, spontaneous abiotic degradation occurs in both aerobic and anaerobic environments at the same rate. The abiotic degradation rate for 1,1,1-TCA is relatively fast, with degradation half-lives of 1.7, 1.1, and 2.5 years found in three studies summarized by Wiedemeier et al. (Wiedemeier, Rifai et al. 1999). If groundwater temperatures fall below 25°C, the rate of spontaneous degradation may be slower (Schwarzenbach, Gschwend et al. 1993).

In order to visualize the relative contributions of the anaerobic and spontaneous degradation pathways to 1,1,1-TCA degradation, trilateral diagrams have been constructed using site analytical data (see Appendix C for an explanation). A trilateral diagram is used to analyze how the parent compound (1,1,1-TCA) is being converted by either the abiotic reaction (1,1-DCE) or the reductive dechlorination reaction (1,1-DCA) at various locations and times. Trilateral diagrams are constructed by calculating the percent (%) molar concentration of each constituent in the groundwater sample relative to the total molar concentration of the three compounds. The relative % molar concentrations are plotted on a three-sided graph, indicating the relative contribution of each constituent to the whole. The location of the point on the trilateral diagram indicates the ratio of contaminants at a particular spatial and/or temporal location in the plume. The trilateral diagram does not indicate the total concentration of contaminant at the site (i.e., low-concentration wells and high-concentration wells are plotted the same way).

The trilateral diagram in Figure 3 indicates compound ratios for wells sampled in April 2009 (see Table 3 for concentrations and molar ratios). Locations with relatively more 1,1,1-TCA are indicated near the top of the triangle, whereas groundwater where abiotic degradation processes dominate or have dominated (generating 1,1-DCE) are located to the lower right. Locations where biodegradation is active (generating 1,1-DCA) appear to the lower left.

Based on the 2009 data, different processes appear to have dominated in different areas of the plume. Groundwater at MW-213 shows only parent 1,1,1-TCA, and therefore has the possibility of generating 1,1-DCE over time. Location MW-203A and MW-3008 show relatively high concentrations of degradation products and, therefore, represent groundwater where active degradation has been on-going for some time. The dominance of 1,1-DCA at MW-203A indicates that biodegradation is causing the plume to shrink in this area. Wells toward the center of the site in the area of groundwater mounding, show a more even distribution of parent and daughter compounds (MW-3009 and MW-3010). Overall, the data are arrayed on the graph such that wells closest to the source, showing the highest amount of degradation, are near the bottom of the triangle, and wells father from the source, with a greater percentage of parent compound, near the top.

Figure 4 compares compound ratios from wells in the east (Culvert Area), west (Hobbs Street Area) and north parts of the plume between 2006 and 2009. Ratios for samples taken 2006 to 2009 for each well are shown (the dates are not indicated on the graph). As in Figure 3, samples in the Culvert Area near the former leach field (wells MW-203A, MW-3008) show on-going biodegradation of 1,1,1-TCA. Groundwater in the north and northwestern areas of the plume (PZ-4002 and MW-213) is dominated by the parent compound 1,1,1-TCA, with some relative increase in 1,1-DCE to the west. Overall, wells in the Hobbs Street Area show more stability in compound ratios over time.

Figure 5 highlights ratios for well MW-3008 for dates between October 2005 and April 2009. The figure shows that 1,1-DCE became a larger proportion and 1,1,1-TCA a smaller portion of the total chlorinated solvent concentration between August 2006 and April 2009. The data indicate that abiotic degradation processes are beginning to dominate. Anaerobic biodegradation is still active, based on the continued generation of 1,1-DCA and chloroethane, but abiotic degradation appears to be occurring at a faster rate. The historical compound ratios for this area are indicated by the results for EW-08 from March 2000.

Areas of the plume that show active biodegradation are less likely to cause expansion of the footprint of groundwater exceeding cleanup standards, and are candidates for reduced monitoring effort. Locations where 1,1,1-TCA dominates may require LTM effort as 1,1,1-TCA has the potential to generate 1,1-DCE, with a lower cleanup standard. Locations where 1,1-DCE already dominates and 1,1,1-TCA concentrations are low are more likely to demonstrate stable concentration trends over time due to the recalcitrance of this compound. Locations with stable 1,1-DCE trends are also candidates for reduced monitoring effort due to the slow rate of change.

Residual 1,1,1-TCA in the Hobbs Street Area (MW-213, MW-5003, and MW-3003) will most likely continue to be a source of 1,1-DCE in the western area of the site. Depending on the strength of attenuation processes specific to 1,1-DCE, 1,1-DCE concentrations may increase slightly over time as 1,1,1-TCA degrades. Because the cleanup goal for 1,1-DCE is significantly lower than that of 1,1,1-TCA continued generation of 1,1-DCE, even with significant production of acetic acid, has the potential to cause an expansion of groundwater above cleanup goals. Qualitatively, the monitoring networks in the Hobbs Street Area and near MW-3008 are priorities for the site.

3.0 MAROS EVALUATION

The MAROS 2.2 software was used to evaluate the LTM network at the KMC site. MAROS is a collection of tools in one software package that is used to statistically evaluate groundwater monitoring programs. The tool includes models, statistics, heuristic rules, and empirical relationships to assist in optimizing a groundwater monitoring network system. Results generated from the software tool can be used to develop lines of evidence, which in combination with professional judgment, can be used to inform regulatory decisions for safe and economical LTM of affected groundwater. A summary description of each tool used in the analysis is provided in Appendix A of this report. For a detailed description of the structure of the software, assumptions underpinning statistical methods and further utilities, refer to the MAROS 2.2 Manual ((AFCEE 2004); http://www.gsi-net.com/software/MAROS_V2_2Manual.pdf) and Aziz et al., 2003 (Aziz, Newell et al. 2003).

Groundwater data collected between 2006 and April 2009, the time period since total shut down of the P&T systems, were used for the majority of statistical analyses. Additional data collected in September 2009 were reviewed, but not included in the formal analysis. Affected groundwater at KMC was evaluated as a single plume, despite radial groundwater flow and the variability in saturated thickness and depth to the aquitard between eastern and western zones. The majority of statistical analyses, including the trend analyses and zeroth and first moments are not affected by the direction of groundwater flow, so treating the plume as a single unit did not affect these calculations. Additionally, affected groundwater was analyzed as a single plume because of the small dataset since cessation of P&T (2006 - 2009) and the small number of wells that can be grouped in any one groundwater flow direction. MAROS analyses that rely on a single groundwater flow direction or seepage velocity (e.g. heuristic analyses, Second Moment) have not been performed. A summary of wells evaluated is presented in Table 1 with generalized aquifer specific input parameters for the MAROS software presented in Table 2.

3.1 COC CHOICE

MAROS includes a short module that provides recommendations on prioritizing COCs plume-wide based on toxicity, prevalence, and mobility. 1,1-DCE is the priority constituent at the KMC site. 1,1-DCE is the only constituent that significantly exceeds its cleanup goal, exceeding the goal at the most individual monitoring locations across the site. By comparison, other contaminants do not exceed cleanup goals on a plume-wide basis. These results are consistent with the qualitative evaluation of priority constituents in Section 2. Consequently, statistical results for 1,1-DCE were prioritized when evaluating the monitoring network at KMC. A report showing results of the COC prioritization is shown in Appendix B.

3.2 PLUME STABILITY

Plume stability is an important concept in long-term site maintenance. A stable plume, one that is predictable under ambient conditions, requires less monitoring effort than plumes that are expanding or changing rapidly. Within MAROS, time-series concentration data at individual wells and plume-wide trends are analyzed to develop a conclusion about "plume stability".

3.2.1 Individual Well Trends

Summary statistics, including maximum detected concentrations (1983 - 2009), detection frequencies (2006 - 2009) and concentration trends for 1,1,-TCA and 1,1-DCE are shown in Table 4. Historical maximum concentrations for 1,1-DCE and 1,1,1-TCA have been normalized by the cleanup goals and plotted on Figures 6 and 7 in order to provide an idea of probable long-term source areas for affected groundwater. Current concentrations at most locations are below cleanup goals. Overall, TCE has not been detected since shut-down of the P&T system (only one detection of TCE in the full dataset at EW-03). Recent analytical data and plume contours have been illustrated in other site reports (see Geotrans 2009 and Weston 2008).

Individual well concentration trends were determined using the Mann-Kendall (MK) and linear regression methods for data collected between 2006 and 2009. A summary of trend results is provided in the table below and in Table 4. Detailed reports for MK trends 2006

- 2009 and trends 1983 - 2009 for all wells and COCs are provided in Appendix B. Results of the individual well MK trends (2006 - 2009) along with summary statistics for 1,1-DCE and 1,1,1-TCA are illustrated on Figures 6 and 7.

Constituent	**Total Wells**	**Number and Percentage of Wells for Each Trend Category**					
		Non Detect	**PD, D**	**S**	**I, PI**	**No Trend**	**N/A**
1,1,1-TCA	31	12 (39%)	7 (23%)	3 (10%)	1 (3%)	3 (10%)	5 (16%)
1,1-DCE	31	12 (39%)	5 (16%)	4 (13%)	2 (6%)	3 (10%)	5 (16%)
1,1-DCA	31	12 (39%)	6 (19%)	4 (13%)	0	4 (13%)	5 (16%)
Chloroethane	31	19 (61%)	1 (3%)	2 (6%)	1 (3%)	3 (10%)	5 (16%)

Note: Number and percentage of total wells in each category shown. Decreasing trend (D), Probably Decreasing trend (PD), Stable (S), Probably Increasing trend (PI), and Increasing trend (I); (N/A) insufficient data to evaluate a trend.

Almost 40% of site wells show no detections for priority contaminants 2006 - 2009. Non-detect locations address monitoring objectives for delineation of affected zones, monitoring IC boundaries and as POCs. Because groundwater flow is radial, several delineation or POC wells will be required going forward.

Concentrations of 1,1,1-TCA are decreasing at several locations including EW-06 and MW-203A in the southeast and PZ-4002, PZ-4003, EW-09, MW-3010 and MW-3009 north of the excavation. Only MW-3003 shows an increasing trend for 1,1,1-TCA; however the concentration is still below the cleanup level. The increasing trend for MW-3003 began after cessation of the P&T system. The only location sampled in 2009 with 1,1,1-TCA above the screening level (200 µg/L) was MW-3010 in the Culvert Area, which has a probably decreasing trend since 2006. Results for MW-3010 showed a transient increase in both 1,1,1-TCA and 1,1-DCE after shutdown of the P&T system, but concentrations have since stabilized or reduced. Locations with lower detection frequencies (MW-5003, MW-3011 and MW-3004) show no trend results due to variability in the data associated with intermittent detections.

Historical high concentrations of 1,1-DCE are located in the Culvert Area wells MW-205, MW-3010, MW-3008, and EW-13B. Recently, concentrations at EW-13B have fallen below detection limits. MW-205 has not been sampled since 2006; however, historically it has exhibited a strongly decreasing trend 1983 - 2006. Nearby well MW-3009 shows a probably decreasing trend for 1,1-DCE 2006 - April 2009. The September 2009 sample at MW-3009 showed an increase in concentration changing the trend from probably decreasing to stable, but this may be related to dry conditions resulting in a drop in potentiometric surface.

MW-3010 shows a recent stable trend for 1,1-DCE, but did exhibit a transient increase in concentration immediately after shut-down of the P&T system. MW-3010 and MW-3008 in the Culvert Area have the highest concentrations of 1,1-DCE in the recent time-frame, and MW-3008 shows a strongly increasing trend for 1,1-DCE. MW-3003 shows an increasing trend for both 1,1-DCE and 1,1,1-TCA; however, only 1,1-DCE is found above the screening level at this time..

1,1-DCE is the constituent most likely to increase in concentration under current site conditions (no active P&T and abiotic degradation of 1,1,1-TCA); however, only two locations, MW-3003 and MW-3008, show increasing 1,1-DCE concentration trends. Decreasing 1,1-DCE concentrations are found at EW-06 to the southeast, and EW-09, PZ-4003, PZ-4002 and MW-3009 north of the excavation. No increasing trends for 1,1-DCA were found. Chloroethane at MW-3008 shows a probably increasing trend indicating active anaerobic degradation of 1,1-DCA in this area.

Five monitoring locations within the plume have insufficient data to determine a trend either due to intermittent sampling (MW-3006 and MW-213) or removal from service (MW-206, MW-8, and MW-205). For these locations, the MK trends were determined for their full dataset (1983 - 2009) with results reported in Appendix B.

Based on site hydrogeology and seasonal effects associated with fluctuating potentiometric surfaces, concentration trends may show relatively high variability in the near-term, resulting in more “no trend” results. Data from some locations show intermittent high concentrations. Locations with a high rate of ND results may also show intermittent detections due to changing groundwater levels and flow directions. See Trend Reports for wells MW-202A, MW-3011 and MW-3008 for examples of intermittent high concentrations. Consequently, trend data for KMC is best interpreted over the long term (from 2006 forward).

3.2.2 Moment Analysis

Moment analysis was used to estimate the total dissolved mass (zeroth moment) and center of mass (first moment) for dissolved 1,1,1-TCA and 1,1-DCE. Zeroth and first moments were found for sampling events conducted between January 2006 and April 2009, and an MK trend was determined for each. Results of the zeroth and first moments are shown on Table 5 with first moments illustrated on Figures 6 and 7. MAROS reports for zeroth and first moments are located in Appendix B.

Zeroth moments are rough estimates of dissolved mass, assuming a constant porosity and uniform plume thickness across the site. At the KMC site, the saturated depth changes significantly between the eastern and western parts of the plume, but the thickness of the plume is roughly equivalent. The mass estimates are best interpreted as a basis for determining the trend of dissolved mass within the network rather than accurate calculations of total mass. Total dissolved mass estimates between 2006 and 2009 indicate a strongly decreasing trend for 1,1,1-TCA and a stable trend for 1,1-DCE. These results support the interpretation that 1,1,1-TCA is degrading with a fraction of the total mass converting to 1,1-DCE, while 1,1-DCE generation is being balanced by attenuation, either through decay or dilution.

The plume center of mass was estimated for each sampling event, and the distance of the center of mass from the source (assumed to be near EW-13B) was calculated. MK trends were evaluated for the distance of the center of mass from the source over time. The calculated centers of mass for 1,1-DCE and 1,1,1-TCA for the years 2006 - 2009 are shown in Figures 6 and 7. Estimated distance from the source for each sample event is listed on Table 5.

The center of mass for 1,1,1-TCA has a probably increasing trend, although the trend is not particularly significant given the area of the plume. The probably increasing trend is most likely a result of the increasing trend for 1,1,1-TCA at well MW-3003 and recent decreasing trends at MW-3009, MW-3010 and MW-203A. First moment results for 1,1-DCE indicate a stable trend, with the center of mass near NW-205/MW-3009. Stable centers of mass likely result from increasing trends at MW-3003 to the west and MW-3008 to east.

3.3 WELL REDUNDANCY AND SUFFICIENCY

Spatial analysis modules in MAROS recommend elimination of sampling locations that have little impact on the historical characterization of the spatial distribution of contaminant concentrations. Algorithms also identify areas within the monitoring network where additional data may be needed. The spatial redundancy and sufficiency analysis for KMC included a statistical analysis using data collected between 2006 and 2009. The statistical results were reviewed considering qualitative factors in order to account for subsurface heterogeneity. For details on the statistical redundancy and sufficiency methods, see Appendix A or the MAROS Users Manual (AFCEE 2004).

The spatial distribution of the plume at KMC is impacted by significant heterogeneity in site hydrogeology. As discussed above, groundwater surface is impacted by changing levels in Pequawket Pond and groundwater flows radially from near the excavation area. The confining silt layer varies in depth across the site and the upper layers of the silt show heterogeneity in both composition (tan and gray layers) and in thickness. The drainage culvert appears to provide a flow barrier to the east. Because of the significant spatial heterogeneity, the spatial algorithms in MAROS (which rely on a homogeneous, diffuse flow assumption) were combined with a qualitative evaluation of hydrogeology and regulatory requirements to recommend final monitoring locations.

3.3.1 Redundancy

A Delaunay mesh spatial analysis method was used to evaluate well redundancy for 31 wells at the site. The algorithm includes calculation of a slope factor (SF) that mathematically evaluates how well the concentration at a particular location can be estimated from the nearest neighbors. A preliminary SF of less than 0.30 indicates a well may not provide unique information and may be eligible for removal from the network. SFs for 1,1-DCE are shown in Table 7. Before a well is identified as redundant, the software calculates how the total area and total estimated mass of contaminant will be changed if the well is removed. For a well to be recommended for removal, the total estimated area cannot change by more than 10% and the total estimated mass cannot change by more than 15%.

The general results of the spatial redundancy analysis indicate some well redundancy particularly on the outer edges of the plume. Locations MW-211, EW-01, EW-02, MW-

203A, MW-206, EW-06, and MW3007 had low SFs for both 1,1-DCE and 1,1,1-TCA. Of these wells, MW-211, EW-01, MW-203A, and MW-3007 are recommended for removal from the routine monitoring program. EW-02, MW-206 and EW-06 are recommended for retention to serve as POC or delineation wells to confirm the containment of the plume within the current network. MW-3009 had a low SF but was retained in the network to monitor possible contaminant migration from the high concentration area at MW-3010 and to replace MW-205, which has not been sampled since 2006.

EW-10, MW-8, and MW-5001 were recommended for removal from the routine monitoring network due to very low concentrations and qualitative redundancy with wells farther downgradient that can serve as POC monitoring locations. PZ-4003 is recommended for elimination as it is redundant with PZ-4002 and EW-09 in the area north of the excavation.

3.3.2 Sufficiency

The results of the well sufficiency analysis are shown on Figure 8. Like the redundancy analysis, well sufficiency is evaluated using SF as an estimator of concentration uncertainty. Areas between wells with higher SF, corresponding to higher concentration uncertainty, are candidates for new wells. For the KMC network, no areas of excess concentration uncertainty were found, so no new wells are recommended.

3.4 SAMPLING FREQUENCY

The current sampling frequency at the KMC site is semiannual. Based on the data, however, there does not appear to be a consistent set of wells sampled during each event. The reasons for sampling some locations and leaving out others are not clear from the documents reviewed.

Table 6 summarizes the results of the MAROS preliminary location sampling frequency (PLSF) module for 1,1-DCE. The MCES method evaluates overall (2000 - 2009) and recent (2006 -2009) temporal trends and rates of concentration change for 1,1-DCE, and recommends an optimized sampling frequency based on the rate of concentration change. The dataset for evaluating the overall rate of change presents problems, as the rate of concentration change during this time was strongly influenced by the P&T remedy.

As with the redundancy analysis, a qualitative review of the PLSF is conducted before recommending a final sampling frequency. The qualitative review considers groundwater flow velocity and direction relative to receptors, probable location of IC boundaries, remedial activities, anticipated frequency of site management decisions and reporting requirements.

Most sampling locations were recommended for an annual or biennial (every two years) PLSF (Table 6) by the software. The annual recommendation results from low rate of concentration change and decreasing or stable overall and recent trends. Non-detect wells (EW-01 -03, MW-211, MW-3007, and PZ-4004) and wells with a few historical detections (MW-3004) were recommended for biennial sampling frequency by the software algorithm.

Wells with recent increasing trends (MW-3008 and MW-3003) or fewer than four recent samples (MW-205, and MW-3006) are flagged by default in the software for quarterly or semiannual sampling. After a qualitative review, increasing the sampling frequency to quarterly at these locations will not contribute important information for management decisions. An annual sampling frequency is recommended for wells in the network that delineate the outer edge of the plume. A semiannual monitoring frequency is recommended for wells MW-3003, MW-3006, MW-3008, MW-3009, and MW-3010 in order to evaluate potentially increasing concentration trends and to collect a statistically significant dataset (MW-3006).

3.5 DATA SUFFICIENCY

The data sufficiency module was used to identify sampling locations that have statistically attained cleanup goals. Sequential and student t-tests are used to determine if the mean concentration at the well is below the cleanup goal. Locations that have sufficient data, with sufficiently low concentrations and detection limits to statistically demonstrate attainment of MCLs were identified. Statistically clean wells for all COCs are identified on Table 7. Many locations are below the cleanup goals for all COCs but 1,1-DCE .

Locations that have attained the cleanup standard can be used as a POC or background locations or can be removed from the network. In the case of KMC, several clean wells are recommended to be retained as POC or delineation wells.

3.6 SUMMARY RESULTS

The final recommended monitoring network is shown on Figure 9 and summarized in the table below an on Table 7.

Wells have been recommended to address the monitoring objectives for delineating the plume, monitoring the site boundaries, assessing source attenuation and for monitoring the plume for possible expansion.

Because the GMZ has not been officially recorded, a preliminary recommendation of locations to monitor the GMZ is proposed based on a best estimate of the final location of the GMZ. The final network must satisfy regulatory requirements for GMZ monitoring. Should locations such as EW-01 and MW-211 fulfill these requirements better than the proposed wells, these wells should be included in the final program, with removal of redundant POC wells in the same flow direction. Additionally, historical wells such as MW-11 and MSW-115 may be appropriate as GMZ monitoring locations.

Monitoring Objective	Recommended Wells	Number of Wells	Recommended Sampling Frequency	Recommended Statistical Analysis
Delineation of Plume and IC Boundaries, POC Wells	EW-02, EW-03, MW-202A, EW-13B, MW-206, MW-213, MW-3004, MW-3005, MW-5002, MW-5004, PZ-4004	11	Annual	Detection Monitoring, Comparison with cleanup goals
Sentry/Plume Attenuation	MW-5003, PZ-4002, EW-06, EW-09, MW-3011	5	Annual	Statistical Trends; 95% UCL
	MW-3003, MW-3006	2	Semi-annual	
Source Attenuation	MW-3008, MW-3009; MW-3010	3	Semi-annual	Statistical Trends; Comparison with cleanup goals
TOTAL Wells		**21**		
TOTAL Samples Annually		**26**		

Note: The recommended statistical trend analysis is Mann-Kendall, UCL= upper confidence limit.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Remedial activities at the KMC site have resulted in very low levels of residual chlorinated solvent contamination in groundwater. Many areas of the plume have shown dramatic reductions in contaminant concentrations. However, the dataset collected since shutdown of the P&T system is not large enough to confidently anticipate future trends given the heterogeneity of the hydrogeology. KMC groundwater has radial flow patterns under ambient conditions, and variability in infiltration and recharge. Changing water levels in Pequawket Pond and variable depth to the aquitard create a very complex environment. Plume monitoring wells are required in several groundwater flow directions in order to confirm containment of the plume and attenuation of contaminants under ambient conditions in the near term. Site complexity may also introduce high variability in COC concentrations over the short term.

In order to recommend an optimized monitoring network for the site, a qualitative analysis of chemical degradation at the site was performed along with quantitative statistical analyses to evaluate the stability of the plume and identify areas requiring greater monitoring effort.

Chemical Degradation Pathways

Indicators of parent compound degradation were examined to assess the relative strength of each of the degradation pathways in various parts of the plume. This was done because the generation of daughter products by various pathways influences the persistence and future footprint of the plume. Based on the data, anaerobic biodegradation has been an active process in the eastern area of the plume. Anaerobic biodegradation of 1,1,1-TCA has produced both 1,1-DCA and chloroethane, which have high cleanup standards and are labile in the environment. Historical anaerobic processes have reduced the size and toxicity of the plume, most notably in the Culvert Area.

However, since cessation of the P&T system, the spontaneous abiotic conversion of 1,1,1-TCA to 1,1-DCE has become more dominant, particularly at location MW-3008. Laboratory studies indicate that 20% of 1,1,1-TCA is spontaneously converted to 1,1-DCE under ambient conditions with 80% conversion to acetic acid. However 1,1-DCE has a much lower cleanup standard and is persistent in the environment. 1,1-DCE is increasing in concentration at MW-3003 and MW-3008.and is becoming a larger percentage of total contamination at these points (see Figures 3 and 5). In the Hobbs Street Area, little to no 1,1-DCA is found, indicating that the primary degradation process in this area is going to involve generation of 1,1-DCE.

The implication of this observation is that monitoring effort is required along the MW-3006, MW-3003, MW-5003, MW-213 flow path to monitor for potential plume expansion to the northwest. MW-3003 shows strongly increasing trends for both 1,1,1-TCA and 1,1-DCE, showing the potential for further generation of 1,1-DCE. Currently, MW-5003 shows a stable concentration trend for 1,1-DCE at concentrations generally below the cleanup goal. MW-213, a historical non-detect location, showed a detectable quantity of 1,1,1-TCA during the April and September 2009 sampling events. The conceptual site model (GeoTrans 2009) indicates that contaminants may be reaching MW-5003 either from the southeast (near MW-3003) or moving north to MW-205 and then spreading east. In either case, monitoring the area northwest of the excavation (MW-3003, MW-5003, and MW-213 along with MW-3009 and PZ-4002) is a priority. During the September 2009 sampling event, historical wells MW-11 and MW-115 (west of MW-3003) showed no detections of site contaminants. These results indicate that MW-3003 may represent the edge of contamination.

Similarly, the area around MW-3008 should be monitored as a possible source for plume migration due to increasing concentrations of 1,1-DCE. Monitoring locations along the culvert where groundwater discharges to surface water should be included in the routine monitoring program. Locations CB 5-6, CB 6-7, and CB 7-8 should be included on an annual basis to confirm that concentrations of 1,1-DCE are not exceeding surface water quality criteria.

Plume Stability and Trend Analysis

Concentration trends are used by the MAROS software to help evaluate plume stability. As mentioned above, results of individual well trend analysis support the conclusion that two areas of increasing concentration trends require monitoring attention: the area of MW-3008 in the Culvert Area and the area of MW-3003 toward the Hobbs Street Area.

The area east of the 2003 excavated area, around MW-3008, shows a strongly increasing concentration trend for 1,1-DCE since shutdown of the P&T system. The area currently shows active anaerobic degradation of residual 1,1,1-TCA and 1,1-DCA as indicated by an increasing trend for chloroethane and the stable trend for 1,1-DCA. 1,1,1-TCA shows a statistically stable trend in the area, indicating some continued source influx of residual 1,1,1-TCA which balances degradation to 1,1-DCE and 1,1-DCA. The source of residual 1,1,1-TCA may be matrix diffusion from residual contaminated sediments. As a result of the combined input and output processes, concentrations of 1,1-DCE may be increasing in the short term and will most likely be the primary long-term contaminant of concern.

To date, discharge of groundwater to surface water in the drainage culvert and subsequent discharge to Pequawket Pond have not resulted in concentrations of contaminants exceeding the surface water criteria. As stated above, the monitoring program should include routine sampling of groundwater discharge to the drainage culvert to monitor the effect of potentially increasing concentrations in groundwater near the culvert.

As indicated above, the second area of concern for the monitoring network is along the line of wells from MW-3006, MW-3003, MW-5003 to MW-213 and MW-3009 to PZ-4002. Well MW-3003 shows strongly increasing recent trends for both 1,1,1-TCA and 1,1-DCE. MW-3006 does not have a sufficient recent sampling record to determine a trend in the area.

Moment analyses indicate an overall decreasing trend for the mass of 1,1,1-TCA in the plume consistent with evidence of on-going degradation. Plume-wide, the dissolved mass of 1,1-DCE is stable indicating that overall attenuation rates are balancing generation of 1,1-DCE from degradation of 1,1,1-TCA. Estimates of the center of mass since shutdown of the P&T system indicate mostly stable trends, but apparent stability may be an artifact of radial groundwater flow, with concentration increases in the east balanced by those in the west. A longer-term dataset collected under ambient conditions is required to confirm plume stability.

Well Redundancy and Sufficiency

The monitoring network was evaluated both qualitatively and quantitatively for well redundancy and sufficiency. Spatial redundancy analysis indicates that there are redundant monitoring locations on the edges of the plume and in the Hobbs Street area. Ten locations are recommended for removal from routine monitoring: EW-01, EW-10, MW-203A, MW-205, MW-211; MW-3007, MW-5001; MW-8, MW-9, and PZ-4003. The recommendation is not to plug and abandon the wells, as they may provide useful hydrogeologic data or may become useful should the plume change shape.

The spatial sufficiency algorithm indicates that no new wells are necessary and that the existing well density can be reduced without loss of information. Due to the radial groundwater flow conditions, however, delineation or POC wells are required in a number of different directions. The final recommended monitoring network is shown on Figure 9.

Because the GMZ has not been officially recorded, a preliminary recommendation of locations to monitor the GMZ is proposed based on a best estimate of the final location of the GMZ. The final network must satisfy regulatory requirements for GMZ monitoring. Should locations such as EW-01 and MW-211 fulfill these requirements better than the proposed wells, these wells should be included in the final program, with removal of redundant POC wells in the same flow direction. Additionally, historical wells such as MW-11 and MSW-115 may be appropriate as GMZ monitoring locations.

Final Recommendations

- Sample wells MW-3006, MW-3003, MW-3010, MW-3009, and MW-3008 semiannually to monitor concentration trends and generate a statistically significant dataset. Continued increases in concentration may signal possible migration of the plume or exceedance of surface water standards in the culvert. Monitor surrounding wells (MW-5003, EW-09, and MW-3011), drainage culvert locations (CB 5-6, CB 6-7, and CB 7-8) and other plume sentry wells annually to determine if residual contamination in the source concentration wells is migrating.
- Sample the POC and delineation wells on an annual basis to confirm the plume has not spread beyond the current footprint and is not migrating outside of the IC boundary (Note, the precise wells used to monitor the GMZ boundary may change after the GMZ has been confirmed, and regulatory requirements have been established).
- Remove ten locations from routine monitoring: EW-01, EW-10, MW-203A, MW-205, MW-211, MW-3007, MW-5001, MW-8, MW-9, and PZ-4003. Continue hydrogeologic sampling at these locations to evaluate groundwater flow directions and gradients.
- Monitor a consistent set of wells for the next 2 to 3 years. The network can be re-evaluated after collection of a larger dataset under ambient conditions. Future efficiencies can be gained by reducing the frequency of monitoring, particularly at POC or delineation points and by eliminating redundant locations after the plume has been confirmed to be stable.

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Groundwater Monitoring Network Optimization
Kearsarge Metallurgical Corporation

Conway, New Hampshire

TABLES

TABLE 1
KMC MONITORING WELL NETWORK

Long-Term Monitoring Optimization
Kearsarge Metallurgical Corporation, Conway, New Hampshire

Well Name	Screened Lithology	Screened Interval (FT below TOC)		Minimum Sample Date	Maximum Sample Date	Number of Samples	Well Description
		Top	Bottom				
EW01	water table aquifer	37.84	47.84	3/2/1994	4/29/2009	37	Extraction well Hobbs St. area
EW02	water table aquifer	28.72	38.72	3/2/1994	4/29/2009	36	Extraction well Hobbs St. area
EW03	water table aquifer	31.95	41.95	3/2/1994	4/29/2009	34	Extraction well Hobbs St. area
EW06	water table aquifer	5.47	8.47	3/27/2000	4/29/2009	22	Extraction well Culver area
EW09	water table aquifer	9.29	12.29	3/2/1994	4/30/2009	34	Extraction well Culver area
EW10	water table aquifer	9.99	12.99	11/30/2000	4/30/2009	8	Extraction well Culver area
EW13B	water table aquifer	14.85	19.85	4/13/2004	4/29/2009	29	Extraction well Culver area, nearest source.
MW202A	aquitard	9.88	13.88	10/20/2004	4/29/2009	10	Monitoring well, Culvert area, downgradient toward pond.
MW203A	water table aquifer/aquitard	8.41	13.41	4/14/2004	4/29/2009	16	Monitoring well, Culvert area, downgradient toward pond.
MW205	water table aquifer	10.08	14.08	7/6/1992	8/21/2006	49	Monitoring well (MWS-205), Culvert area, near MW-3009.
MW206	water table aquifer	7.38	17.38	7/5/1992	4/30/2009	8	Delineation monitoring well, northern section of Culvert Area.
MW211	water table aquifer	31.27	41.27	7/6/1992	4/29/2009	34	Monitoring well west of Hobbs St.; monitors historic area of TCE affected groundwater.
MW213	water table aquifer	25.94	30.94	7/6/1992	4/29/2009	28	Hobbs Street monitoring well (MWS-213), farthest downgradient along N/NW groundwater flow path.
MW3003	water table aquifer/aquitard	42.98	52.98	4/7/2005	4/29/2009	18	Monitoring well, center of plume area.
MW3004	water table aquifer/aquitard	9.56	13.56	10/20/2004	4/30/2009	11	Monitoring well north of excavation, near MW-205. Intermittent detections of 111TCA.
MW3005	water table aquifer/aquitard	10.95	14.95	10/20/2004	4/30/2009	10	Monitoring well near former KMC building. Non-detect results through 2009. Along with MW-3007, hydraulic high point.
MW3006	water table aquifer/aquitard	10.15	14.15	10/21/2004	4/30/2009	10	Intermittently sampled in center of plume.
MW3007	water table aquifer/aquitard	7.83	11.83	10/20/2004	4/30/2009	11	Monitoring well south of excavation. 11DCA detections, no parent compound. Hydraulic high point.
MW3008	water table aquifer/aquitard	8.68	12.68	4/5/2005	4/29/2009	18	Monitors Culvert area, east of excavation. Degradation products dominate.
MW3009	water table aquifer/aquitard	8.79	12.79	10/20/2004	4/30/2009	17	Monitoring well north of excavation near MW-205, low detections, degradation products dominant.
MW3010	water table aquifer/aquitard	9.5	13.5	4/6/2005	4/30/2009	16	Monitoring well north/northeast of excavation.
MW3011	water table aquifer/aquitard	10.9	14.9	10/21/2004	4/29/2009	14	Monitoring well near Culvert, southeast of excavation. Detections of degradation products including chloroethane.
MW5001	water table aquifer/aquitard	42.44	52.44	6/20/2007	4/29/2009	6	Monitoirng well delineating north of plume area, non-detect results.
MW5002	water table aquifer/aquitard	38.73	48.73	6/20/2007	4/29/2009	6	Monitoirng well delineating north of plume area, non-detect results.
MW5003	water table aquifer/aquitard	39.34	49.34	6/20/2007	4/29/2009	7	Monitoring well just east of Hobbs St., delineates deeper sand.

See Notes End of Table

TABLE 1
KMC MONITORING WELL NETWORK

Long-Term Monitoring Optimization
Kearsarge Metallurgical Corporation, Conway, New Hampshire

Well Name	Screened Lithology	Screened Interval (FT below TOC)		Minimum Sample Date	Maximum Sample Date	Number of Samples	Well Description
		Top	Bottom				
MW5004	water table aquifer/aquitard	44.53	54.53	6/20/2007	4/29/2009	6	Monitoring well near Hobbs St., delineating downgradient location, all non-detect results.
MW8	water table aquifer/aquitard	12.29	32.04	1/25/1983	8/21/2006	21	Monitoring well north of PZ-4002, south of EW-10. Intermittent detections.
MW9	water table aquifer/aquitard	7.28	17.28	7/20/1983	4/30/2009	21	Monitoring well east of Culvert area; largely non-detect results.
PZ4002	water table aquifer	8.68	10.68	8/16/2005	4/30/2009	13	Piezometer north area of plume, detections of parent and degradation products.
PZ4003	water table aquifer	8.5	10.5	6/20/2007	4/30/2009	6	Piezometer north area of plume, detections of parent and degradation products.
PZ4004	water table aquifer	8.92	10.92	10/19/2006	4/30/2009	7	Piezometer east of excavation and Culvert area; non-detect results.

Notes:
1. Well analytical data from Weston Solutions, 2009.
2. Well screened intervals and lithology description from the Weston database, 2009.

TABLE 2
AQUIFER INPUT PARAMETERS

LONG-TERM MONITORING OPTIMIZATION
Kearsarge Metallurgical Corporation, Conway, New Hampshire

Parameter	Value	Units
Porosity n	0.25	
Seepage velocity	71.5	ft/yr
Plume Thickness	5 -15	ft bgs
Plume Length	120	ft
Plume Width	240	ft
Distance to Receptors (Property Boundaries)	300	ft
GWFluctuations	Yes	--
SourceTreatment	Excavation/historic pump and treat	--
Contaminant Type	Chlorinated solvents	--
NAPLPresent	No	--
Groundwater flow direction (N/NW)	Variable (north, northwest)	
Source Location near Well	EW-13B	--
Source X-Coordinate	1125996	ft
Source Y-Coordinate	537249.1	ft
Coordinate System	NAD 83 SP New Hampshire	
Priority Constituent	**Screening Levels**	
1,1,1-Trichloroethane (TCA)	200	ug/L
1,1-Dichloroethene (DCE)	7	ug/L
1,1-Dichloroethane (DCA)	3650	ug/L
Trichloroethene	5	ug/L
1,2-Dichloroethane (12DCA)	5	ug/L

Notes:
1. Aquifer data from Weston Solutions (2009).
2. The source area has been extensivey excavated, EW-13B was chosen as a source due to the presence of historic high concentrations.
3. Screening levels are remdial goals from the Five Year Review (USACE, 2008)
4. Seepage velocity for Hobbs Street Area.

TABLE 3
RELATIVE PERCENT MOLAR CONCENTRATIONS SELECTED WELLS AND DATES

LONG-TERM MONITORING OPTIMIZATION
Kearsarge Metallurgical Corporation, Conway, New Hampshire

Well Name	Sample Date	Concentration [ug/L]			Sum of Concentrations	Relative % Molar Concentration		
		1,1,1-TCA	1,1-DCE	1,1-DCA		1,1,1-TCA	1,1-DCE	1,1-DCA
MW-203A	4/29/2009	<0.002	3.7	12	15.7	0.06	23.92	76.02
MW-3008	4/29/2009	54	**222.5**	147	423.5	9.76	54.78	35.46
MW-3009	4/30/2009	6.6	3.7	7.4	17.7	30.47	23.49	46.04
MW-3010	4/30/2009	**203**	**187**	72	462	36.43	46.16	17.41
MW-5003	4/29/2009	9.7	3.4	2.6	15.7	54.25	26.15	19.59
MW-3003	4/29/2009	42	**19**	3.8	64.8	57.34	35.67	6.99
MW-3006	4/30/2009	17	**8.9**	2	27.9	53.23	38.33	8.44
PZ-4002	4/30/2009	12	2	2.5	16.5	66.23	15.18	18.59
MW-213	4/29/2009	8.1	<0.002	<0.002	8.1	99.67	0.16	0.16
MW3008	10/28/2005	8.8	6.6	6.9	22.3	32.38	33.40	34.21
MW3008	11/30/2005	17.0	**10.0**	14.0	41.0	34.26	27.72	38.02
MW3008	4/5/2006	35.0	**34.0**	51.0	120.0	23.26	31.07	45.67
MW3008	5/3/2006	5.4	4.9	9.2	19.5	22.01	27.47	50.53
MW3008	6/6/2006	27.0	**30.0**	40.0	97.0	22.10	33.77	44.12
MW3008	8/22/2006	32.0	**18.0**	22.0	72.0	37.04	28.65	34.31
MW3008	6/19/2007	88.0	**90.0**	70.0	248.0	28.75	40.44	30.81
MW3008	8/15/2007	84.0	**101.0**	77.0	262.0	25.72	42.52	31.76
MW3008	11/28/2007	23.5	**49.5**	36.5	109.5	16.70	48.36	34.94
MW3008	4/16/2008	17.0	**26.5**	19.5	63.0	21.32	45.72	32.96
MW3008	8/14/2008	27.5	**111.0**	73.5	212.0	9.85	54.68	35.47
MW3008	4/29/2009	54.5	**222.5**	147.0	424.0	9.76	54.78	35.46

Notes:
1. Concentrations from Weston database for dates indicated. Numbers in **bold** above cleanup level.
2. Results are plotted on Figure 3 and 5.
3. Relative % molar concentration as plotted on trilateral diagrams is illustrated in Appendix C.

TABLE 4
TREND SUMMARY RESULTS: 2006-2009

LONG-TERM MONITORING OPTIMIZATION
Kearsarge Metallurgical Corporation, Conway, New Hampshire

WellName	Number of Samples	Number of Detects	Percent Detection	Maximum Result 1983 - 2009 [ug/L]	Max Result Above Standard?	Average Result 2006 - 2009 [mg/L]	Average Result Above Standard?	Mann-Kendall Trend	Linear Regression Trend
1,1,1-Trichloroethane									
EW01	7	0	0%	ND	ND	ND	ND	ND	ND
EW02	7	0	0%	ND	ND	ND	ND	ND	ND
EW03	7	0	0%	ND	ND	ND	ND	ND	ND
EW06	7	3	43%	11	No	3.29	No	PD	D
EW09	7	7	100%	30	No	17.10	No	PD	D
EW10	6	6	100%	6.6	No	4.98	No	S	NT
EW13B	8	0	0%	ND	ND	ND	ND	ND	ND
MW202A	7	5	71%	10	No	3.56	No	S	D
MW203A	7	5	71%	5.9	No	2.84	No	PD	S
MW205	2	2	100%	53	No	36.90	No	N/A	N/A
MW206	5	0	0%	ND	ND	ND	ND	ND	ND
MW211	7	0	0%	ND	ND	ND	ND	ND	ND
MW213	1	1	100%	8.1	No	8.10	No	N/A	N/A
MW3003	8	8	100%	45	No	32.50	No	I	I
MW3004	7	3	43%	4.2	No	1.46	No	NT	NT
MW3005	7	0	0%	ND	ND	ND	ND	ND	ND
MW3006	2	2	100%	17	No	13.15	No	N/A	N/A
MW3007	7	0	0%	ND	ND	ND	ND	ND	ND
MW3008	8	8	100%	88	No	43.60	No	S	NT
MW3009	8	8	100%	37	No	14.30	No	D	PD
MW3010	7	7	100%	**457**	**Yes**	**244.00**	**Yes**	PD	S
MW3011	7	1	14%	3.8	No	0.89	No	NT	NT
MW5001	6	0	0%	ND	ND	ND	ND	ND	ND
MW5002	6	0	0%	ND	ND	ND	ND	ND	ND
MW5003	6	5	83%	28	No	13.70	No	NT	NT
MW5004	6	0	0%	ND	ND	ND	ND	ND	ND
MW8	2	2	100%	16.0	No	6.00	No	N/A	N/A
MW9	7	0	0%	ND	ND	ND	ND	ND	ND
PZ4002	8	8	100%	132.0	No	52.50	No	D	D
PZ4003	6	6	100%	25	No	10.50	No	PD	D
PZ4004	7	0	0%	ND	ND	ND	ND	ND	ND

See Notes End of Table

TABLE 4
TRENDS SUMMARY RESULTS: 2006-2009

LONG-TERM MONITORING OPTIMIZATION
Kearsarge Metallurgical Corporation, Conway, New Hampshire

WellName	Number of Samples	Number of Detects	Percent Detection	Maximum Result 1983 - 2009 [ug/L]	Max Result Above Standard?	Average Result 2006 - 2009 [mg/L]	Average Result Above Standard?	Mann-Kendall Trend	Linear Regression Trend
1,1-Dichloroethene									
EW01	7	0	0%	ND	ND	ND	ND	ND	ND
EW02	7	0	0%	ND	ND	ND	ND	ND	ND
EW03	7	0	0%	ND	ND	ND	ND	ND	ND
EW06	7	3	43%	3.6	No	1.46	No	PD	D
EW09	7	5	71%	**9.8**	**Yes**	4.99	No	PD	D
EW10	6	0	0%	ND	ND	ND	ND	ND	ND
EW13B	8	2	25%	**8.5**	**Yes**	1.66	No	INT	INT
MW202A	7	4	57%	5.5	No	2.09	No	S	S
MW203A	7	7	100%	**7.5**	**Yes**	4.87	No	S	NT
MW205	2	2	100%	**8.9**	**Yes**	6.74	No	N/A	N/A
MW206	5	0	0%	ND	ND	ND	ND	ND	ND
MW211	7	0	0%	ND	ND	ND	ND	ND	ND
MW213	1	0	0%	ND	ND	ND	ND	ND	ND
MW3003	8	8	100%	**19**	**Yes**	**14.90**	**Yes**	I	I
MW3004	7	1	14%	2	No	0.63	No	INT	INT
MW3005	7	0	0%	ND	ND	ND	ND	ND	ND
MW3006	2	2	100%	**8.9**	**Yes**	6.40	No	N/A	N/A
MW3007	7	0	0%	ND	ND	ND	ND	ND	ND
MW3008	8	8	100%	**231**	**Yes**	**80.20**	**Yes**	I	I
MW3009	8	8	100%	**12**	**Yes**	6.28	No	PD	S
MW3010	7	7	100%	**201**	**Yes**	**136.00**	**Yes**	S	NT
MW3011	7	5	71%	**21**	**Yes**	6.06	No	NT	NT
MW5001	6	0	0%	ND	ND	ND	ND	ND	ND
MW5002	6	0	0%	ND	ND	ND	ND	ND	ND
MW5003	6	6	100%	**12**	**Yes**	5.56	No	S	NT
MW5004	6	0	0%	ND	ND	ND	ND	ND	ND
MW8	2	0	0%	ND	ND	ND	ND	ND	ND
MW9	7	0	0%	ND	ND	ND	ND	ND	ND
PZ4002	8	8	100%	**15.0**	**Yes**	6.23	No	D	D
PZ4003	6	2	33%	3.8	No	1.38	No	PD	D
PZ4004	7	0	0%	ND	ND	ND	ND	ND	ND

Notes
1. Trends were evaluated for data collected between 2006 and April 2009.
2. Number of Samples is the number of samples for the compound at this location 2006 -2009.
   Number of Detects is the number of times the compound has been detected for data 2006 - 2009.
3. Maximum Result is the maximum concentration for the COC analyzed between 1983 and 2009.
4. Screening level TCA = 200 ug/L; DCE = 7 ug/L.
5. D = Decreasing; PD = Probably Decreasing; S = Stable; PI = Probably Increasing; I = Increasing; N/A = Insufficient Data to determine trend;
   NT = No Trend; ND = well has all non-detect results for COC; INT = Intermittent detections <30% detection frequency.
6. Mann-Kendall trend results are illustrated on Figures 6 and 7.

TABLE 5
MOMENT ESTIMATES AND TRENDS: 2006 - 2009

LONG-TERM MONITORING OPTIMIZATION
Kearsarge Metallurgical Corporation, Conway, New Hampshire

Constituent	Effective Sample Event Date	Estimate of Dissolved Mass [Kg]	Distance of Center of Mass from Source [ft]
1,1,1-TCA	5/1/2006	0.04	119
	8/21/2006	0.08	111
	6/19/2007	0.06	115
	8/15/2007	0.06	106
	11/28/2007	0.04	112
	4/17/2008	0.04	130
	8/13/2008	0.03	130
	4/30/2009	0.03	149
	Trend	**D**	**PI**
1,1-DCE	5/1/2006	0.01	94
	8/21/2006	0.04	80
	6/19/2007	0.03	91
	8/15/2007	0.04	85
	11/28/2007	0.03	89
	4/17/2008	0.02	105
	8/13/2008	0.03	87
	4/30/2009	0.03	83
	Trend	**S**	**S**

Notes:
1. Input parameters for the moment analysis are listed in Table 2.
2. Estimated mass is the total dissolved mass within the network indicated.
3. Trends are Mann Kendall trends on the moments, S=Stable, D = Decreasing.
   PI = Probably Increasing.
4. First moments are illustrated on Figures 6 and 7.

TABLE 6
MCES SAMPLING FREQUENCY ANALYSIS RESULTS: 1,1-DCE

LONG-TERM MONITORING OPTIMIZATION
Kearsarge Metallurgical Corporation, Conway, New Hampshire

Well Name	Recent Concentration Rate of Change [mg/yr]	Recent MK Trend (2006-2009)	Frequency Based on Recent Data (2006-2009)	Overall Concentration Rate of Change [mg/yr]	Overall MK Trend (2000 - 2009)	Frequency Based on Overall Data (2000 - 2009)	MAROS Recommended Frequency
1,1-Dichloroethene							
EW01	0.00E+00	ND	Annual	0.00E+00	ND	Annual	Biennial
EW02	0.00E+00	ND	Annual	0.00E+00	ND	Annual	Biennial
EW03	0.00E+00	ND	Annual	0.00E+00	ND	Annual	Biennial
EW06	-3.22E-06	PD	Annual	-1.85E-06	NT	Annual	Annual
EW09	-8.81E-06	PD	Annual	1.14E-06	NT	Annual	Annual
EW10	0.00E+00	ND	Annual	0.00E+00	ND	Annual	Biennial
EW13B	-4.80E-06	NT	Annual	-3.25E-05	D	Annual	Annual
MW202A	-2.94E-06	S	Annual	6.50E-07	NT	Annual	Annual
MW203A	1.63E-06	S	Annual	-6.07E-08	NT	Annual	Annual
MW205	0.00E+00	N/A	Quarterly	-1.39E-06	S	Quarterly	Quarterly
MW206	0.00E+00	N/A	Annual	0.00E+00	N/A	Annual	Annual
MW211	0.00E+00	ND	Annual	0.00E+00	ND	Annual	Biennial
MW213	0.00E+00	N/A	Annual	0.00E+00	N/A	Annual	Annual
MW3003	9.59E-06	I	SemiAnnual	1.12E-05	I	SemiAnnual	SemiAnnual
MW3004	3.02E-07	NT	Annual	2.38E-07	NT	Annual	Biennial
MW3005	0.00E+00	ND	Annual	0.00E+00	ND	Annual	Biennial
MW3006	0.00E+00	N/A	Quarterly	0.00E+00	N/A	Quarterly	Quarterly
MW3007	0.00E+00	ND	Annual	0.00E+00	ND	Annual	Biennial
MW3008	1.44E-04	I	Quarterly	1.12E-04	I	Quarterly	Quarterly
MW3009	-3.50E-06	PD	Annual	-1.69E-05	PD	Annual	Annual
MW3010	1.61E-05	S	Annual	1.00E-04	PI	Quarterly	SemiAnnual
MW3011	-5.06E-07	NT	Annual	4.17E-06	PI	Annual	Annual
MW5001	0.00E+00	ND	Annual	0.00E+00	ND	Annual	Biennial
MW5002	0.00E+00	ND	Annual	0.00E+00	ND	Annual	Biennial
MW5003	-2.94E-07	S	Annual	-2.94E-07	S	Annual	Annual
MW5004	0.00E+00	ND	Annual	0.00E+00	ND	Annual	Biennial
MW8	0.00E+00	N/A	Annual	0.00E+00	N/A	Annual	Annual
MW9	0.00E+00	ND	Annual	0.00E+00	ND	Annual	Biennial
PZ4002	-1.08E-05	D	Annual	-9.97E-06	D	Annual	Annual
PZ4003	-4.51E-06	PD	Annual	-4.51E-06	PD	Annual	Annual
PZ4004	0.00E+00	ND	Annual	0.00E+00	ND	Annual	Biennial

Notes:

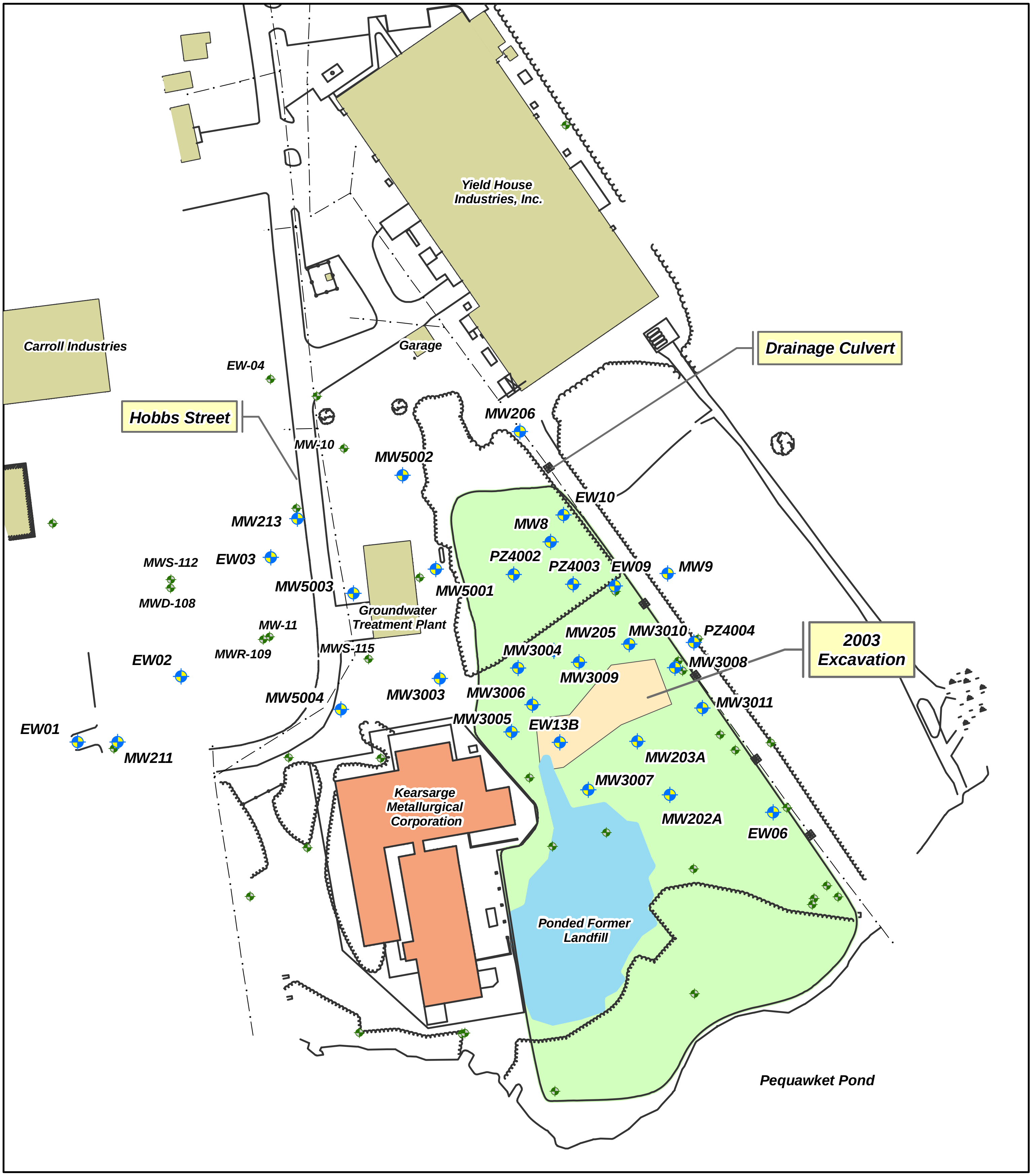
1. Concentration rate of change is from linear regression calculations. 'Recent' concentration rate of change and
Overall rates and trends are for data 2000 - 2009.
MK trends are calculated from data collected 2006 - 2009.
2. MK Trends: D = Decreasing, PD = Probably Decreasing, S = Stable, PI = Probably Increasing, I = Increasing; NT = No Trend; ND= Non detect.
3. Recent data frequency is the estimated sampling frequency based on the recent trend.
4. The overall result is the estimated sample frequncy based on the data record 2000 - 2009.
6. MAROS Recommended Frequency is the final frequency from the MAROS calculations based on both recent and overall trends.

TABLE 7
FINAL RECOMMENDED MONITORING NETWORK

LONG-TERM MONITORING OPTIMIZATION
Kearsarge Metallurgical Corporation, Conway, New Hampshire

	Lines of Evidence					
Well Name	**Cleanup Status**	**Mann Kendall Trends 1,1-DCE**	**Average SF**	**Monitoring Rationale**	**Recommendation After Qualitative Review**	**Final Recommended Frequency**
EW01	Below for all COCs	ND	0.00	Former extraction well, non-detect, redundant with EW-02 and MW5004.	Eliminate, plume shrinking in Hobbs Street Area.	Eliminate
EW02	Below for all COCs	ND	0.08	**Delineate** plume west of Hobbs Street, potential POC well	Software recommends removal, retained for delineation in Hobbs Street Area	Annual
EW03	Below for all but TCE	ND	0.41	**Delineate** plume west of Hobbs Street, monitor for residual TCE, potential POC well.	Retain for delineation in Hobbs Street Area	Annual
EW06	Below for all COCs	PD	0.26	**Monitors possible spread of plume** from high concentration area	Annual	Annual
EW09	Below for all but 1,1-DCE	PD	0.46	**Monitors possible spread** of plume from high concentration area	Annual	Annual
EW10	Insufficient Data	ND	0.32	Redundant with MW 206	Eliminate	Eliminate
EW13B	Below for all but 1,1-DCE	NT	0.38	**Former Source area**, monitor to confirm source control and as **Delineation** point.	Retain	Annual
MW202A	Below for all COCs	S	0.34	**Delineate** plume south of excavation. Some mobilization of TCA after excavation, returning below detection recently.	Retain	Annual
MW203A	Below for all but 1,1-DCE	S	0.11	Redundant with MW-202A	Recommended by software for removal from network. Eliminate.	Eliminate
MW205	Below for all but 1,1-DCE	N/A		Not monitored since 2006. Replaced by MW-3009.	Removed from sampling program in 2006.	Eliminate
MW206	Insufficient Data	N/A	0.20	**Delineate** northern Culvert Area	Retain	Annual
MW211	Below for all COCs	ND	0.00	Non-detect area, redundant with EW-02 and MW5004.	Recommended by software for removal from network. Eliminate.	Eliminate
MW213	Insufficient Data	N/A	0.40	**Delinate** extent of plume in northern Hobbs Street Area	Retain	Annual
MW3003	Below for all but 1,1-DCE	I	0.60	Retain to monitor possible **impending exceedance** of cleanup levels toward Hobbs Street and spread of **Source**.	Retain.	SemiAnnual
MW3004	Below for all COCs	NT	0.35	Retain to **delineate** plume between source and Hobbs Street	Retain	Annual
MW3005	Below for all COCs	ND	0.36	**Delinate** plume near source area	Retain	Annual
MW3006	Insufficient Data	N/A	0.69	**Monitor flow path of plume.** New well installed to monitor plume between source and Hobbs Street	Retain	SemiAnnual
MW3007	Below for all COCs	ND	0.30	Intermittent detecctions of 1,1-DCA and chloroethane, consistently below cleanup levels. Redundant with EW-13B.	Low SF and redundant after qualitative analysis. Eliminate	Eliminate
MW3008	Below for all but 1,1-DCE	I	0.50	Monitor **source attenuation**. Retain to monitor high concentration area downgradient of leachfield and possible discharge to drainage culvert.	Retain	SemiAnnual
MW3009	Exceeds	PD	0.15	**Monitor source attenuation.** Monitor plume attenuation.	Retain	SemiAnnual
MW3010	Exceeds	S	0.51	Monitor **source attenuation** and flow path to surface water.	Retain	SemiAnnual
MW3011	Below for all but 1,1-DCE	NT	0.29	Retain to monitor southern Culvert Area potential **discharge to storm drain** and expansion of plume to the south.	Retain	Annual
MW5001	Insufficient Data	ND	0.58	Redundant with MW-5002.	Eliminate	Eliminate
MW5002	Insufficient Data	ND	0.40	**Delineate** northern area of property.	Retain	Annual
MW5003	Insufficient Data	S	0.49	Retain to monitor north/northwest area of Hobbs Street	Retain	Annual
MW5004	Insufficient Data	ND	0.49	**Delineate plume to southwest.**	Retain for delineation in Hobbs Street Area	Annual
MW8	Insufficient Data	N/A		Not monitored since 2006.	Eliminate	Eliminate
MW9	Below for all COCs	ND	0.52	Drainage culvert is a flow barrier, decreasing trends upgradient.	Eliminate	Eliminate
PZ4002	Exceeds	D	0.40	Monitors area **flow path** north of excavation.	Retain	Annual
PZ4003	Insufficient Data	PD	0.43	Redundant with EW-09 and PZ-4002.	Eliminate	Eliminate
PZ4004	Below for all COCs	ND	0.71	**Delineate** plume east of Culvert Area	Retain	Annual

FIGURES



Legend

- Ponded Excavation
- Kearsarge Metallurgical Corporation
- Buildings
- Excavation
- Wetland
- Active Monitoring Locations
- Inactive Locations
- Line Drains

Scale (FT)
0 80 160

N

GROUNDWATER MONITORING LOCATIONS

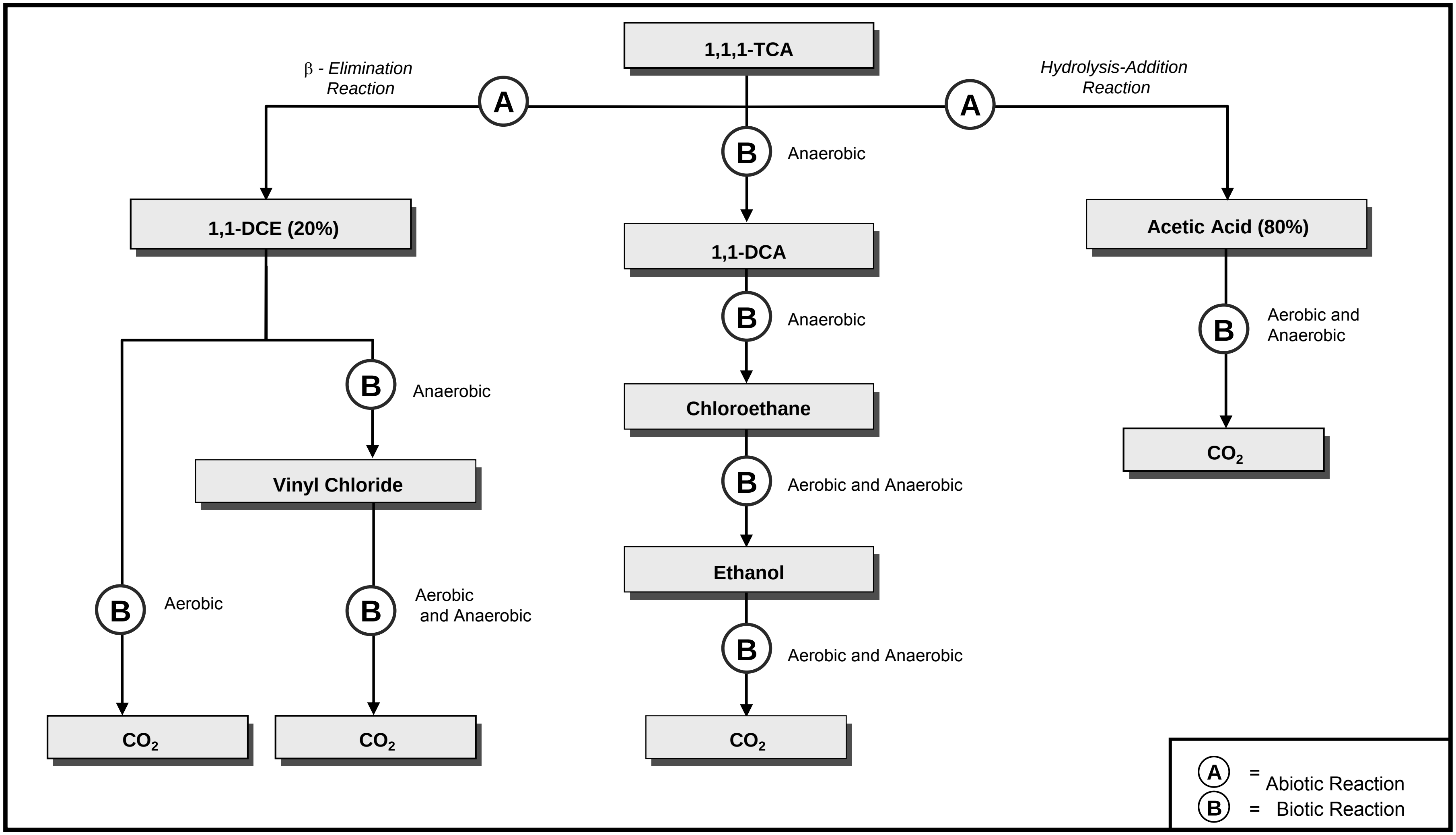
Kearsarge Metallurgical Corporation

Conway, New Hampshire

Coord sys: NAD 83 SP N. Hamp. FT	Issued: 4-November-2009
Drawn By: MV	Revised:
Ck'd By: MV	Map ID:
Appv'd By: MV	**Figure 1**

Figure 2. 1,1,1-Trichloroethane Degradation Pathway

Long-Term Monitoring Optimization
Kearsarge Metallurgical Corporation



Reference: Vogel and McCarty (1987)

Figure 3 Spatial Distribution of Degradation Processes

April 2009 Monitoring Data

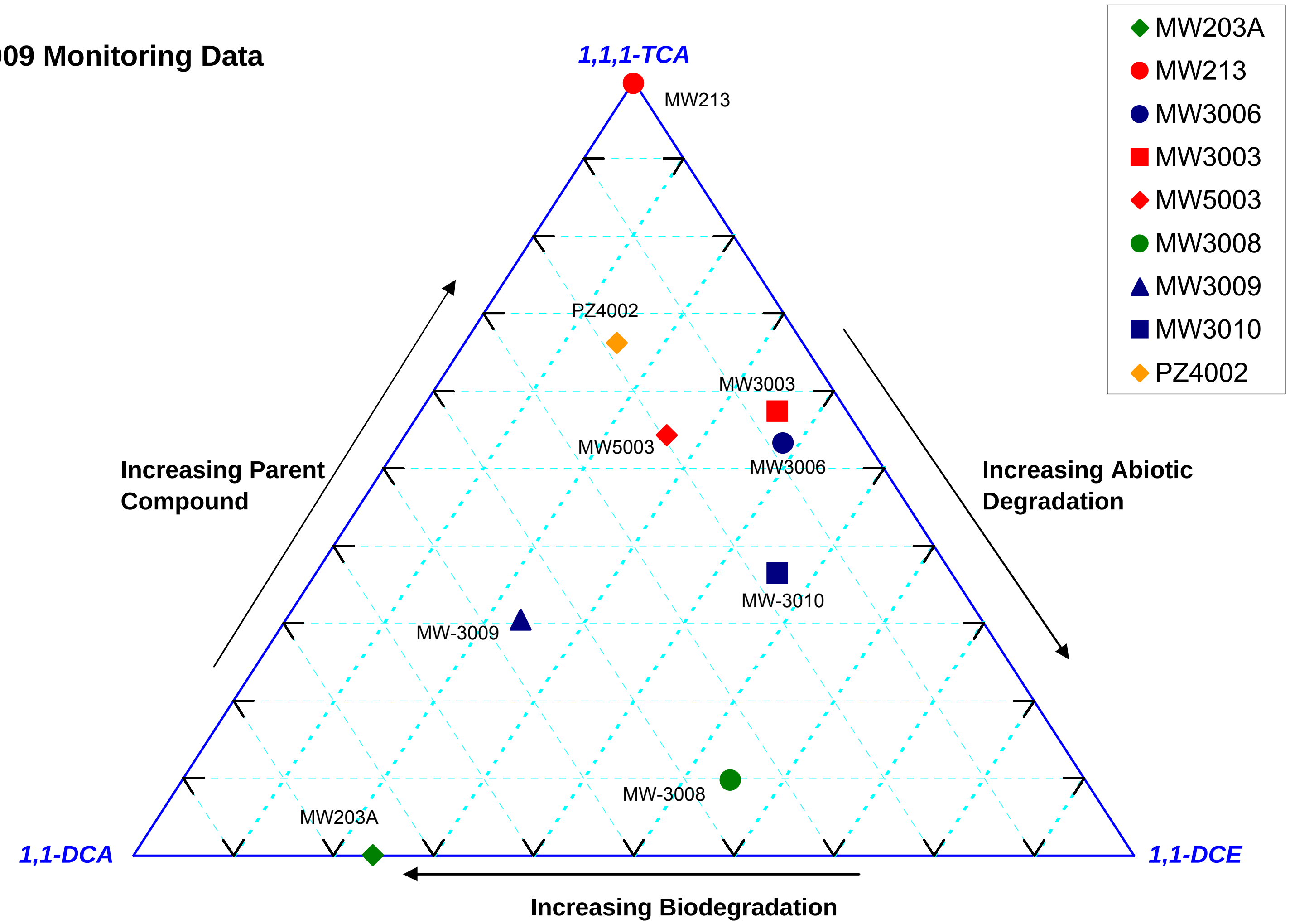


Figure 4 Hobbs Street and Culvert Area Wells

2006 - 2009

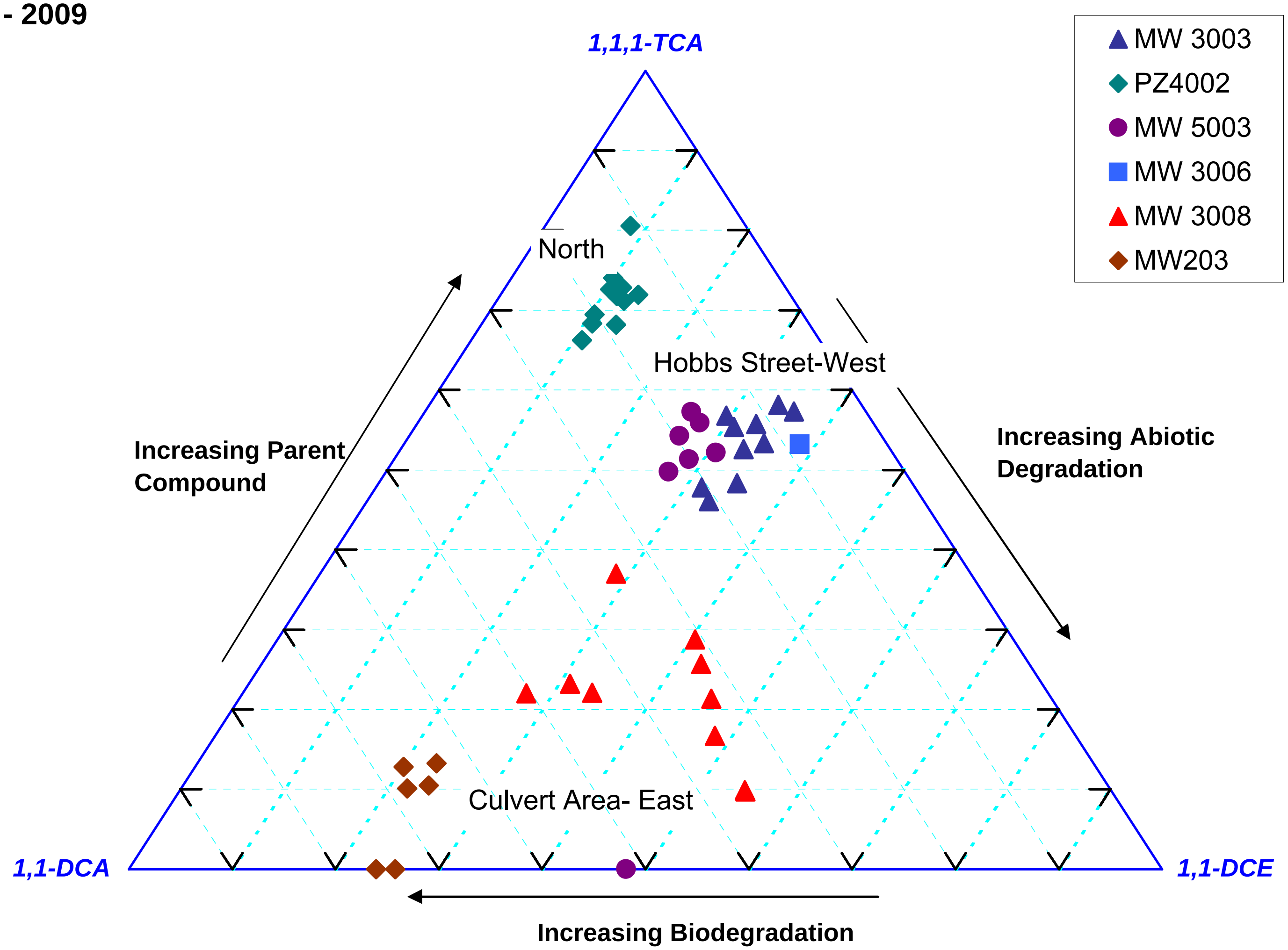
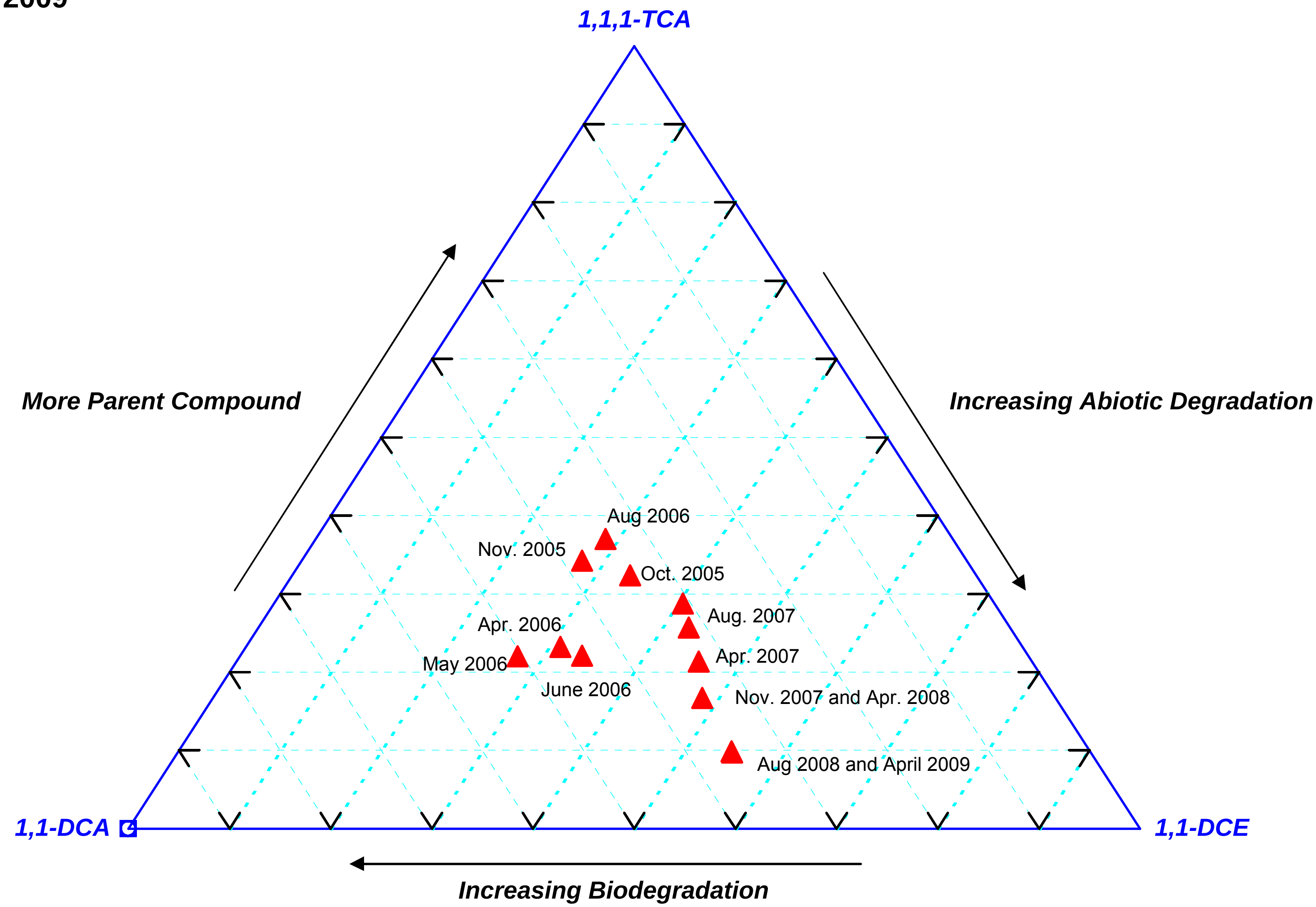
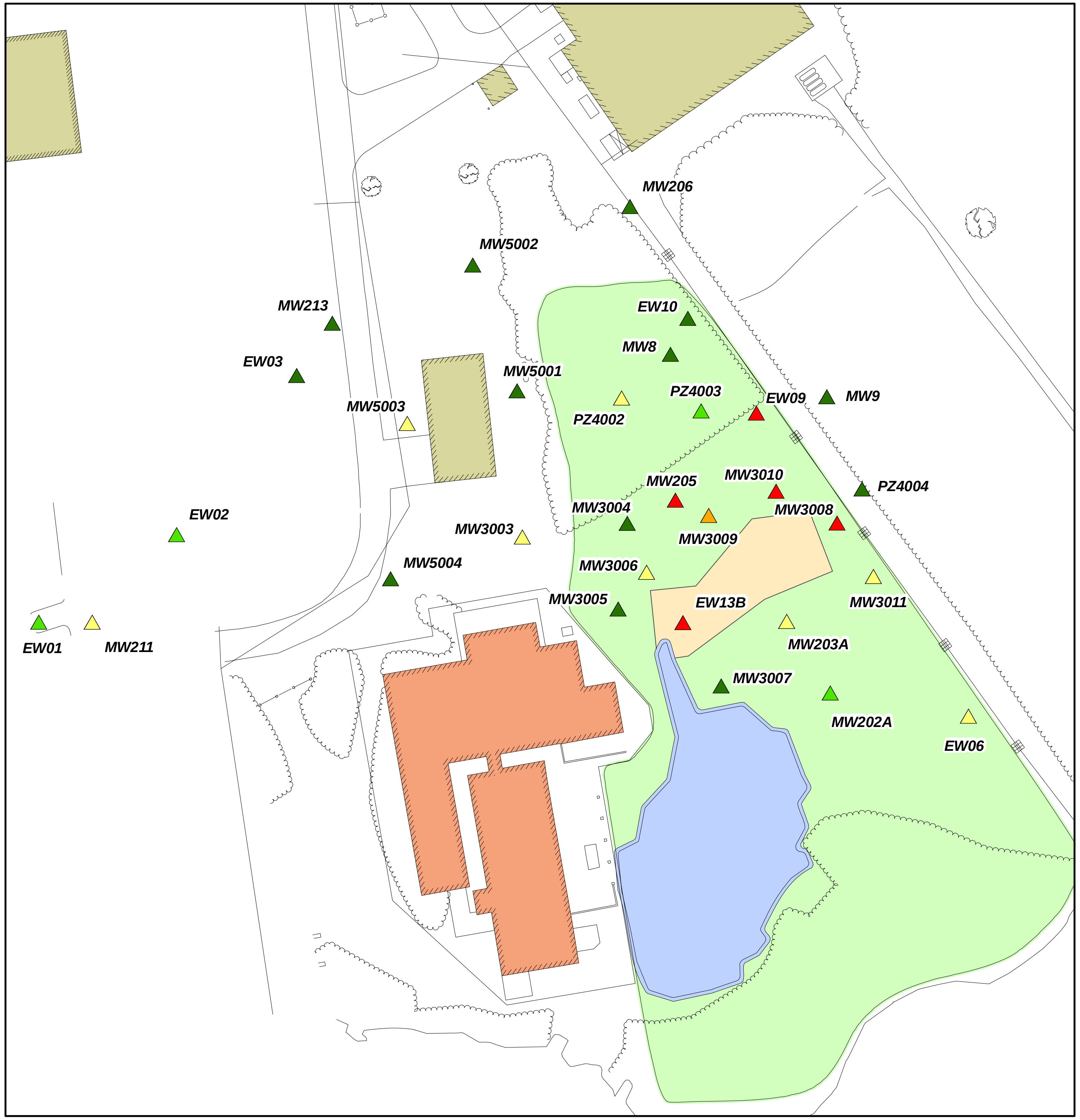
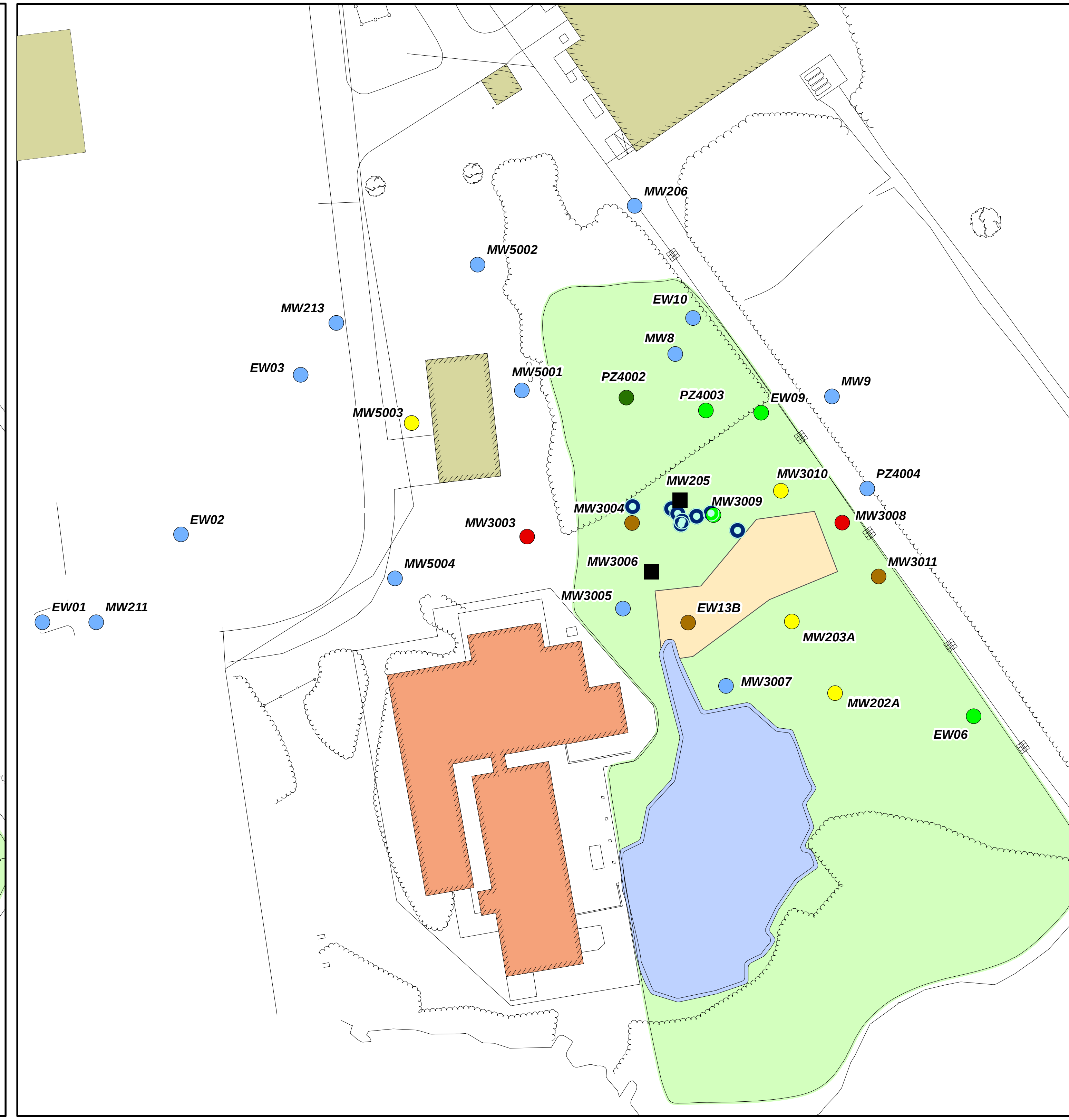


Figure 5 MW-3008 Temporal Analysis

2005 - 2009







Legend

Ratio of Historic High Concentration to Cleanup Level

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 5.0
- 5.0 - 10.0
- 10 - >100

Mann-Kendall Trend Results

- Non-Detect
- Decreasing
- Probably Decreasing
- Stable
- Probably Increasing
- Increasing
- No Trend
- Insufficient Data
- Center of Mass (First Moments)

- Ponded Former Landfill
- Kearsarge Metallurgical Corporation
- Buildings
- Excavation
- Wetland

Scale (FT)
0 60 120

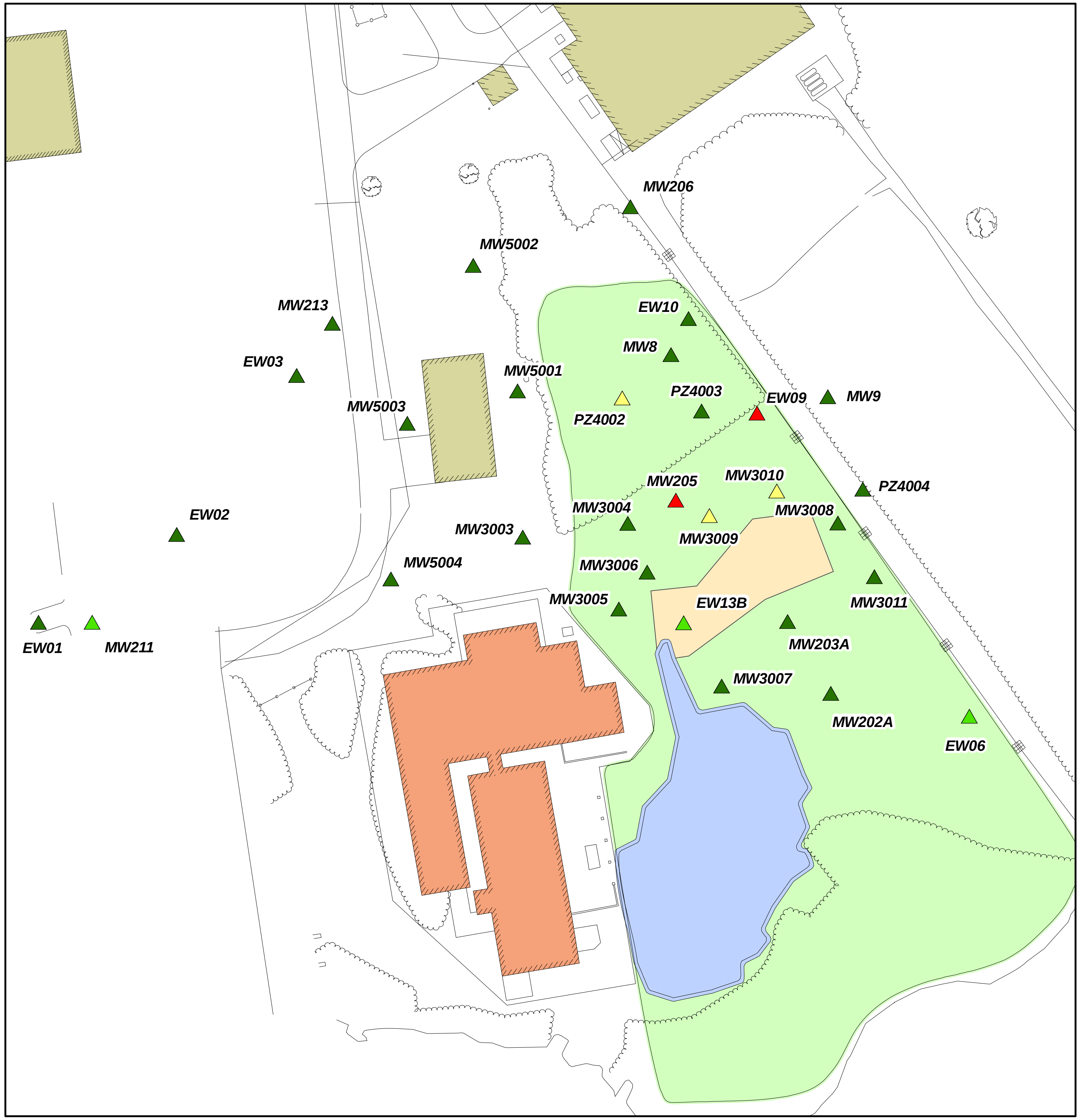
N

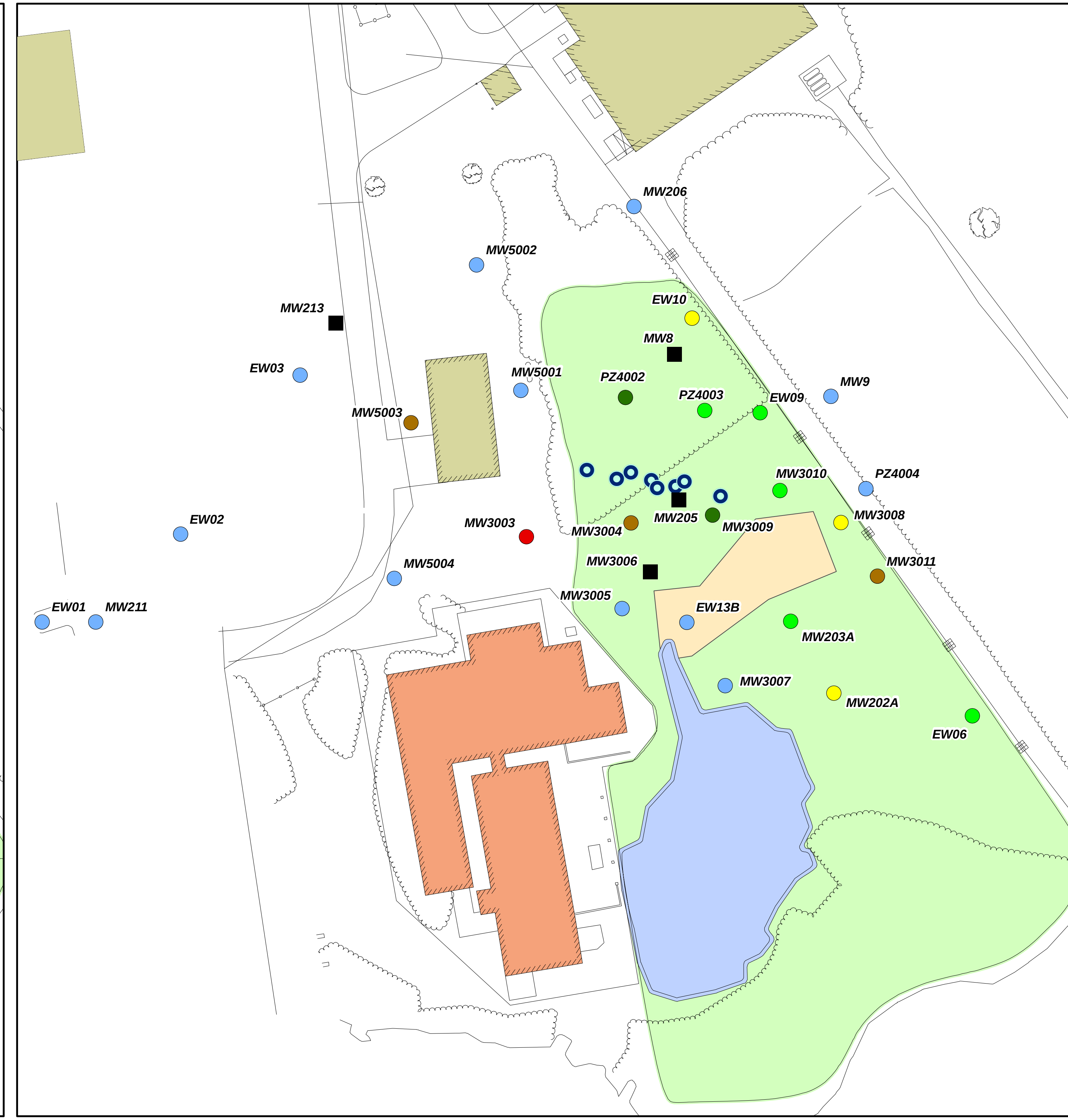
1,1-DCE MAXIMUM CONCENTRATIONS, TRENDS AND FIRST MOMENTS

Kearsarge Metallurgical Corporation

Conway, New Hampshire

Coord sys:	NAD 83 SP N. Hamp. FT	Issued:	4-November-2009
Drawn By:	MV	Revised:	
Ck'd By:	MV	Map ID:	
Appv'd By:	MV		**Figure 6**





Legend

Ratio of Historic High Concentration to Cleanup Level

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 5.0
- 5.0 - 10.0
- 10 - >100

Mann-Kendall Trend Results

- Non-Detect
- Decreasing
- Probably Decreasing
- Stable
- Probably Increasing
- Increasing
- No Trend
- Insufficient Data
- Center of Mass (First Moments)

- Ponded Former Landfill
- Kearsarge Metallurgical Corporation
- Buildings
- Excavation
- Wetland

Scale (FT)
0 60 120

N

1,1,1-TCA MAXIMUM CONCENTRATIONS, TRENDS AND FIRST MOMENTS

Kearsarge Metallurgical Corporation

Conway, New Hampshire

Coord sys:	NAD 83 SP N. Hamp. FT	Issued:	4-November-2009
Drawn By:	MV	Revised:	
Ck'd By:	MV	Map ID:	
Appv'd By:	MV		**Figure 7**

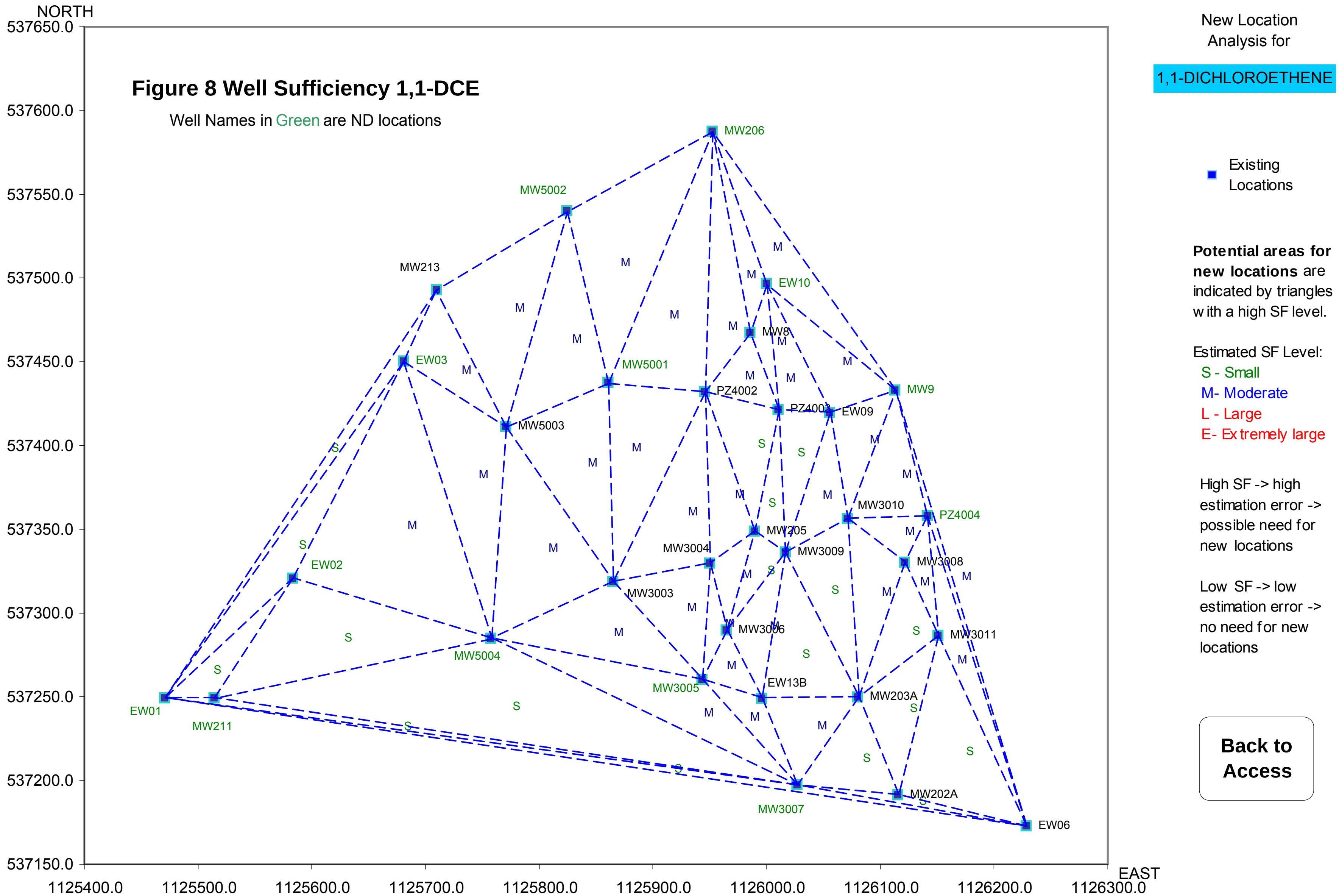
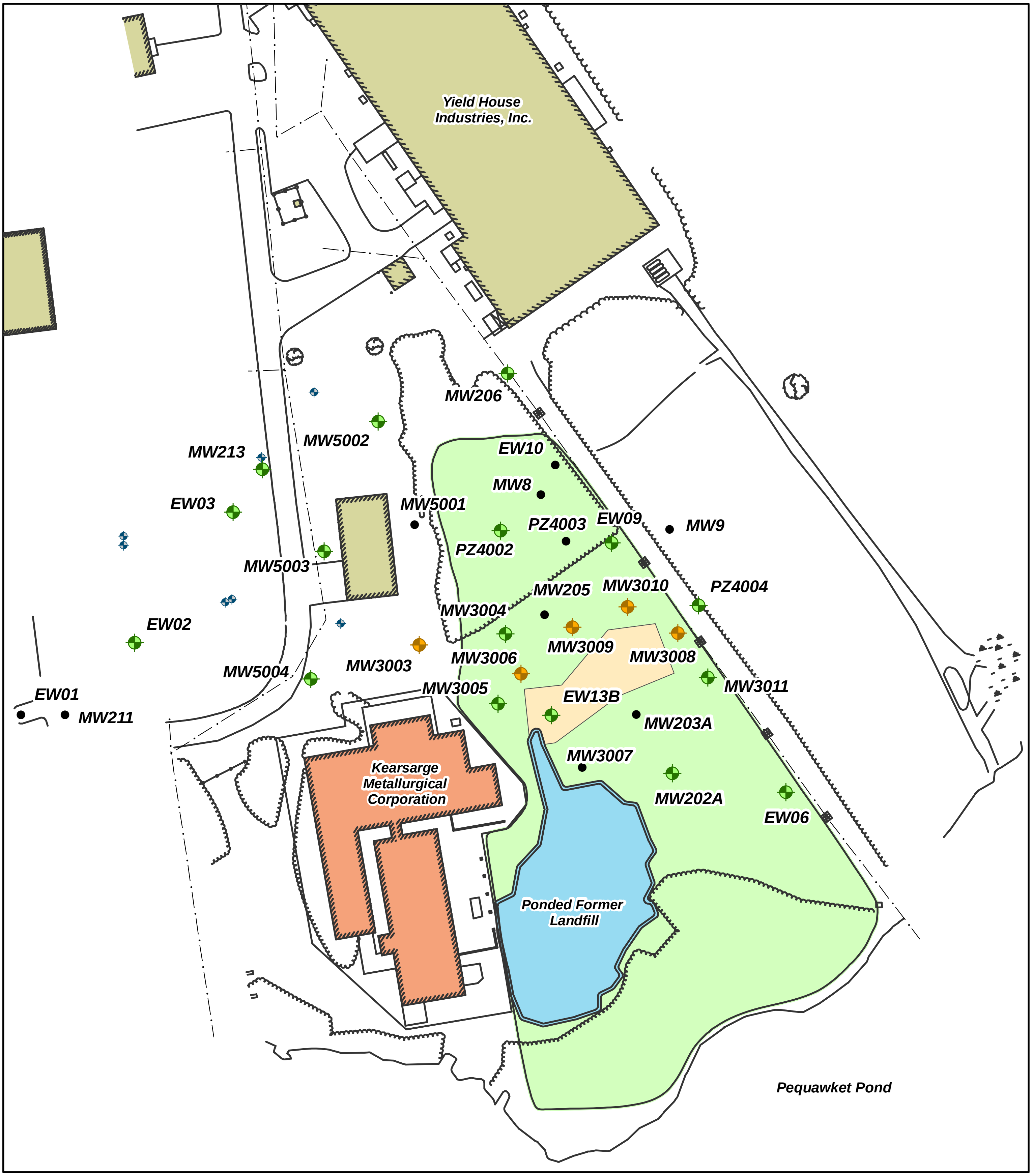


Figure 8 Well Sufficiency 1,1-DCE
Well Names in Green are ND locations
NORTH
EAST
537650.0
537600.0
537550.0
537500.0
537450.0
537400.0
537350.0
537300.0
537250.0
537200.0
537150.0
1125400.0
1125500.0
1125600.0
1125700.0
1125800.0
1125900.0
1126000.0
1126100.0
1126200.0
1126300.0
MW206
MW5002
MW213
EW10
MW8
EW03
MW5001
PZ4002
MW9
PZ4001
EW09
MW5003
MW3010
PZ4004
MW205
MW3004
MW3009
MW3008
EW02
MW3003
MW3006
MW3011
MW5004
MW3005
EW13B
MW203A
EW01
MW211
MW3007
MW202A
EW06
New Location Analysis for
1,1-DICHLOROETHENE
Existing Locations
Potential areas for new locations are indicated by triangles with a high SF level.
Estimated SF Level:
S - Small
M- Moderate
L - Large
E- Extremely large
High SF -> high estimation error -> possible need for new locations
Low SF -> low estimation error -> no need for new locations
Back to Access



Legend

- Ponded Excavation
- Kearsarge Metallurgical Corporation
- Buildings
- Excavation
- Wetland

Recommended Sampling Frequency

- Annual
- SemiAnnual
- Eliminate
- Possible Alternate GMZ Monitoring Locations

Scale (FT)

0 70 140

N

RECOMMENDED MONITORING LOCATIONS

Kearsarge Metallurgical Corporation

Conway, New Hampshire

Coord sys: NAD 83 SP N. Hamp. FT	Issued: 4-November-2009
Drawn By: MV	Revised:
Ck'd By: MV	Map ID:
Appv'd By: MV	**Figure 9**

Groundwater Monitoring Network Optimization
Kearsarge Metallurgical Corporation

Conway, New Hampshire

APPENDIX A

MAROS 2.2 METHODOLOGY

TABLES

FIGURES

MAROS METHODOLOGY

MAROS is a collection of tools in one software package that is used in an explanatory, non-linear but linked fashion to review and increase the efficiency of groundwater monitoring networks. The tool includes models, statistics, heuristic rules, and empirical relationships to assist the user in optimizing a groundwater monitoring network system. The final optimized network maintains adequate delineation while providing information on plume dynamics over time. Results generated from the software tool can be used to develop lines of evidence, which, in combination with expert opinion, can be used to inform regulatory decisions for safe and economical long-term monitoring of groundwater plumes. For a more detailed description of the structure of the software and further utilities, refer to the MAROS 2.2 Manual (AFCEE, 2003; http://www.gsi-net.com/en/software/free-software/maros.html) and Aziz et al., 2003.

1.0 MAROS CONCEPTUAL MODEL

In MAROS 2.2, two levels of analysis are used for optimizing long-term monitoring plans: 1) an overview statistical evaluation based on temporal trend analyses and plume stability information; and 2) a more detailed statistical optimization based on spatial and temporal redundancy and sufficiency identification methods (see Figures A.1 and A.2 for further details). In general, the MAROS method applies to 2-D aquifers that have relatively simple site hydrogeology. However, for a multi-aquifer (3-D) system, the user has the option to apply the statistical analysis layer-by-layer.

The overview statistics or interpretive trend analyses assess the general monitoring system category by considering individual well concentration trends, overall plume stability, and qualitative factors such as seepage velocity, remedial systems, and the location of potential receptors. The method relies on temporal trend analysis to assess plume stability, which is then used to determine the general monitoring system category. The monitoring system category is evaluated separately for both source and tail regions.

Source zone monitoring wells could include areas with non-aqueous phase liquids (NAPLs), contaminated vadose zone soils, and areas where aqueous-phase releases have been introduced into ground water. Alternately, a source zone could be an area upgradient of a remedy such as a pump and treat (P&T) system or barrier wall. The source zone generally contains locations with historical high groundwater concentrations of the COCs.

The tail zone is usually the area downgradient of the contaminant source zone or major remedial system. Although this classification is a simplification of the plume conceptual model, this broadness makes the user aware on an individual well basis that the concentration trend results can have a different interpretation depending on the well location in and around the plume. The location and type of the individual wells allows further interpretation of the trend results, depending on what type of well is being analyzed (e.g., remediation well, leading plume edge well, or source monitoring well).

General recommendations for the monitoring network frequency and density are suggested based on heuristic rules applied to the source and tail trend results.

The detailed sampling optimization modules consist of well redundancy and well sufficiency analyses using the Delaunay method, a sampling frequency analysis using the Modified Cost Effective Sampling (MCES) method. For plumes very close to the cleanup standards, a data sufficiency analysis including statistical power analysis can be used to identify statistically ‘clean’ locations. The well redundancy analysis is designed to eliminate monitoring locations that do not contribute unique data to the program. The sampling frequency module is designed to suggest an optimal frequency of sampling based on the rate of change of constituent concentrations. The data sufficiency analysis uses simple statistical methods to assess the sampling record to determine if groundwater concentrations are statistically below target levels and if the current monitoring network and record is sufficient to evaluate concentrations at downgradient locations.

2.0 DATA MANAGEMENT

In MAROS, groundwater monitoring data can be imported from simple database-format Microsoft® Excel spreadsheets, Microsoft Access tables, previously created MAROS database archive files, or entered manually. Monitoring data interpretation in MAROS is based on historical analytical data from a consistent set of wells over a series of sampling events. The analytical data is composed of the well name, coordinate location, constituent, result, detection limit and associated data qualifiers. Statistical validity of the concentration trend analysis requires constraints on the minimum data input of at least four wells (ASTM 1998) in which COCs have been detected. Individual sampling locations need to include data from at least six most-recent sampling events. To ensure a meaningful comparison of COC concentrations over time and space, both data quality and data quantity need to be considered. Prior to statistical analysis, the user can consolidate irregularly sampled data or smooth data that might result from seasonal fluctuations or a change in site conditions. Because MAROS is a later-stage analytical tool designed for long-term planning after site investigation and remedial system installation, impacts of seasonal variation in the water unit are treated on a broad scale, as they relate to multi-year trends.

Imported ground water monitoring data and the site-specific information entered in the *Site Details* input screens can be archived and exported as MAROS archive files. These archive files can be appended as new monitoring data becomes available, resulting in a dynamic long-term monitoring database that reflects the changing conditions at the site (i.e. biodegradation, compliance attainment, completion of remediation phase, etc.). For wells with a limited monitoring history, addition of information as it becomes available can change the frequency or redundancy recommendations made by MAROS.

The type of data required to run MAROS is shown in Table 1 below.

TABLE 1: Data Input for MAROS

Data Input	Format	Details
Sample Dates	MM/DD/YYYY	Sampling event dates can be consolidated in the
Well Names	Text format	Well names must be spelled consistently
Analyte Name	Text format	Analyte names must conform to MAROS input standards outlined shown in MAROS_ConstituentList.xls
Result	Number format; null cell for non-detect results	
Detection Limit	Number format	Detection limits must be included for all samples. Missing detection limits can be estimated.
Data Flag	ND or TR	Flag non-detect results with "ND". Identification of trace values (J flag) data is optional.
X and Y Coordinates	Geographical coordinates in number format; units are feet.	Coordinates can be in State Plane feet or in a site specific coordinate system. Values must be in units of feet.
Seepage velocity	Number in units of feet per year	Estimated value for formation
Plume length and width	Number in units of feet	Estimated value from plume maps
Distance to receptors	Number >0	Estimated distance from source/tail to surface water, property boundaries or drinking water wells that represent potential points of exposure.
Groundwater flow direction	Number between 1 and 359	Predominant groundwater flow direction with due east being 0 and moving counter-clockwise, north 90, west 180 and south 270.
Porosity	Number <1	Total porosity estimate for soil type
Source Coordinates	Geographic coordinates in number format; units are feet	An estimate of the coordinates of the most likely source area
Saturated Thickness	Number >1	An estimate of plume thickness, either plume-wide or at each well location.

3.0 SITE DETAILS

Information needed for the MAROS analysis includes site-specific parameters such as seepage velocity and current plume length and width. Information on the location of potential receptors relative to the source and tail regions of the plume is entered at this point. Part of the trend analysis methodology applied in MAROS focuses on where the monitoring well is located, therefore the user needs to divide site wells into two different zones: the source zone or the tail zone. Although this classification is a simplification of the well function, this broadness makes the user aware on an individual well basis that the concentration trend results can have a different interpretation depending on the well location in and around the plume. It is up to the user to make further interpretation of the trend results, depending on what type of well is being analyzed (e.g., remediation well, leading plume edge well, or monitoring well). The Site Details section of MAROS contains a preliminary map of well locations to confirm well coordinates.

4.0 CONSTITUENT SELECTION

A database with multiple COCs can be entered into the MAROS software. MAROS allows the analysis of up to 5 COCs concurrently and users can pick COCs from a list of compounds existing in the monitoring data. MAROS runs separate optimizations for each compound. For sites with a single source, the suggested strategy is to choose one to three priority COCs for the optimization. If, for example, the site contains multiple chlorinated volatile organic compounds (VOCs), the standard sample chemical analysis will evaluate all VOCs, so the sample locations and frequency should based on the concentration trends of the most prevalent, toxic or mobile compounds. If different chemical classes are present, such as metals and chlorinated VOCs, choose and evaluate the priority constituent in each chemical class.

MAROS includes a short module that provides recommendations on prioritizing COCs based on toxicity, prevalence, and mobility of the compound. The toxicity ranking is determined by examining a representative concentration for each compound for the entire site. The representative concentration is then compared to the screening level (PRG or MCL) for that compound and the COCs are ranked according to the representative concentrations' percent exceedance of the screening level. The evaluation of prevalence is performed by determining a representative concentration for each well location and evaluating the total number of wells with exceedances (values above screening levels) compared to the total number of wells. Compounds found over screening levels are ranked for mobility based on Kd (sorption partition coefficient). The MAROS COC assessment provides the relative ranking of each COC, but the user must choose which COCs are included in the analysis.

5.0 DATA CONSOLIDATION

Typically, raw data from long-term monitoring networks have been measured irregularly in time or contain many non-detects, trace level results, and duplicate results. Therefore, before the data can be further analyzed, raw data are filtered, consolidated, transformed, and possibly smoothed to allow for a consistent dataset meeting the minimum data requirements for statistical analysis mentioned previously.

MAROS allows users to specify the period of interest in which data will be consolidated (i.e., monthly, bi-monthly, quarterly, semi-annual, yearly, or a biennial basis). In computing the representative value when consolidating, one of four statistics can be used: median, geometric mean, mean, and maximum. Non-detects can be transformed to one half the reporting or method detection limit (DL), the DL, or a fraction of the DL. Trace level results can be represented by their actual values, one half of the DL, the DL, or a fraction of their actual values. Duplicates are reduced in MAROS by one of three ways: assigning the average, maximum, or first value. The reduced data for each COC and each well can be viewed as a time series in a graphical form on a linear or semi-log plot generated by the software.

6.0 OVERVIEW STATISTICS: PLUME TREND ANALYSIS

Within the MAROS software, analyses of historical data provide support for a conclusion about plume stability (e.g., increasing plume, etc.). Plume stability results are assessed from time-series concentration data with the application of three statistical tools: Mann-Kendall Trend analysis, linear regression trend analysis and moment analysis. Mann-Kendall and Linear Regression methods are used to estimate the concentration trend for individual well and COC combinations based on the statistical trend analysis of concentrations versus time. These trend analyses are then consolidated to give the user a general stability estimate for source, tail and plume-wide areas as well as a preliminary recommendation for monitoring frequency and well density (see Figures 1 through 3 for further step-by-step details). The Overview Statistics are designed to allow site personnel to develop a better understanding of the plume behavior over time and understand how the individual well concentration trends are spatially distributed within the plume. The Overview step allows the user to gain information that will support a more informed decision in the next level of detailed statistical optimization analysis.

6.1 MANN-KENDALL ANALYSIS

The Mann-Kendall test is a statistical procedure that is well suited for analyzing trends in groundwater data. The Mann-Kendall test is a non-parametric test for zero slope of the first-order regression of time-ordered concentration data versus time. The advantage of the Mann-Kendall test is that no assumptions as to the statistical distribution of the data (e.g. normal, lognormal, etc.) are required, and it can be used with data sets that include irregular sampling intervals and missing data. The Mann-Kendall test is designed for analyzing a single groundwater constituent, multiple constituents are analyzed separately.

The Mann-Kendall test for trend, relies on three statistical metrics. The first metric, the S statistic, is based on the sum of the differences between data in sequential order. An S with a positive value may indicate an increase in concentrations over time and negative values indicate possible decreases. The strength of the trend is proportional to the magnitude of the S statistic (i.e., a large value indicates a strong trend). The confidence in the trend is determined by performing a hypothesis test to determine the probability of accepting the null hypothesis (no trend). The S statistic and the sample size, n, are found in a Kendall probability table such as the one reported in Hollander and Wolfe (1973). The Confidence in the Trend is found by subtracting the probability of no trend (ρ) from 1. For low values of ρ (<0.05), confidence in the trend is high (>90%) or ($\rho < 0.01$) very high (>95%).

The concentration trend is determined for each well and each COC based on results of the S statistic, the confidence in the trend, and the coefficient of variation (COV). The coefficient of variation (COV) is calculated from the standard deviation divided by the mean for the dataset. The decision matrix for the Mann-Kendall evaluation is shown in Table 2 below. A Mann-Kendall statistic that is greater than 0 combined with a confidence of greater than 95% is categorized as an Increasing trend while a Mann-Kendall statistic of less than 0 with a confidence between 90% and 95% is defined as a probably Increasing trend, and so on.

Depending on statistical indicators, the concentration trend is classified into six categories:

- Decreasing (D),
- Probably Decreasing (PD),
- Stable (S),
- No Trend (NT),
- Probably Increasing (PI)
- Increasing (I)
- Non-detect (ND)
- Insufficient data (N/A).

Wells where the compound is not detected are labeled “ND” for the COC evaluated. These trend estimates are then analyzed to identify the source and tail region overall stability category (see Figure 2 for further details).

TABLE 2
Mann-Kendall Analysis Decision Matrix (Aziz, et. al., 2003)

Mann-Kendall Statistic	Confidence in the Trend	Concentration Trend
S > 0	> 95%	Increasing
S > 0	90 - 95%	Probably Increasing
S > 0	< 90%	No Trend
S ≤ 0	< 90% and COV ≥ 1	No Trend
S ≤ 0	< 90% and COV < 1	Stable
S < 0	90 - 95%	Probably Decreasing
S < 0	> 95%	Decreasing
S = 0	0	Non-detect

6.2 LINEAR REGRESSION ANALYSIS

Linear Regression is a parametric statistical procedure that is typically used for analyzing trends in data over time for datasets that have a normal or lognormal distribution. The objective of linear regression analysis is to find the trend in the dat through the estimation of the log-slope as well as placing confidence limits on the log-slope of the trend. The Linear Regression analysis in MAROS is performed on Ln(concentration) versus time. The regression model assumes that for a fixed value of x (sample date) the expected value of y (ln(concentration)) can be found by evaluating a linear function. The method of least squares is used to obtain the estimate of the linear function.

In order to test the confidence in the regression trend, confidence limits are placed on the slope of the regression line. A t-test is used to find the confidence interval for the slope by dividing the slope by the standard error of the slope. The result of the t-test along with the degrees of freedom (n-2) are used to find the confidence in the trend from a t-distribution table. The coefficient of variation, defined as the standard deviation divided by the average, is used as a secondary measure of scatter to distinguish between “Stable” or “No Trend” conditions for negative slopes. The resulting confidence in the trend, slope of the regression through the data and variance are used to determine a final trend based on the decision matrix shown on Table 3.

Using this type of analysis, a higher degree of scatter simply corresponds to a wider confidence interval about the average log-slope. Assuming the sign (i.e., positive or negative) of the estimated log-slope is correct, a level of confidence that the slope is not zero can be easily determined. Thus, despite a poor goodness of fit, the overall trend in the data may still be ascertained, where low levels of confidence correspond to “Stable” or “No Trend” conditions (depending on the degree of scatter) and higher levels of confidence indicate the stronger likelihood of a trend. Depending on statistical indicators, the concentration trend is classified into six categories:

- Decreasing (D),
- Probably Decreasing (PD),
- Stable (S),
- No Trend (NT),
- Probably Increasing (PI)
- Increasing (I).

TABLE 3 Linear Regression Analysis Decision Matrix (Aziz, et. al., 2003)		
Confidence in the Trend	**Log-slope**	
	Positive	**Negative**
< 90%	No Trend	COV < 1 Stable COV > 1 No Trend
90 - 95%	Probably Increasing	Probably Decreasing
> 95%	Increasing	Decreasing

6.3 MOMENT ANALYSIS

The role of moment analysis in MAROS is to provide a relative estimate of plume stability and condition within the context of results from other MAROS modules. The moment analysis algorithms in MAROS are simple approximations of complex calculations and are meant to estimate changes in total mass, center of mass and spread of mass within the network over time. The Moment Analysis module is sensitive to the number and arrangement of wells in each sampling event, so, changes in the number and identity of wells during monitoring events, and the parameters chosen for data consolidation can cause changes in the estimated moments.

The analysis of moments can be summarized as:

- Zeroth Moment: An estimate of the total dissolved mass of the constituent within the network for each sample event;
- First Moment: An estimate of the center of mass for each sample event;
- Second Moment: An estimate of the spread of the plume around the center of mass for each sample event.

Moments are calculated using the method of Delaunay Triangulation. The software constructs triangles between all of the wells in the network and estimates the total mass within each triangle using the Saturated Thickness value input as the depth of the plume. To determine the zeroth moment, the mass within each of the triangles is summed to give a plume-wide value. To find the center of mass, or first moment, the center of each triangle is determined and multiplied by the mass within the triangle, which is then normalized by the total mass in the plume. The second moment is an estimate of the relative distribution of mass between the center of the plume and the edges of the plume. Estimates are made of the relative distribution of mass in the direction of groundwater flow (X) and orthogonal to groundwater flow (Y) for each sample event.

Once moments are calculated for each sample event, the Mann-Kendall trend test is applied to determine if the results show increasing, stable or decreasing trends. When considering the results of the zeroth moment trend, the following factors could effect the calculation and interpretation of the plume mass over time: 1) change in the spatial distribution of the wells sampled historically 2) different wells sampled within the well network over time (addition and subtraction of wells within the network). 3) delineation of the plume as mass outside of the network is not included in the estimate.

The first moment estimates the center of mass, coordinates (Xc and Yc) for each sample event and COC and the distance of these coordinates from the source. If the center of mass is farther from the source, then there is an increasing trend. The changing center of mass indicates the relative distribution of mass between the source and tail over time and an increasing trend does not necessarily signal and expanding plume. An increasing center of mass is often found where significant source reduction has occurred. No appreciable movement or a stable trend in the center of mass would indicate plume stability. However, changes in the first moment over time do not necessarily completely characterize the changes in the concentration distribution (and the mass) over time. Therefore, in order to fully characterize the plume the First Moment trend should be compared to the zeroth moment trend (mass change over time).

The second moment indicates the spread of the contaminant about the center of mass (Sxx and Syy), or the distance of contamination from the center of mass for a particular COC and sample event. An increasing trend in the second moment indicates that there is less mass in the center of the plume relative to the edge. This is often seen in cases where diffusion is occurring or when a remedial system may be removing mass from the center of the plume. A decreasing trend may indicate that mass destructive processes are active on the edge of the plume.

6.4 OVERALL PLUME ANALYSIS

General recommendations for the monitoring network sampling frequency and density are provided by MAROS after the trend and moment analysis modules. Monitoring network improvements are suggested based on heuristic rules applied to the source and tail trend results as well as qualitative factors such as seepage velocity and distance to potential receptors.

Individual well trend results are consolidated and weighted by the MAROS software according to user input, and the direction and strength of contaminant concentration trends in the source zone and tail zone for each COC are determined. The software suggests a general, preliminary optimization plan for the current monitoring. The flow chart detailing how the trend analysis results and other site-specific parameters are used to form a general sampling frequency and well density recommendation is shown in Figure 2.

For example, a generic plan for a shrinking petroleum hydrocarbon plume (BTEX) in a slow hydrogeologic environment (silt) with no nearby receptors would entail minimal, low frequency sampling of just a few indicators. On the other hand, the generic plan for a chlorinated solvent plume in a fast hydrogeologic environment that is expanding but has very erratic concentrations over time would entail more extensive, higher frequency sampling. The preliminary plan is based on a heuristically derived algorithm for assessing future sampling duration, location and density that takes into consideration plume stability. For a detailed description of the heuristic rules used in the MAROS software, refer to the MAROS 2.2Manual (AFCEE, 2003).

7.0 DETAILED STATISTICS: OPTIMIZATION ANALYSIS

Although the overall plume analysis shows a general recommendation for sampling frequency and sampling density, a more detailed analysis is also available with the MAROS software in order to allow for further refinements on a well-by-well basis. The MAROS Detailed Statistics allows for a quantitative analysis for spatial and temporal optimization of the well network. The MAROS Detailed Statistics results should be evaluated considering the results of the Overview Statistics as well as other qualitative features such as site monitoring objectives and the frequency of site decision making.

The Detailed Statistics sampling optimization in MAROS consists of four parts:

- Well redundancy analysis using the Delaunay method
- Well sufficiency analysis using the Delaunay method
- Sampling frequency determination using the Modified Cost Effective Sampling method
- Data sufficiency analysis using statistical power analysis.

The well redundancy analysis using the Delaunay method identifies and eliminates redundant locations from the monitoring network. The well sufficiency analysis can determine the areas where new sampling locations might be needed. The Modified CES method determines the optimal sampling frequency for a sampling location based on the direction, magnitude, and uncertainty in its concentration trend. The data sufficiency analysis examines the risk-based site cleanup status and power and expected sample size associated with the cleanup status evaluation.

7.1 WELL REDUNDANCY ANALYSIS – DELAUNAY METHOD

The well redundancy analysis using the Delaunay method is designed to select the minimum number of sampling locations based on the spatial analysis of the relative importance of each sampling location in the monitoring network. The approach allows elimination of sampling locations that have little impact on the historical characterization of the contaminant plume. An extended method for evaluating well sufficiency based on the Delaunay method is used for recommending new sampling locations in areas with high concentration uncertainty. Details about the Delaunay method can be found in Appendix A.2 of the MAROS Manual (AFCEE, 2003).

The sampling location modules use the Delaunay triangulation method employed during the moment analysis. The method determines the significance of each sampling location relative to the overall monitoring network with respect to characterizing concentration within the plume. The Delaunay method calculates the area within the network and the average concentration of the plume using data from multiple monitoring wells. A slope factor (SF) is calculated for each well by assessing how accurately concentration at the well can be estimated from concentrations at neighboring wells.

The sampling location optimization process is performed in a stepwise fashion. Step one involves assessing the SF; if a well has a small SF (little significance to the network), the well may be removed from the monitoring network. Locations with a SF = 0.3 or less are candidates for removal. Step two involves evaluating the information loss of removing a well from the network. Information loss is measured by evaluating and Area Ratio and a Concentration Ratio, which is the plume-wide area or concentration after removal of the well normalized by the original values. If one well has a small SF, it may or may not be eliminated depending on whether the information loss in terms of area or average concentration estimates is significant. If the information loss is not significant, the well can be eliminated from the monitoring network and the process of optimization continues with fewer wells. However if the well information loss is significant then the optimization terminates. This sampling optimization process allows the user to assess "redundant" wells that will not incur significant information loss on a constituent-by-constituent basis for individual sampling events.

7.2 WELL SUFFICIENCY ANALYSIS – DELAUNAY METHOD

The well sufficiency analysis, using the Delaunay method, is designed to recommend new sampling locations in areas *within* the existing monitoring network where there is a high level of uncertainty in contaminant concentration. Details about the well sufficiency analysis can be found in Appendix A.2 of the MAROS Manual (AFCEE, 2003).

In many cases, new sampling locations need to be added to the existing network to enhance the spatial characterization of the plume. If the MAROS algorithm calculates a high level of uncertainty in predicting the constituent concentration at nodes for a particular Delaunay triangle, a new sampling location is recommended for that area. The SF values obtained from the redundancy evaluation described above are used to calculate the concentration estimation error for each triangle. The estimated concentration uncertainty value, based on the calculated SF for each area is then classified into four levels: Small, Moderate, Large, or Extremely large (S, M, L, E). Therefore, the triangular areas with the estimated SF value at the Extremely large or Large level can be candidate regions for new sampling locations.

The results from the Delaunay method and the method for determining new sampling locations are derived solely from the spatial configuration of the monitoring network and the spatial pattern of the contaminant plume. No parameters such as the hydrogeologic conditions or regulatory factors are considered in the analysis. Therefore, professional judgment and regulatory considerations must be used to make final decisions.

7.3 SAMPLING FREQUENCY DETERMINATION - MODIFIED CES METHOD

The Modified CES method optimizes sampling frequency for each sampling location based on the magnitude, direction, and uncertainty of its concentration trend derived from its recent and historical monitoring records. The Modified Cost Effective Sampling (MCES) estimates a conservative lowest-frequency sampling schedule for a given groundwater monitoring location that still provides needed information for regulatory and remedial decision-making. The MCES method was developed on the basis of the Cost Effective Sampling (CES) method developed by Ridley et al (1995). Details about the MCES method can be found in Appendix A.9 of the MAROS Manual (AFCEE, 2003).

In order to estimate the least frequent sampling schedule for a monitoring location that still provides enough information for regulatory and remedial decision-making, MCES employs three steps to determine the sampling frequency. The first step involves analyzing frequency based on recent trends. A preliminary location sampling frequency (PLSF) is developed based on the rate of change of well concentrations calculated by linear regression along with the Mann-Kendall trend analysis of the most recent monitoring data (see Figure 3). The variability within the sequential sampling data is accounted for by the Mann-Kendall analysis. The rate of change vs. trend result matrix categorizes wells as requiring annual, semi-annual or quarterly sampling. The PLSF is then reevaluated and adjusted based on overall trends. If the long-term history of change is significantly greater than the recent trend, the frequency may be reduced by one level.

The final step in the analysis involves reducing frequency based on risk, site-specific conditions, regulatory requirements or other external issues. Since not all compounds in the target being assessed are equally harmful, frequency is reduced by one level if recent maximum concentration for a compound of high risk is less than 1/2 of the Maximum Concentration Limit (MCL). The result of applying this method is a suggested sampling frequency based on recent sampling data trends and overall sampling data trends and expert judgment.

The final sampling frequency determined from the MCES method can be Quarterly, Semiannual, Annual, or Biennial. Users can further reduce the sampling frequency to, for example, once every three years, if the trend estimated from Biennial data (i.e., data drawn once every two years from the original data) is the same as that estimated from the original data.

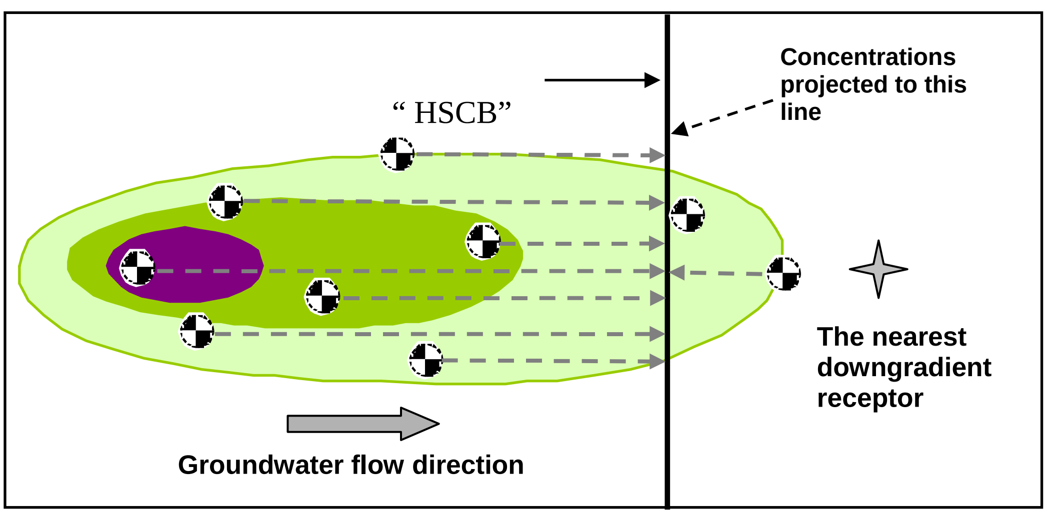
7.4 DATA SUFFICIENCY ANALYSIS – POWER ANALYSIS

The MAROS Data Sufficiency module employs simple statistical methods to evaluate whether the collected data are adequate both in quantity and in quality for revealing changes in constituent concentrations. The first section of the module evaluates individual well concentrations to determine if they are statistically below a target screening level. The second section includes a simple calculation for estimating projected groundwater concentrations at a specified point downgradient of the plume. A statistical Power analysis is then applied to the projected concentrations to determine if the downgradient concentrations are statistically below the cleanup standard. If the number of projected concentrations is below the level to provide statistical significance, then the number of sample events required to statistically confirm concentrations below standards is estimated from the Power analysis.

Before testing the cleanup status for individual wells, the stability or trend of the contaminant plume should be evaluated. Only after the plume has reached stability or is reliably diminishing can we conduct a test to examine the cleanup status of wells. Applying the analysis to wells in an expanding plume may cause incorrect conclusions and is less meaningful.

Statistical power analysis is a technique for interpreting the results of statistical tests. The Power of a statistical test is a measure of the ability of the test to detect an effect given that the effect actually exists. The method provides additional information about a statistical test: 1) the power of the statistical test, i.e., the probability of finding a difference in the variable of interest when a difference truly exists; and 2) the expected sample size of a future sampling plan given the minimum detectable difference it is supposed to detect. For example, if the mean concentration is lower than the cleanup goal but a statistical test cannot prove this, the power and expected sample size can tell the reason and how many more samples are needed to result in a significant test. The additional samples can be obtained by a longer period of sampling or an increased sampling frequency. Details about the data sufficiency analysis can be found in Appendix A.6 of the MAROS Manual (AFCEE, 2003).

When applying the MAROS power analysis method, a hypothetical statistical compliance boundary (HSCB) is assigned to be a line perpendicular to the groundwater flow direction (see figure below). Monitoring well concentrations are projected onto the HSCB using the distance from each well to the compliance boundary along with a decay coefficient. The projected concentrations from each well and each sampling event are then used in the risk-based power analysis. Since there may be more than one sampling event selected by the user, the risk-based power analysis results are given on an event-by-event basis. This power analysis can then indicate if target are statistically achieved at the HSCB. For instance, at a site where the historical monitoring record is short with few wells, the HSCB would be distant; whereas, at a site with longer duration of sampling with many wells, the HSCB would be close. Ultimately, at a site the goal would be to have the HSCB coincide with or be within the actual compliance boundary (typically the site property line).



In order to perform a risk-based cleanup status evaluation for the whole site, a strategy was developed as follows.

- Estimate concentration versus distance decay coefficient from plume centerline wells.
- Extrapolate concentration versus distance for each well using this decay coefficient.
- Comparing the extrapolated concentrations with the compliance concentration using power analysis.

Results from this analysis can be *Attained* or *Not Attained*, providing a statistical interpretation of whether the cleanup goal has been met on the site-scale from the risk-based point of view. The results as a function of time can be used to evaluate if the monitoring system has enough power at each step in the sampling record to indicate certainty of compliance by the plume location and condition relative to the compliance boundary. For example, if results are *Not Attained* at early sampling events but are *Attained* in recent sampling events, it indicates that the recent sampling record provides a powerful enough result to indicate compliance of the plume relative to the location of the receptor or compliance boundary.

CITED REFERENCES

AFCEE 2003. Monitoring and Remediation Optimization System (MAROS) 2.1 Software Users Guide. Air Force Center for Environmental Excellence. http://www.gsi-net.com/software/MAROS_V2_1Manual.pdf

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Gilbert, R. O., 1987, Statistical Methods for Environmental Pollution Monitoring, Van Nostrand Reinhold, New York, NY, ISBN 0-442-23050-8.

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U.S. Environmental Protection Agency, 1992. Methods for Evaluating the Attainment of Cleanup Standards Volume 2: Ground Water.

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Figure 1. MAROS Decision Support Tool Flow Chart

MAROS: Decision Support Tool

MAROS is a collection of tools in one software package that is used in an explanatory, non-linear fashion. The tool includes models, geostatistics, heuristic rules, and empirical relationships to assist the user in optimizing a groundwater monitoring network system while maintaining adequate delineation of the plume as well as knowledge of the plume state over time. Different users utilize the tool in different ways and interpret the results from a different viewpoint.

Overview Statistics

What it is: Simple, qualitative and quantitative plume information can be gained through evaluation of monitoring network historical data trends both spatially and temporally. The MAROS Overview Statistics are the foundation the user needs to make informed optimization decisions at the site.

What it does: The Overview Statistics are designed to allow site personnel to develop a better understanding of the plume behavior over time and understand how the individual well concentration trends are spatially distributed within the plume. This step allows the user to gain information that will support a more informed decision to be made in the next level of optimization analysis.

What are the tools: Overview Statistics includes two analytical tools:

1) **Trend Analysis:** includes Mann-Kendall and Linear Regression statistics for individual wells and results in general heuristically-derived monitoring categories with a suggested sampling density and monitoring frequency.

2) **Moment Analysis:** includes dissolved mass estimation (0^{th} Moment), center of mass (1^{st} Moment), and plume spread (2^{nd} Moment) over time. Trends of these moments show the user another piece of information about the plume stability over time.

What is the product: A first-cut blueprint for a future long-term monitoring program that is intended to be a foundation for more detailed statistical analysis.

Detailed Statistics

What it is: The MAROS Detailed Statistics allows for a quantitative analysis for spatial and temporal optimization of the well network on a well-by-well basis.

What it does: The results from the Overview Statistics should be considered along side the MAROS optimization recommendations gained from the Detailed Statistical Analysis. The MAROS Detailed Statistics results should be reassessed in view of site knowledge and regulatory requirements as well as the Overview Statistics.

What are the tools: Detailed Statistics includes four analytical tools:

1) **Sampling Frequency Optimization:** uses the Modified CES method to establish a recommended future sampling frequency.

2) **Well Redundancy Analysis:** uses the Delaunay Method to evaluate if any wells within the monitoring network are redundant and can be eliminated without any significant loss of plume information.

3) **Well Sufficiency Analysis:** uses the Delaunay Method to evaluate areas where new wells are recommended within the monitoring network due to high levels of concentration uncertainty.

4) **Data Sufficiency Analysis:** uses Power Analysis to assess if the historical monitoring data record has sufficient power to accurately reflect the location of the plume relative to the nearest receptor or compliance point.

What is the product: List of wells to remove from the monitoring program, locations where monitoring wells may need to be added, recommended frequency of sampling for each well, analysis if the overall system is statistically powerful to monitor the plume.

Figure 2. MAROS Overview Statistics Trend Analysis Methodology

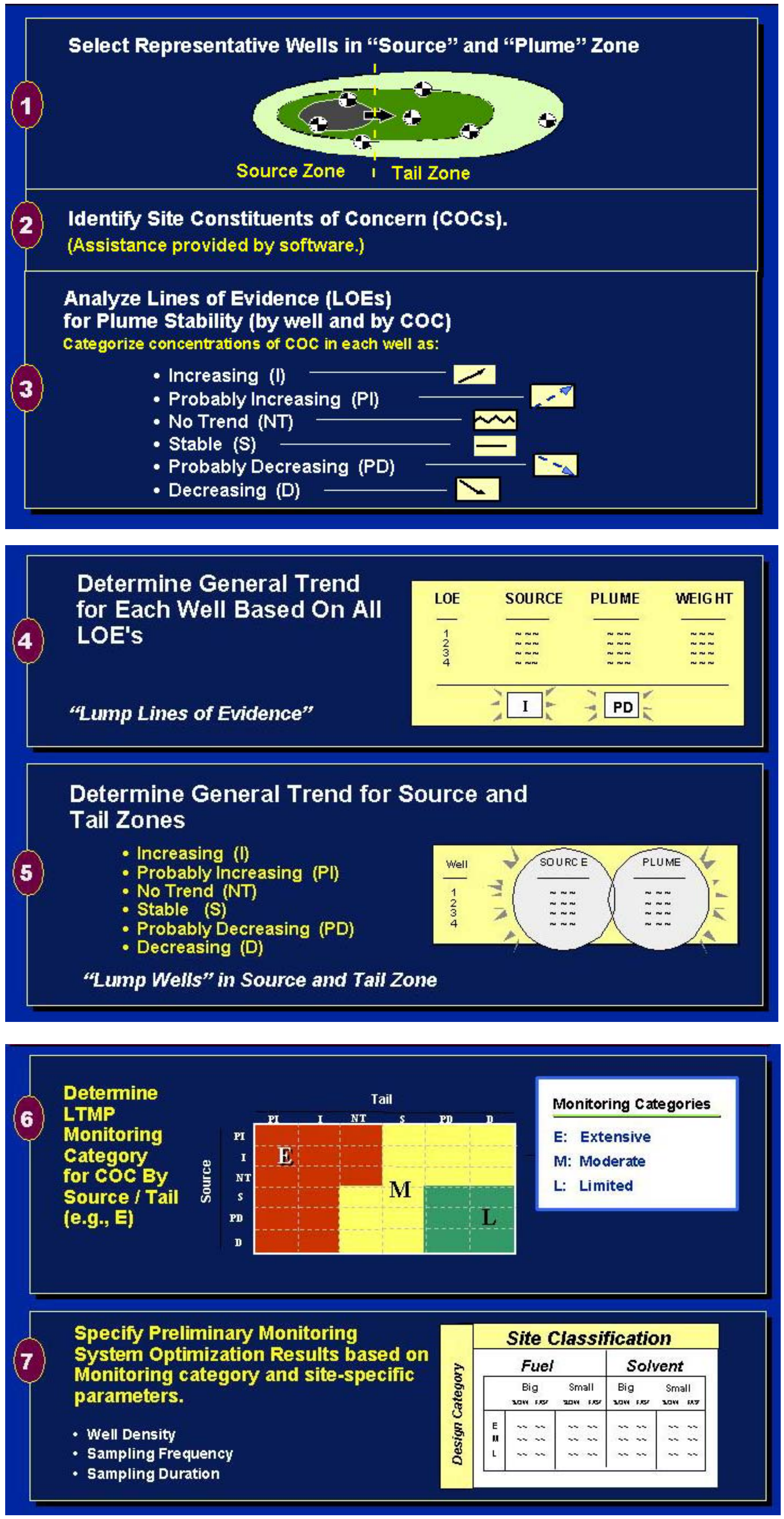
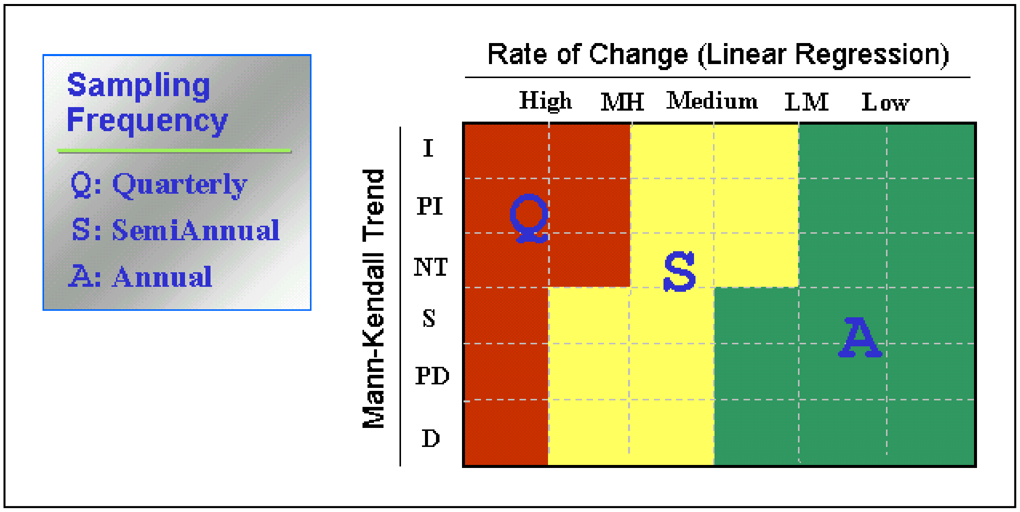


Figure 3. Decision Matrix for Determining Provisional Frequency
(*Figure A.3.1 of the MAROS Manual (AFCEE 2003*)



APPENDIX B

MAROS REPORTS

COC Assessment

Trend Summary Report: 2006 – April 2009

Trend Summary Report: 1983 – April 2009

Individual Trend Summary Reports 2006 – April 2009

Zeroth Moment Summary Reports

Supplemental Trend Reports 2006 – September 2009

MAROS COC Assessment

Project: KMC **User Name:** MV

Location: Conway **State:** New Hampshire

Toxicity:

Contaminant of Concern	Representative Concentration (mg/L)	PRG (mg/L)	Percent Above PRG
1,1-DICHLOROETHENE	1.2E-02	7.0E-03	73.1%

Note: Top COCs by toxicity were determined by examining a representative concentration for each compound over the entire site. The compound representative concentrations are then compared with the chosen PRG for that compound, with the percentage exceedance from the PRG determining the compound's toxicity. All compounds above exceed the PRG.

Prevalence:

Contaminant of Concern	Class	Total Wells	Total Exceedances	Percent Exceedances	Total detects
1,1-DICHLOROETHENE	ORG	31	9	29.0%	20

Note: Top COCs by prevalence were determined by examining a representative concentration for each well location at the site. The total exceedances (values above the chosen PRGs) are compared to the total number of wells to determine the prevalence of the compound.

Mobility:

Contaminant of Concern	Kd
1,1-DICHLOROETHENE	0.13

Note: Top COCs by mobility were determined by examining each detected compound in the dataset and comparing their mobilities (Koc's for organics, assume foc = 0.001, and Kd's for metals).

Contaminants of Concern (COC's)

1,1,1-TRICHLOROETHANE

1,1-DICHLOROETHANE

1,1-DICHLOROETHENE

CHLOROETHANE

TRICHLOROETHYLENE (TCE)

MAROS Statistical Trend Analysis Summary

Project: Kearsarge

Location: Conway

User Name: MV

State: New Hampshire

Time Period: 1/1/2006 **to** 4/30/2009

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: Specified Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Average Conc. (mg/L)	Median Conc. (mg/L)	All Samples "ND" ?	Mann-Kendall Trend	Linear Regression Trend
1,1,1-TRICHLOROETHANE								
CB10+	T	1	0	4.0E-04	4.0E-04	Yes	ND	ND
CB7-8	T	2	1	1.8E-03	1.8E-03	No	N/A	N/A
EW01	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
EW02	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
EW03	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
EW06	T	7	3	3.3E-03	4.0E-04	No	PD	D
EW09	T	7	7	1.7E-02	1.9E-02	No	PD	D
EW10	T	6	6	5.0E-03	4.8E-03	No	S	NT
EW13B	S	8	0	4.0E-04	4.0E-04	Yes	ND	ND
MW202A	T	7	5	3.6E-03	3.1E-03	No	S	D
MW203A	T	7	5	2.8E-03	2.6E-03	No	PD	S
MW205	S	2	2	3.7E-02	3.7E-02	No	N/A	N/A
MW206	T	5	0	4.0E-04	4.0E-04	Yes	ND	ND
MW211	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
MW213	T	1	1	8.1E-03	8.1E-03	No	N/A	N/A
MW3003	T	8	8	3.2E-02	3.3E-02	No	I	I
MW3004	T	7	3	1.5E-03	4.0E-04	No	NT	NT
MW3005	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
MW3006	T	2	2	1.3E-02	1.3E-02	No	N/A	N/A
MW3007	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
MW3008	S	8	8	4.4E-02	3.0E-02	No	S	NT
MW3009	S	8	8	1.4E-02	1.2E-02	No	D	PD
MW3010	S	7	7	2.4E-01	2.2E-01	No	PD	S
MW3011	T	7	1	8.9E-04	4.0E-04	No	NT	NT
MW5001	T	6	0	4.0E-04	4.0E-04	Yes	ND	ND
MW5002	T	6	0	4.0E-04	4.0E-04	Yes	ND	ND
MW5003	T	6	5	1.4E-02	1.4E-02	No	NT	NT
MW5004	T	6	0	4.0E-04	4.0E-04	Yes	ND	ND
MW8	T	2	2	6.0E-03	6.0E-03	No	N/A	N/A
MW9	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
PZ4002	S	8	8	5.3E-02	4.3E-02	No	D	D
PZ4003	T	6	6	1.1E-02	6.1E-03	No	PD	D
PZ4004	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
1,1-DICHLOROETHANE								

MAROS Statistical Trend Analysis Summary

Well	Source/ Tail	Number of Samples	Number of Detects	Average Conc. (mg/L)	Median Conc. (mg/L)	All Samples "ND" ?	Mann-Kendall Trend	Linear Regression Trend
1,1-DICHLOROETHANE								
CB10+	T	1	0	5.0E-04	5.0E-04	Yes	ND	ND
CB7-8	T	2	0	5.0E-04	5.0E-04	Yes	ND	ND
EW01	T	7	0	5.0E-04	5.0E-04	Yes	ND	ND
EW02	T	7	0	5.0E-04	5.0E-04	Yes	ND	ND
EW03	T	7	0	5.0E-04	5.0E-04	Yes	ND	ND
EW06	T	7	4	1.5E-02	1.1E-02	No	D	D
EW09	T	7	5	3.6E-03	3.3E-03	No	PD	D
EW10	T	6	0	5.0E-04	5.0E-04	Yes	ND	ND
EW13B	S	8	5	2.5E-03	2.7E-03	No	D	S
MW202A	T	7	7	1.7E-02	1.5E-02	No	S	S
MW203A	T	7	7	1.5E-02	1.5E-02	No	S	NT
MW205	S	2	2	1.4E-02	1.4E-02	No	N/A	N/A
MW206	T	5	0	5.0E-04	5.0E-04	Yes	ND	ND
MW211	T	7	0	5.0E-04	5.0E-04	Yes	ND	ND
MW213	T	1	0	5.0E-04	5.0E-04	Yes	ND	ND
MW3003	T	8	8	5.6E-03	5.7E-03	No	S	S
MW3004	T	7	0	5.0E-04	5.0E-04	Yes	ND	ND
MW3005	T	7	0	5.0E-04	5.0E-04	Yes	ND	ND
MW3006	T	2	1	1.3E-03	1.3E-03	No	N/A	N/A
MW3007	T	7	5	2.1E-03	2.5E-03	No	PD	D
MW3008	S	8	8	6.0E-02	5.3E-02	No	NT	PI
MW3009	S	8	8	6.2E-03	6.3E-03	No	NT	PI
MW3010	S	7	7	5.0E-02	5.9E-02	No	NT	NT
MW3011	T	7	6	2.4E-02	1.2E-02	No	NT	NT
MW5001	T	6	0	5.0E-04	5.0E-04	Yes	ND	ND
MW5002	T	6	0	5.0E-04	5.0E-04	Yes	ND	ND
MW5003	T	6	6	4.0E-03	3.7E-03	No	S	S
MW5004	T	6	0	5.0E-04	5.0E-04	Yes	ND	ND
MW8	T	2	2	2.5E-03	2.5E-03	No	N/A	N/A
MW9	T	7	0	5.0E-04	5.0E-04	Yes	ND	ND
PZ4002	S	8	8	1.0E-02	7.9E-03	No	D	D
PZ4003	T	6	6	5.5E-03	3.6E-03	No	D	D
PZ4004	T	7	0	5.0E-04	5.0E-04	Yes	ND	ND
1,1-DICHLOROETHENE								
CB10+	T	1	0	4.0E-04	4.0E-04	Yes	ND	ND
CB7-8	T	2	1	1.2E-03	1.2E-03	No	N/A	N/A
EW01	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
EW02	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
EW03	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
EW06	T	7	3	1.5E-03	4.0E-04	No	PD	D
EW09	T	7	5	5.0E-03	5.4E-03	No	PD	D
EW10	T	6	0	4.0E-04	4.0E-04	Yes	ND	ND
EW13B	S	8	2	1.7E-03	4.0E-04	No	NT	D
MW202A	T	7	4	2.1E-03	2.2E-03	No	S	S
MW203A	T	7	7	4.9E-03	5.1E-03	No	S	NT

MAROS Statistical Trend Analysis Summary

Well	Source/ Tail	Number of Samples	Number of Detects	Average Conc. (mg/L)	Median Conc. (mg/L)	All Samples "ND" ?	Mann-Kendall Trend	Linear Regression Trend
1,1-DICHLOROETHENE								
MW205	S	2	2	6.7E-03	6.7E-03	No	N/A	N/A
MW206	T	5	0	4.0E-04	4.0E-04	Yes	ND	ND
MW211	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
MW213	T	1	0	4.0E-04	4.0E-04	Yes	ND	ND
MW3003	T	8	8	1.5E-02	1.5E-02	No	I	I
MW3004	T	7	1	6.3E-04	4.0E-04	No	NT	NT
MW3005	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
MW3006	T	2	2	6.4E-03	6.4E-03	No	N/A	N/A
MW3007	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
MW3008	S	8	8	8.0E-02	7.0E-02	No	I	I
MW3009	S	8	8	6.3E-03	6.3E-03	No	PD	S
MW3010	S	7	7	1.4E-01	1.4E-01	No	S	NT
MW3011	T	7	5	6.1E-03	3.0E-03	No	NT	NT
MW5001	T	6	0	4.0E-04	4.0E-04	Yes	ND	ND
MW5002	T	6	0	4.0E-04	4.0E-04	Yes	ND	ND
MW5003	T	6	6	5.6E-03	4.9E-03	No	S	NT
MW5004	T	6	0	4.0E-04	4.0E-04	Yes	ND	ND
MW8	T	2	0	4.0E-04	4.0E-04	Yes	ND	ND
MW9	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
PZ4002	S	8	8	6.2E-03	5.5E-03	No	D	D
PZ4003	T	6	2	1.4E-03	4.0E-04	No	PD	D
PZ4004	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
CHLOROETHANE								
CB10+	T	1	0	2.0E-03	2.0E-03	Yes	ND	ND
CB7-8	T	2	0	2.0E-03	2.0E-03	Yes	ND	ND
EW01	T	7	0	2.0E-03	2.0E-03	Yes	ND	ND
EW02	T	7	0	2.0E-03	2.0E-03	Yes	ND	ND
EW03	T	7	0	2.0E-03	2.0E-03	Yes	ND	ND
EW06	T	7	0	2.0E-03	2.0E-03	Yes	ND	ND
EW09	T	7	0	2.0E-03	2.0E-03	Yes	ND	ND
EW10	T	6	0	2.0E-03	2.0E-03	Yes	ND	ND
EW13B	S	8	6	3.2E-03	3.0E-03	No	D	D
MW202A	T	7	3	2.3E-03	2.0E-03	No	S	PD
MW203A	T	7	7	4.9E-03	4.6E-03	No	S	S
MW205	S	2	1	2.2E-03	2.2E-03	No	N/A	N/A
MW206	T	5	0	2.0E-03	2.0E-03	Yes	ND	ND
MW211	T	7	0	2.0E-03	2.0E-03	Yes	ND	ND
MW213	T	1	0	2.0E-03	2.0E-03	Yes	ND	ND
MW3003	T	8	0	2.0E-03	2.0E-03	Yes	ND	ND
MW3004	T	7	0	2.0E-03	2.0E-03	Yes	ND	ND
MW3005	T	7	0	2.0E-03	2.0E-03	Yes	ND	ND
MW3006	T	2	0	2.0E-03	2.0E-03	Yes	ND	ND
MW3007	T	7	0	2.0E-03	2.0E-03	Yes	ND	ND
MW3008	S	8	8	4.2E-02	3.2E-02	No	PI	I
MW3009	S	8	5	2.7E-03	2.2E-03	No	NT	NT

MAROS Statistical Trend Analysis Summary

Well	Source/ Tail	Number of Samples	Number of Detects	Average Conc. (mg/L)	Median Conc. (mg/L)	All Samples "ND" ?	Mann-Kendall Trend	Linear Regression Trend
CHLOROETHANE								
MW3010	S	7	4	5.4E-03	3.8E-03	No	NT	NT
MW3011	T	7	2	3.2E-03	2.0E-03	No	NT	NT
MW5001	T	6	0	2.0E-03	2.0E-03	Yes	ND	ND
MW5002	T	6	0	2.0E-03	2.0E-03	Yes	ND	ND
MW5003	T	6	0	2.0E-03	2.0E-03	Yes	ND	ND
MW5004	T	6	0	2.0E-03	2.0E-03	Yes	ND	ND
MW8	T	2	0	2.0E-03	2.0E-03	Yes	ND	ND
MW9	T	7	0	2.0E-03	2.0E-03	Yes	ND	ND
PZ4002	S	8	0	2.0E-03	2.0E-03	Yes	ND	ND
PZ4003	T	6	0	2.0E-03	2.0E-03	Yes	ND	ND
PZ4004	T	7	0	2.0E-03	2.0E-03	Yes	ND	ND
TRICHLOROETHYLENE (TCE)								
CB10+	T	1	0	6.0E-04	6.0E-04	Yes	ND	ND
CB7-8	T	2	0	6.0E-04	6.0E-04	Yes	ND	ND
EW01	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND
EW02	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND
EW03	T	7	1	9.9E-04	6.0E-04	No	NT	D
EW06	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND
EW09	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND
EW10	T	6	0	6.0E-04	6.0E-04	Yes	ND	ND
EW13B	S	8	0	6.0E-04	6.0E-04	Yes	ND	ND
MW202A	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND
MW203A	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND
MW205	S	2	0	6.0E-04	6.0E-04	Yes	ND	ND
MW206	T	5	0	6.0E-04	6.0E-04	Yes	ND	ND
MW211	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND
MW213	T	1	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3003	T	8	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3004	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3005	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3006	T	2	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3007	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3008	S	8	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3009	S	8	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3010	S	7	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3011	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND
MW5001	T	6	0	6.0E-04	6.0E-04	Yes	ND	ND
MW5002	T	6	0	6.0E-04	6.0E-04	Yes	ND	ND
MW5003	T	6	0	6.0E-04	6.0E-04	Yes	ND	ND
MW5004	T	6	0	6.0E-04	6.0E-04	Yes	ND	ND
MW8	T	2	0	6.0E-04	6.0E-04	Yes	ND	ND
MW9	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND
PZ4002	S	8	0	6.0E-04	6.0E-04	Yes	ND	ND
PZ4003	T	6	0	6.0E-04	6.0E-04	Yes	ND	ND
PZ4004	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND

MAROS Statistical Trend Analysis Summary

Project: Kearsarge

Location: Conway

User Name: MV

State: New Hampshire

Time Period: 1/25/1983 **to** 4/30/2009

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: Specified Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Average Conc. (mg/L)	Median Conc. (mg/L)	All Samples "ND" ?	Mann-Kendall Trend	Linear Regression Trend
1,1,1-TRICHLOROETHANE								
CB10+	T	2	0	4.0E-04	4.0E-04	Yes	ND	ND
CB5-6	T	1	1	4.7E-02	4.7E-02	No	N/A	N/A
CB6-7	T	1	1	2.3E-02	2.3E-02	No	N/A	N/A
CB7-8	T	3	2	8.9E-03	3.2E-03	No	N/A	N/A
CB8-9	T	1	1	6.1E-03	6.1E-03	No	N/A	N/A
EW01	T	36	16	4.5E-03	4.0E-04	No	D	D
EW02	T	36	10	4.7E-03	4.0E-04	No	D	D
EW03	T	34	17	3.2E-03	1.3E-03	No	D	D
EW06	T	22	13	1.3E-02	3.1E-03	No	NT	NT
EW09	T	33	27	1.3E+00	9.5E-03	No	D	D
EW10	T	8	8	5.1E-03	4.8E-03	No	S	S
EW13B	S	14	6	1.3E-02	4.0E-04	No	D	D
MW202A	T	10	5	2.6E-03	1.4E-03	No	NT	NT
MW203A	T	13	9	2.4E-03	2.4E-03	No	NT	S
MW205	S	31	31	2.4E-01	1.0E-01	No	D	D
MW206	T	8	0	4.0E-04	4.0E-04	Yes	ND	ND
MW211	T	34	11	8.8E-03	4.0E-04	No	D	D
MW213	T	27	1	6.9E-04	4.0E-04	No	NT	I
MW3003	T	12	12	2.6E-02	2.3E-02	No	I	I
MW3004	T	10	4	1.3E-03	4.0E-04	No	NT	NT
MW3005	T	10	0	4.0E-04	4.0E-04	Yes	ND	ND
MW3006	T	7	7	8.2E-03	5.9E-03	No	NT	I
MW3007	T	10	0	4.0E-04	4.0E-04	Yes	ND	ND
MW3008	S	12	11	3.2E-02	2.3E-02	No	I	I
MW3009	S	13	13	4.6E-02	1.6E-02	No	D	D
MW3010	S	9	7	1.9E-01	2.0E-01	No	NT	I
MW3011	T	12	2	8.4E-04	4.0E-04	No	NT	NT
MW5001	T	6	0	4.0E-04	4.0E-04	Yes	ND	ND
MW5002	T	6	0	4.0E-04	4.0E-04	Yes	ND	ND
MW5003	T	6	5	1.4E-02	1.4E-02	No	NT	NT
MW5004	T	6	0	4.0E-04	4.0E-04	Yes	ND	ND
MW8	T	18	10	3.4E-03	4.0E-03	No	NT	NT
MW9	T	21	0	4.0E-04	4.0E-04	Yes	ND	ND
PZ4002	S	10	10	6.9E-02	6.0E-02	No	D	D
PZ4003	T	6	6	1.1E-02	6.1E-03	No	PD	D

MAROS Statistical Trend Analysis Summary

Well	Source/ Tail	Number of Samples	Number of Detects	Average Conc. (mg/L)	Median Conc. (mg/L)	All Samples "ND" ?	Mann-Kendall Trend	Linear Regression Trend
1,1,1-TRICHLOROETHANE								
PZ4004	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
1,1-DICHLOROETHANE								
CB10+	T	2	0	5.0E-04	5.0E-04	Yes	ND	ND
CB5-6	T	1	1	1.1E-02	1.1E-02	No	N/A	N/A
CB6-7	T	1	1	1.9E-02	1.9E-02	No	N/A	N/A
CB7-8	T	3	1	2.1E-03	5.0E-04	No	N/A	N/A
CB8-9	T	1	0	5.0E-04	5.0E-04	Yes	ND	ND
EW01	T	36	0	5.0E-04	5.0E-04	Yes	ND	ND
EW02	T	36	2	5.7E-04	5.0E-04	No	S	S
EW03	T	34	0	5.0E-04	5.0E-04	Yes	ND	ND
EW06	T	22	15	1.7E-02	1.1E-02	No	NT	NT
EW09	T	33	13	1.0E-01	5.0E-04	No	NT	D
EW10	T	8	0	5.0E-04	5.0E-04	Yes	ND	ND
EW13B	S	14	11	2.4E-02	4.7E-03	No	D	D
MW202A	T	10	8	1.3E-02	1.1E-02	No	NT	PI
MW203A	T	13	12	1.2E-02	1.3E-02	No	NT	I
MW205	S	31	22	1.0E-02	6.4E-03	No	D	NT
MW206	T	8	0	5.0E-04	5.0E-04	Yes	ND	ND
MW211	T	34	15	1.6E-03	5.0E-04	No	S	PD
MW213	T	27	0	5.0E-04	5.0E-04	Yes	ND	ND
MW3003	T	12	9	4.1E-03	4.7E-03	No	I	I
MW3004	T	10	0	5.0E-04	5.0E-04	Yes	ND	ND
MW3005	T	10	0	5.0E-04	5.0E-04	Yes	ND	ND
MW3006	T	7	1	7.1E-04	5.0E-04	No	NT	I
MW3007	T	10	7	2.4E-03	2.6E-03	No	S	S
MW3008	S	12	10	4.2E-02	2.8E-02	No	I	I
MW3009	S	13	13	7.8E-03	7.4E-03	No	S	S
MW3010	S	9	7	3.9E-02	4.0E-02	No	I	I
MW3011	T	12	9	1.6E-02	7.5E-03	No	NT	NT
MW5001	T	6	0	5.0E-04	5.0E-04	Yes	ND	ND
MW5002	T	6	0	5.0E-04	5.0E-04	Yes	ND	ND
MW5003	T	6	6	4.0E-03	3.7E-03	No	S	S
MW5004	T	6	0	5.0E-04	5.0E-04	Yes	ND	ND
MW8	T	18	7	1.1E-03	5.0E-04	No	I	PI
MW9	T	21	0	5.0E-04	5.0E-04	Yes	ND	ND
PZ4002	S	10	10	1.2E-02	1.0E-02	No	D	D
PZ4003	T	6	6	5.5E-03	3.6E-03	No	D	D
PZ4004	T	7	0	5.0E-04	5.0E-04	Yes	ND	ND
1,1-DICHLOROETHENE								
CB10+	T	2	0	4.0E-04	4.0E-04	Yes	ND	ND
CB5-6	T	1	1	5.4E-03	5.4E-03	No	N/A	N/A
CB6-7	T	1	1	4.1E-03	4.1E-03	No	N/A	N/A
CB7-8	T	3	2	2.3E-03	2.0E-03	No	N/A	N/A
CB8-9	T	1	0	4.0E-04	4.0E-04	Yes	ND	ND

MAROS Statistical Trend Analysis Summary

Well	Source/ Tail	Number of Samples	Number of Detects	Average Conc. (mg/L)	Median Conc. (mg/L)	All Samples "ND" ?	Mann-Kendall Trend	Linear Regression Trend
1,1-DICHLOROETHENE								
EW01	T	36	4	6.9E-04	4.0E-04	No	D	D
EW02	T	36	5	7.8E-04	4.0E-04	No	D	D
EW03	T	34	3	5.0E-04	4.0E-04	No	S	D
EW06	T	22	7	3.6E-03	4.0E-04	No	NT	NT
EW09	T	33	17	8.5E-02	2.4E-03	No	NT	D
EW10	T	8	0	4.0E-04	4.0E-04	Yes	ND	ND
EW13B	S	14	7	1.6E-02	1.4E-03	No	D	D
MW202A	T	10	4	1.6E-03	4.0E-04	No	NT	NT
MW203A	T	13	8	4.2E-03	3.7E-03	No	NT	I
MW205	S	31	30	3.1E-02	1.9E-02	No	D	D
MW206	T	8	0	4.0E-04	4.0E-04	Yes	ND	ND
MW211	T	34	2	1.1E-03	4.0E-04	No	NT	D
MW213	T	27	0	4.0E-04	4.0E-04	Yes	ND	ND
MW3003	T	12	12	1.2E-02	1.2E-02	No	I	I
MW3004	T	10	1	5.6E-04	4.0E-04	No	NT	NT
MW3005	T	10	0	4.0E-04	4.0E-04	Yes	ND	ND
MW3006	T	7	6	3.4E-03	2.6E-03	No	PI	PI
MW3007	T	10	0	4.0E-04	4.0E-04	Yes	ND	ND
MW3008	S	12	11	5.5E-02	2.5E-02	No	I	I
MW3009	S	13	11	1.2E-02	7.2E-03	No	PD	NT
MW3010	S	9	7	1.1E-01	1.1E-01	No	NT	I
MW3011	T	12	6	3.9E-03	1.5E-03	No	PI	PI
MW5001	T	6	0	4.0E-04	4.0E-04	Yes	ND	ND
MW5002	T	6	0	4.0E-04	4.0E-04	Yes	ND	ND
MW5003	T	6	6	5.6E-03	4.9E-03	No	S	NT
MW5004	T	6	0	4.0E-04	4.0E-04	Yes	ND	ND
MW8	T	18	0	4.0E-04	4.0E-04	Yes	ND	ND
MW9	T	21	0	4.0E-04	4.0E-04	Yes	ND	ND
PZ4002	S	10	10	7.5E-03	7.2E-03	No	D	D
PZ4003	T	6	2	1.4E-03	4.0E-04	No	PD	D
PZ4004	T	7	0	4.0E-04	4.0E-04	Yes	ND	ND
CHLOROETHANE								
CB10+	T	1	0	2.0E-03	2.0E-03	Yes	ND	ND
CB7-8	T	2	0	2.0E-03	2.0E-03	Yes	ND	ND
EW01	T	18	0	2.0E-03	2.0E-03	Yes	ND	ND
EW02	T	19	0	2.0E-03	2.0E-03	Yes	ND	ND
EW03	T	18	0	2.0E-03	2.0E-03	Yes	ND	ND
EW06	T	19	3	2.5E-03	2.0E-03	No	S	D
EW09	T	18	0	2.0E-03	2.0E-03	Yes	ND	ND
EW10	T	7	0	2.0E-03	2.0E-03	Yes	ND	ND
EW13B	S	14	11	7.2E-03	3.9E-03	No	D	D
MW202A	T	10	3	2.2E-03	2.0E-03	No	NT	I
MW203A	T	13	11	3.8E-03	3.1E-03	No	NT	I
MW205	S	15	1	2.0E-03	2.0E-03	No	NT	NT
MW206	T	6	0	2.0E-03	2.0E-03	Yes	ND	ND

MAROS Statistical Trend Analysis Summary

Well	Source/ Tail	Number of Samples	Number of Detects	Average Conc. (mg/L)	Median Conc. (mg/L)	All Samples "ND" ?	Mann-Kendall Trend	Linear Regression Trend
CHLOROETHANE								
MW211	T	18	0	2.0E-03	2.0E-03	Yes	ND	ND
MW213	T	11	0	2.0E-03	2.0E-03	Yes	ND	ND
MW3003	T	12	0	2.0E-03	2.0E-03	Yes	ND	ND
MW3004	T	10	0	2.0E-03	2.0E-03	Yes	ND	ND
MW3005	T	10	0	2.0E-03	2.0E-03	Yes	ND	ND
MW3006	T	7	0	2.0E-03	2.0E-03	Yes	ND	ND
MW3007	T	10	1	2.7E-03	2.0E-03	No	S	PD
MW3008	S	12	9	3.0E-02	1.9E-02	No	I	I
MW3009	S	13	6	2.9E-03	2.0E-03	No	NT	D
MW3010	S	9	4	4.6E-03	2.0E-03	No	PI	I
MW3011	T	12	2	2.7E-03	2.0E-03	No	NT	NT
MW5001	T	6	0	2.0E-03	2.0E-03	Yes	ND	ND
MW5002	T	6	0	2.0E-03	2.0E-03	Yes	ND	ND
MW5003	T	6	0	2.0E-03	2.0E-03	Yes	ND	ND
MW5004	T	6	0	2.0E-03	2.0E-03	Yes	ND	ND
MW8	T	5	0	2.0E-03	2.0E-03	Yes	ND	ND
MW9	T	8	0	2.0E-03	2.0E-03	Yes	ND	ND
PZ4002	S	10	0	2.0E-03	2.0E-03	Yes	ND	ND
PZ4003	T	6	0	2.0E-03	2.0E-03	Yes	ND	ND
PZ4004	T	7	0	2.0E-03	2.0E-03	Yes	ND	ND
TRICHLOROETHYLENE (TCE)								
CB10+	T	2	0	6.0E-04	6.0E-04	Yes	ND	ND
CB5-6	T	1	0	6.0E-04	6.0E-04	Yes	ND	ND
CB6-7	T	1	0	6.0E-04	6.0E-04	Yes	ND	ND
CB7-8	T	3	0	6.0E-04	6.0E-04	Yes	ND	ND
CB8-9	T	1	0	6.0E-04	6.0E-04	Yes	ND	ND
EW01	T	36	4	3.4E-03	6.0E-04	No	D	D
EW02	T	36	7	5.0E-03	6.0E-04	No	D	D
EW03	T	34	17	7.3E-03	1.4E-03	No	D	D
EW06	T	22	0	6.0E-04	6.0E-04	Yes	ND	ND
EW09	T	33	0	6.0E-04	6.0E-04	Yes	ND	ND
EW10	T	8	0	6.0E-04	6.0E-04	Yes	ND	ND
EW13B	S	14	0	6.0E-04	6.0E-04	Yes	ND	ND
MW202A	T	10	0	6.0E-04	6.0E-04	Yes	ND	ND
MW203A	T	13	0	6.0E-04	6.0E-04	Yes	ND	ND
MW205	S	31	1	9.0E-04	6.0E-04	No	NT	PD
MW206	T	8	0	6.0E-04	6.0E-04	Yes	ND	ND
MW211	T	34	22	8.0E-02	9.5E-03	No	D	D
MW213	T	27	6	2.0E-02	6.0E-04	No	D	D
MW3003	T	12	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3004	T	10	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3005	T	10	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3006	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3007	T	10	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3008	S	12	0	6.0E-04	6.0E-04	Yes	ND	ND

MAROS Statistical Trend Analysis Summary

Well	Source/ Tail	Number of Samples	Number of Detects	Average Conc. (mg/L)	Median Conc. (mg/L)	All Samples "ND" ?	Mann-Kendall Trend	Linear Regression Trend
TRICHLOROETHYLENE (TCE)								
MW3009	S	13	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3010	S	9	0	6.0E-04	6.0E-04	Yes	ND	ND
MW3011	T	12	0	6.0E-04	6.0E-04	Yes	ND	ND
MW5001	T	6	0	6.0E-04	6.0E-04	Yes	ND	ND
MW5002	T	6	0	6.0E-04	6.0E-04	Yes	ND	ND
MW5003	T	6	0	6.0E-04	6.0E-04	Yes	ND	ND
MW5004	T	6	0	6.0E-04	6.0E-04	Yes	ND	ND
MW8	T	18	1	8.4E-04	6.0E-04	No	NT	NT
MW9	T	21	1	8.1E-04	6.0E-04	No	NT	NT
PZ4002	S	10	0	6.0E-04	6.0E-04	Yes	ND	ND
PZ4003	T	6	0	6.0E-04	6.0E-04	Yes	ND	ND
PZ4004	T	7	0	6.0E-04	6.0E-04	Yes	ND	ND

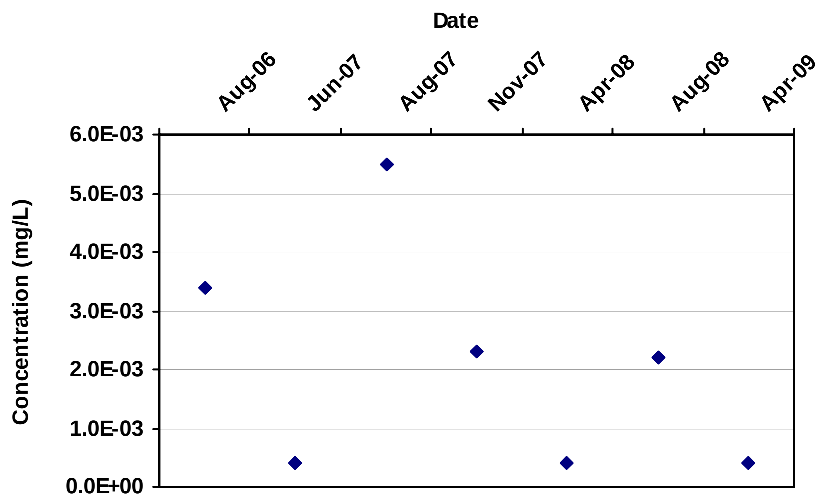
Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); No Detectable Concentration (NDC)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Well: MW202A
Well Type: T
COC: 1,1-DICHLOROETHENE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -8

Confidence in Trend: 84.5%

Coefficient of Variation: 0.92

Mann Kendall Concentration Trend: (See Note) S

Data Table:

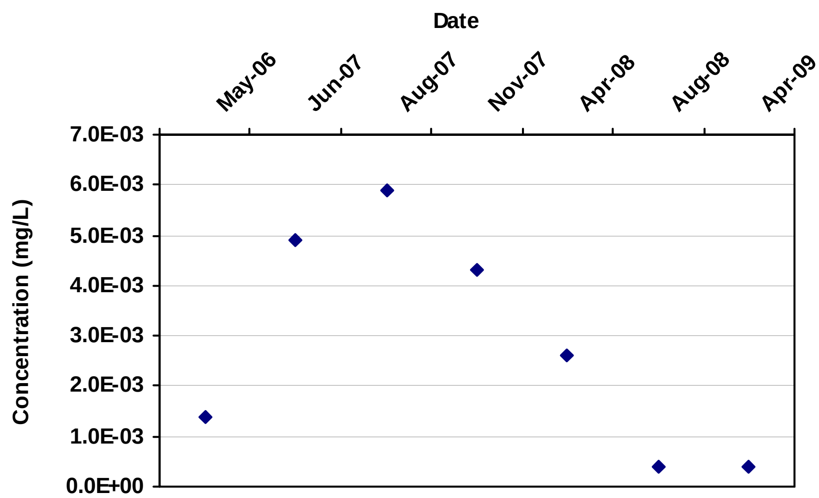
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW202A	T	8/21/2006	1,1-DICHLOROETHENE	3.4E-03		1	1
MW202A	T	6/19/2007	1,1-DICHLOROETHENE	4.0E-04	ND	1	0
MW202A	T	8/15/2007	1,1-DICHLOROETHENE	5.5E-03		1	1
MW202A	T	11/28/2007	1,1-DICHLOROETHENE	2.3E-03		1	1
MW202A	T	4/17/2008	1,1-DICHLOROETHENE	4.0E-04	ND	1	0
MW202A	T	8/13/2008	1,1-DICHLOROETHENE	2.2E-03		1	1
MW202A	T	4/30/2009	1,1-DICHLOROETHENE	4.0E-04	ND	1	0

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW203A
Well Type: T
COC: 1,1,1-TRICHLOROETHANE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -10

Confidence in Trend: 90.7%

Coefficient of Variation: 0.78

Mann Kendall Concentration Trend: (See Note) PD

Data Table:

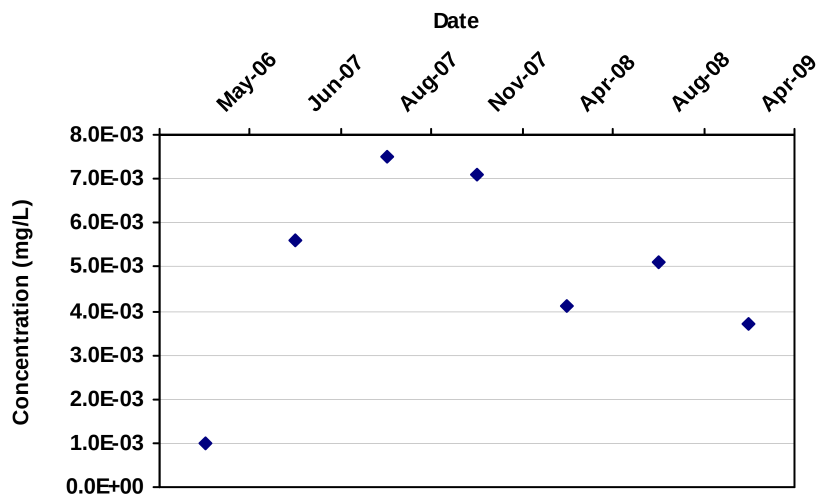
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW203A	T	5/1/2006	1,1,1-TRICHLOROETHANE	1.4E-03		3	1
MW203A	T	6/19/2007	1,1,1-TRICHLOROETHANE	4.9E-03		1	1
MW203A	T	8/15/2007	1,1,1-TRICHLOROETHANE	5.9E-03		1	1
MW203A	T	11/28/2007	1,1,1-TRICHLOROETHANE	4.3E-03		1	1
MW203A	T	4/17/2008	1,1,1-TRICHLOROETHANE	2.6E-03		1	1
MW203A	T	8/13/2008	1,1,1-TRICHLOROETHANE	4.0E-04	ND	1	0
MW203A	T	4/30/2009	1,1,1-TRICHLOROETHANE	4.0E-04	ND	1	0

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW203A
Well Type: T
COC: 1,1-DICHLOROETHENE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -3

Confidence in Trend: 61.4%

Coefficient of Variation: 0.45

Mann Kendall Concentration Trend: (See Note) S

Data Table:

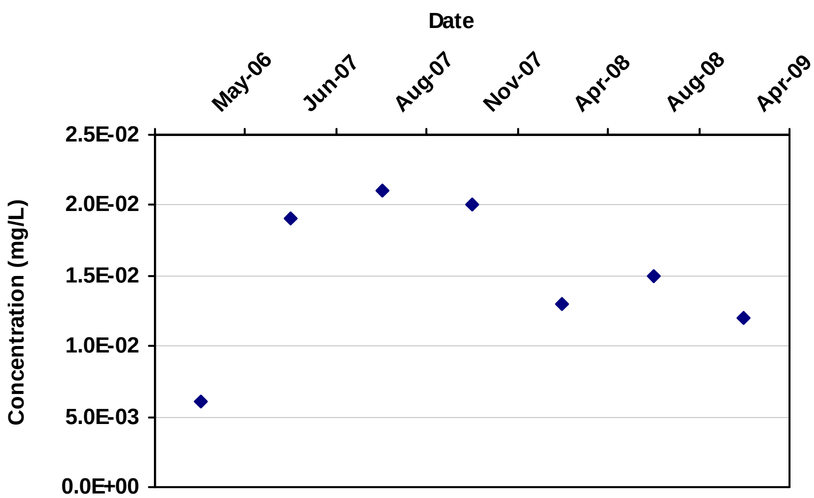
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW203A	T	5/1/2006	1,1-DICHLOROETHENE	1.0E-03		3	1
MW203A	T	6/19/2007	1,1-DICHLOROETHENE	5.6E-03		1	1
MW203A	T	8/15/2007	1,1-DICHLOROETHENE	7.5E-03		1	1
MW203A	T	11/28/2007	1,1-DICHLOROETHENE	7.1E-03		1	1
MW203A	T	4/17/2008	1,1-DICHLOROETHENE	4.1E-03		1	1
MW203A	T	8/13/2008	1,1-DICHLOROETHENE	5.1E-03		1	1
MW203A	T	4/30/2009	1,1-DICHLOROETHENE	3.7E-03		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW203A
Well Type: T
COC: 1,1-DICHLOROETHANE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic:

-3

Confidence in Trend:

61.4%

Coefficient of Variation:

0.35

Mann Kendall Concentration Trend: (See Note)

S

Data Table:

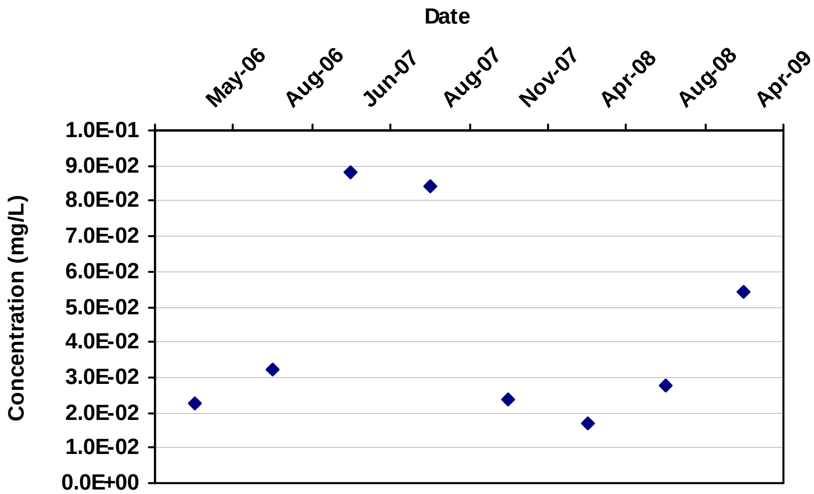
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW203A	T	5/1/2006	1,1-DICHLOROETHANE	6.0E-03		3	3
MW203A	T	6/19/2007	1,1-DICHLOROETHANE	1.9E-02		1	1
MW203A	T	8/15/2007	1,1-DICHLOROETHANE	2.1E-02		1	1
MW203A	T	11/28/2007	1,1-DICHLOROETHANE	2.0E-02		1	1
MW203A	T	4/17/2008	1,1-DICHLOROETHANE	1.3E-02		1	1
MW203A	T	8/13/2008	1,1-DICHLOROETHANE	1.5E-02		1	1
MW203A	T	4/30/2009	1,1-DICHLOROETHANE	1.2E-02		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3008
Well Type: S
COC: 1,1,1-TRICHLOROETHANE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: 0

Confidence in Trend: 45.2%

Coefficient of Variation: 0.65

Mann Kendall Concentration Trend: (See Note) S

Data Table:

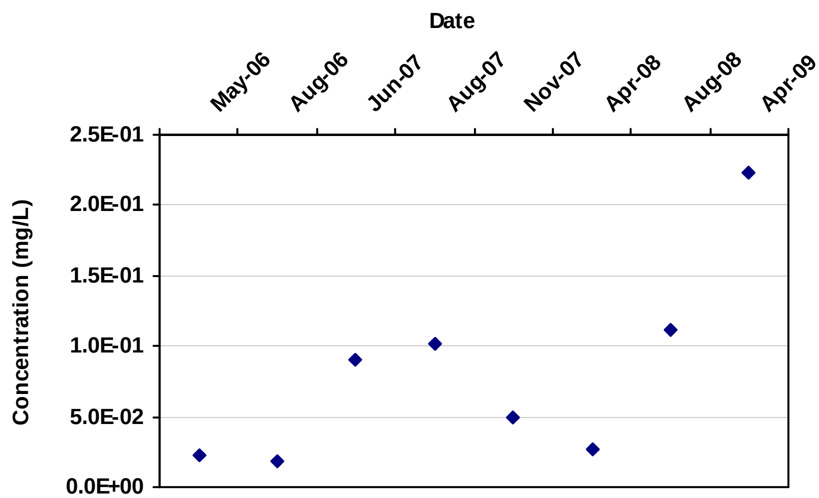
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3008	S	5/1/2006	1,1,1-TRICHLOROETHANE	2.2E-02		3	3
MW3008	S	8/21/2006	1,1,1-TRICHLOROETHANE	3.2E-02		1	1
MW3008	S	6/19/2007	1,1,1-TRICHLOROETHANE	8.8E-02		1	1
MW3008	S	8/15/2007	1,1,1-TRICHLOROETHANE	8.4E-02		1	1
MW3008	S	11/28/2007	1,1,1-TRICHLOROETHANE	2.4E-02		2	2
MW3008	S	4/17/2008	1,1,1-TRICHLOROETHANE	1.7E-02		2	2
MW3008	S	8/13/2008	1,1,1-TRICHLOROETHANE	2.8E-02		2	2
MW3008	S	4/30/2009	1,1,1-TRICHLOROETHANE	5.5E-02		2	2

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3008
Well Type: S
COC: 1,1-DICHLOROETHENE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: 16

Confidence in Trend: 96.9%

Coefficient of Variation: 0.85

Mann Kendall Concentration Trend: (See Note) I

Data Table:

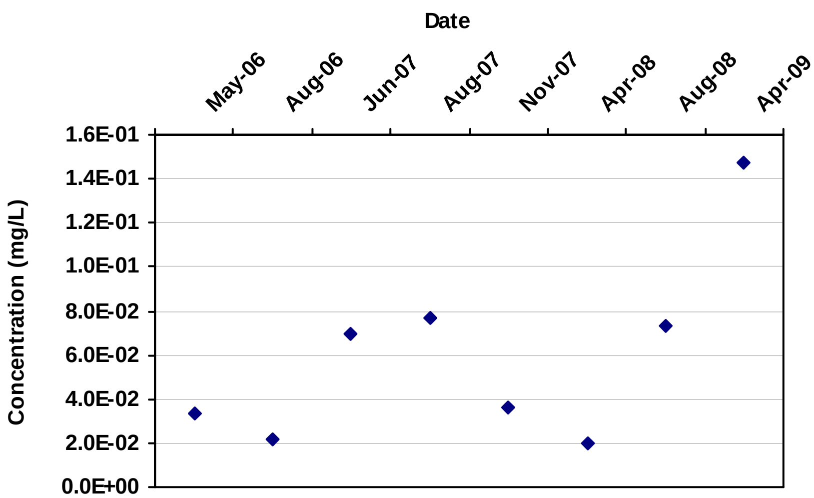
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3008	S	5/1/2006	1,1-DICHLOROETHENE	2.3E-02		3	3
MW3008	S	8/21/2006	1,1-DICHLOROETHENE	1.8E-02		1	1
MW3008	S	6/19/2007	1,1-DICHLOROETHENE	9.0E-02		1	1
MW3008	S	8/15/2007	1,1-DICHLOROETHENE	1.0E-01		1	1
MW3008	S	11/28/2007	1,1-DICHLOROETHENE	5.0E-02		2	2
MW3008	S	4/17/2008	1,1-DICHLOROETHENE	2.7E-02		2	2
MW3008	S	8/13/2008	1,1-DICHLOROETHENE	1.1E-01		2	2
MW3008	S	4/30/2009	1,1-DICHLOROETHENE	2.2E-01		2	2

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3008
Well Type: S
COC: 1,1-DICHLOROETHANE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: 10

Confidence in Trend: 86.2%

Coefficient of Variation: 0.71

Mann Kendall Concentration Trend: (See Note) NT

Data Table:

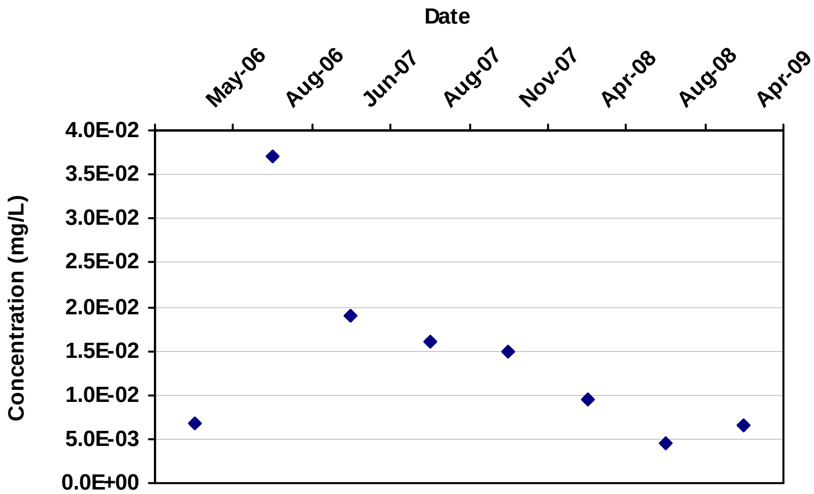
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3008	S	5/1/2006	1,1-DICHLOROETHANE	3.3E-02		3	3
MW3008	S	8/21/2006	1,1-DICHLOROETHANE	2.2E-02		1	1
MW3008	S	6/19/2007	1,1-DICHLOROETHANE	7.0E-02		1	1
MW3008	S	8/15/2007	1,1-DICHLOROETHANE	7.7E-02		1	1
MW3008	S	11/28/2007	1,1-DICHLOROETHANE	3.7E-02		2	2
MW3008	S	4/17/2008	1,1-DICHLOROETHANE	2.0E-02		2	2
MW3008	S	8/13/2008	1,1-DICHLOROETHANE	7.4E-02		2	2
MW3008	S	4/30/2009	1,1-DICHLOROETHANE	1.5E-01		2	2

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3009
Well Type: S
COC: 1,1,1-TRICHLOROETHANE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -16

Confidence in Trend: 96.9%

Coefficient of Variation: 0.73

Mann Kendall Concentration Trend: (See Note) D

Data Table:

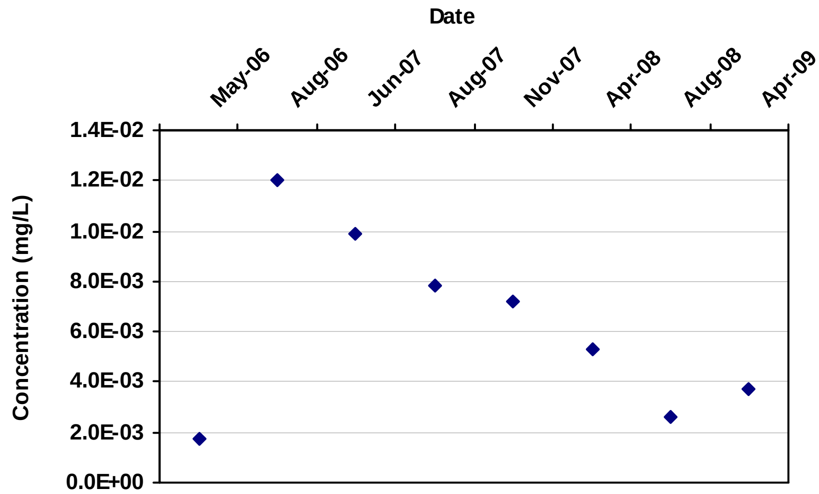
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3009	S	5/1/2006	1,1,1-TRICHLOROETHANE	6.9E-03		3	3
MW3009	S	8/21/2006	1,1,1-TRICHLOROETHANE	3.7E-02		1	1
MW3009	S	6/19/2007	1,1,1-TRICHLOROETHANE	1.9E-02		1	1
MW3009	S	8/15/2007	1,1,1-TRICHLOROETHANE	1.6E-02		2	2
MW3009	S	11/28/2007	1,1,1-TRICHLOROETHANE	1.5E-02		1	1
MW3009	S	4/17/2008	1,1,1-TRICHLOROETHANE	9.4E-03		1	1
MW3009	S	8/13/2008	1,1,1-TRICHLOROETHANE	4.6E-03		1	1
MW3009	S	4/30/2009	1,1,1-TRICHLOROETHANE	6.6E-03		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3009
Well Type: S
COC: 1,1-DICHLOROETHENE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -12

Confidence in Trend: 91.1%

Coefficient of Variation: 0.57

Mann Kendall Concentration Trend: (See Note) PD

Data Table:

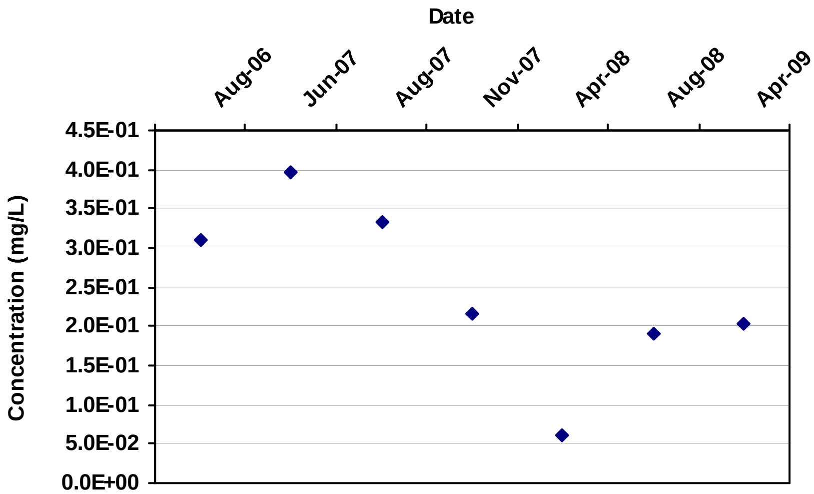
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3009	S	5/1/2006	1,1-DICHLOROETHENE	1.8E-03		3	2
MW3009	S	8/21/2006	1,1-DICHLOROETHENE	1.2E-02		1	1
MW3009	S	6/19/2007	1,1-DICHLOROETHENE	9.9E-03		1	1
MW3009	S	8/15/2007	1,1-DICHLOROETHENE	7.8E-03		2	2
MW3009	S	11/28/2007	1,1-DICHLOROETHENE	7.2E-03		1	1
MW3009	S	4/17/2008	1,1-DICHLOROETHENE	5.3E-03		1	1
MW3009	S	8/13/2008	1,1-DICHLOROETHENE	2.6E-03		1	1
MW3009	S	4/30/2009	1,1-DICHLOROETHENE	3.7E-03		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3010
Well Type: S
COC: 1,1,1-TRICHLOROETHANE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -11

Confidence in Trend: 93.2%

Coefficient of Variation: 0.46

Mann Kendall Concentration Trend: (See Note) PD

Data Table:

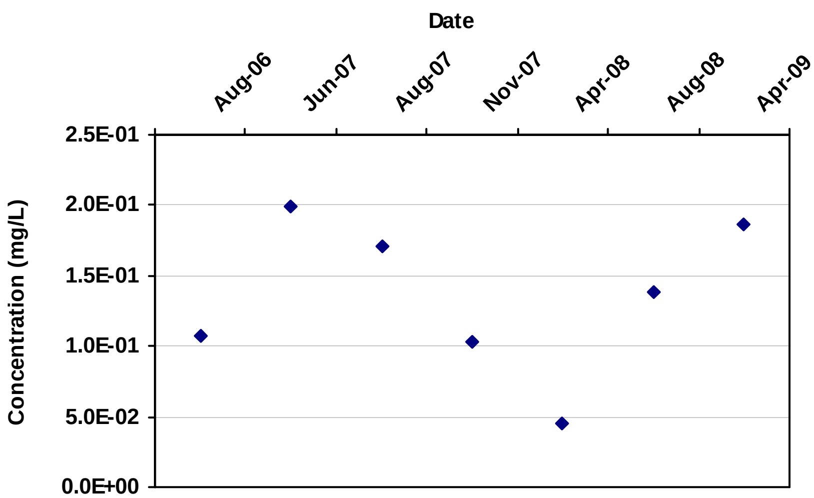
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3010	S	8/21/2006	1,1,1-TRICHLOROETHANE	3.1E-01		3	3
MW3010	S	6/19/2007	1,1,1-TRICHLOROETHANE	4.0E-01		2	2
MW3010	S	8/15/2007	1,1,1-TRICHLOROETHANE	3.3E-01		2	2
MW3010	S	11/28/2007	1,1,1-TRICHLOROETHANE	2.2E-01		2	2
MW3010	S	4/17/2008	1,1,1-TRICHLOROETHANE	6.2E-02		2	2
MW3010	S	8/13/2008	1,1,1-TRICHLOROETHANE	1.9E-01		2	2
MW3010	S	4/30/2009	1,1,1-TRICHLOROETHANE	2.0E-01		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3010
Well Type: S
COC: 1,1-DICHLOROETHENE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -1

Confidence in Trend: 50.0%

Coefficient of Variation: 0.41

Mann Kendall Concentration Trend: (See Note) S

Data Table:

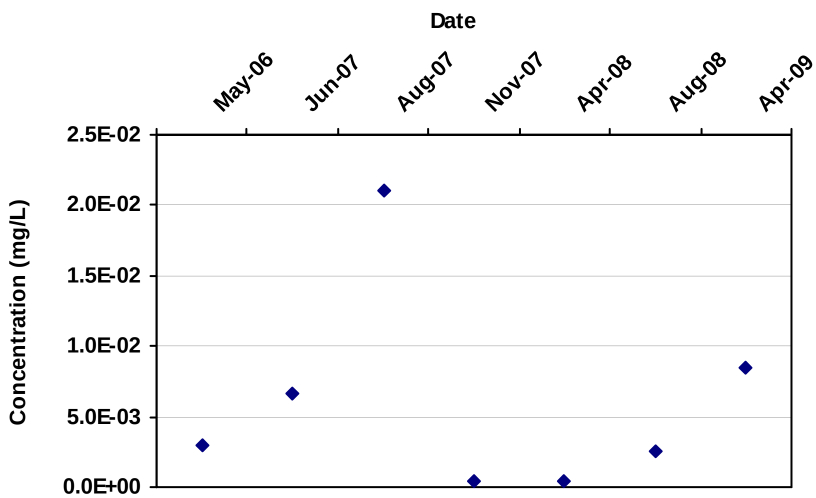
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3010	S	8/21/2006	1,1-DICHLOROETHENE	1.1E-01		3	3
MW3010	S	6/19/2007	1,1-DICHLOROETHENE	2.0E-01		2	2
MW3010	S	8/15/2007	1,1-DICHLOROETHENE	1.7E-01		2	2
MW3010	S	11/28/2007	1,1-DICHLOROETHENE	1.0E-01		2	2
MW3010	S	4/17/2008	1,1-DICHLOROETHENE	4.5E-02		2	2
MW3010	S	8/13/2008	1,1-DICHLOROETHENE	1.4E-01		2	2
MW3010	S	4/30/2009	1,1-DICHLOROETHENE	1.9E-01		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3011
Well Type: T
COC: 1,1-DICHLOROETHENE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: 0

Confidence in Trend: 43.7%

Coefficient of Variation: 1.20

Mann Kendall Concentration Trend: (See Note) NT

Data Table:

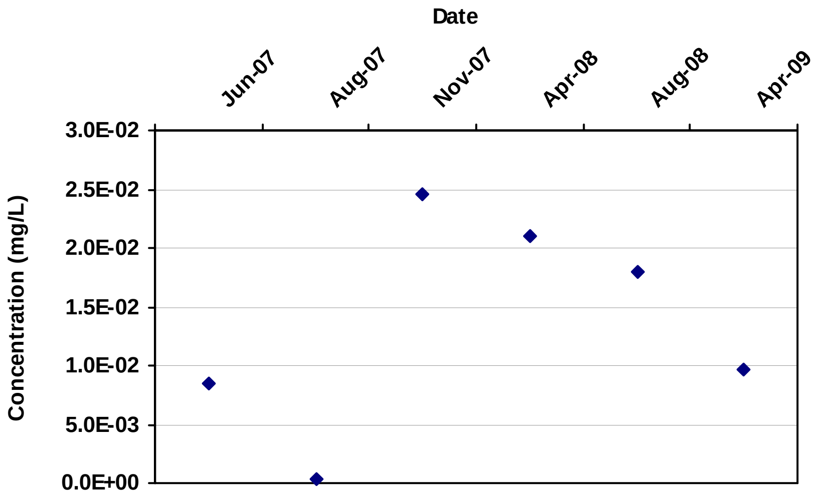
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3011	T	5/1/2006	1,1-DICHLOROETHENE	3.0E-03		3	2
MW3011	T	6/19/2007	1,1-DICHLOROETHENE	6.6E-03		1	1
MW3011	T	8/15/2007	1,1-DICHLOROETHENE	2.1E-02		1	1
MW3011	T	11/28/2007	1,1-DICHLOROETHENE	4.0E-04	ND	1	0
MW3011	T	4/17/2008	1,1-DICHLOROETHENE	4.0E-04	ND	1	0
MW3011	T	8/13/2008	1,1-DICHLOROETHENE	2.5E-03		1	1
MW3011	T	4/30/2009	1,1-DICHLOROETHENE	8.5E-03		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW5003
Well Type: T
COC: 1,1,1-TRICHLOROETHANE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: 1

Confidence in Trend: 50.0%

Coefficient of Variation: 0.66

Mann Kendall Concentration Trend: (See Note) NT

Data Table:

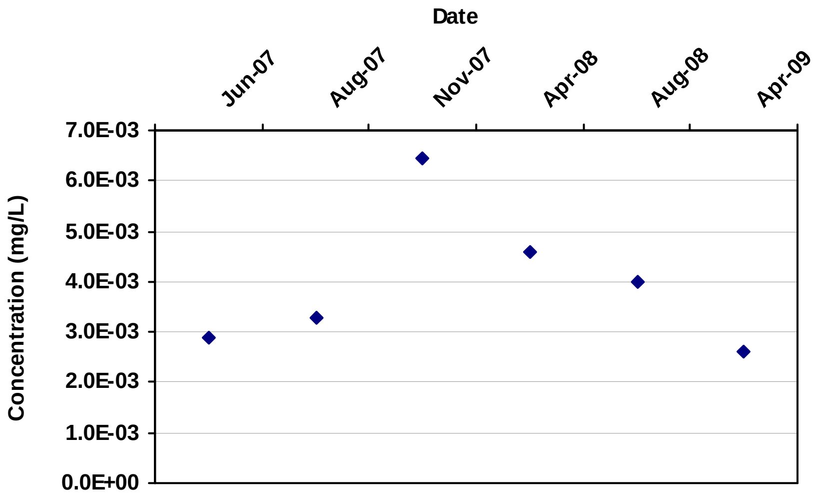
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW5003	T	6/19/2007	1,1,1-TRICHLOROETHANE	8.5E-03		1	1
MW5003	T	8/15/2007	1,1,1-TRICHLOROETHANE	4.0E-04	ND	1	0
MW5003	T	11/28/2007	1,1,1-TRICHLOROETHANE	2.5E-02		2	2
MW5003	T	4/17/2008	1,1,1-TRICHLOROETHANE	2.1E-02		1	1
MW5003	T	8/13/2008	1,1,1-TRICHLOROETHANE	1.8E-02		1	1
MW5003	T	4/30/2009	1,1,1-TRICHLOROETHANE	9.7E-03		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW5003
Well Type: T
COC: 1,1-DICHLOROETHANE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -1

Confidence in Trend: 50.0%

Coefficient of Variation: 0.36

Mann Kendall Concentration Trend: (See Note) S

Data Table:

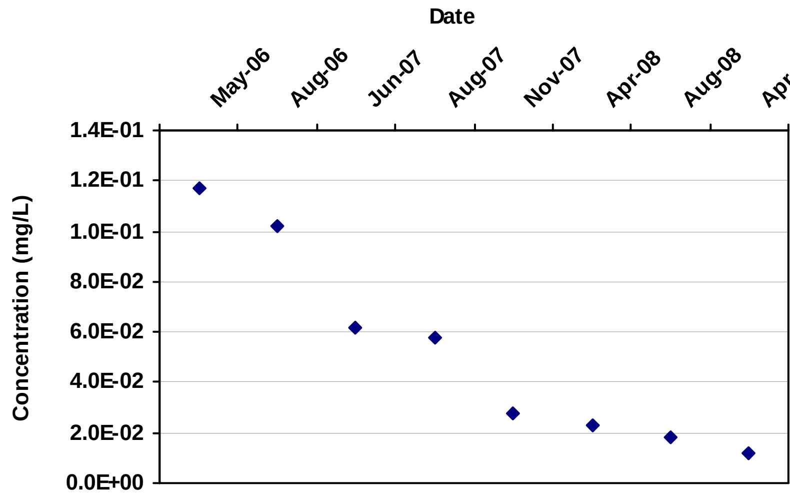
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW5003	T	6/19/2007	1,1-DICHLOROETHANE	2.9E-03		1	1
MW5003	T	8/15/2007	1,1-DICHLOROETHANE	3.3E-03		1	1
MW5003	T	11/28/2007	1,1-DICHLOROETHANE	6.5E-03		2	2
MW5003	T	4/17/2008	1,1-DICHLOROETHANE	4.6E-03		1	1
MW5003	T	8/13/2008	1,1-DICHLOROETHANE	4.0E-03		1	1
MW5003	T	4/30/2009	1,1-DICHLOROETHANE	2.6E-03		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: PZ4002
Well Type: S
COC: 1,1,1-TRICHLOROETHANE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -28

Confidence in Trend: 100.0%

Coefficient of Variation: 0.76

Mann Kendall Concentration Trend: (See Note) D

Data Table:

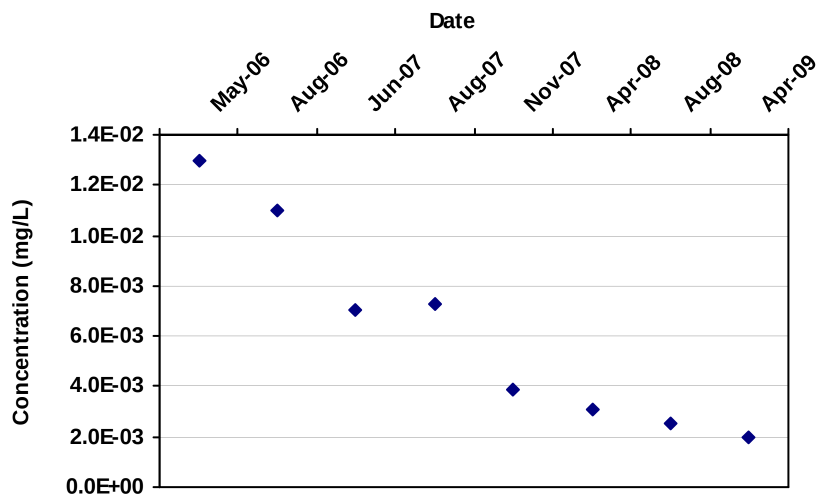
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
PZ4002	S	5/1/2006	1,1,1-TRICHLOROETHANE	1.2E-01		3	3
PZ4002	S	8/21/2006	1,1,1-TRICHLOROETHANE	1.0E-01		1	1
PZ4002	S	6/19/2007	1,1,1-TRICHLOROETHANE	6.2E-02		1	1
PZ4002	S	8/15/2007	1,1,1-TRICHLOROETHANE	5.8E-02		1	1
PZ4002	S	11/28/2007	1,1,1-TRICHLOROETHANE	2.8E-02		1	1
PZ4002	S	4/17/2008	1,1,1-TRICHLOROETHANE	2.3E-02		1	1
PZ4002	S	8/13/2008	1,1,1-TRICHLOROETHANE	1.8E-02		1	1
PZ4002	S	4/30/2009	1,1,1-TRICHLOROETHANE	1.2E-02		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: PZ4002
Well Type: S
COC: 1,1-DICHLOROETHENE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -26

Confidence in Trend: 100.0%

Coefficient of Variation: 0.66

Mann Kendall Concentration Trend: (See Note) D

Data Table:

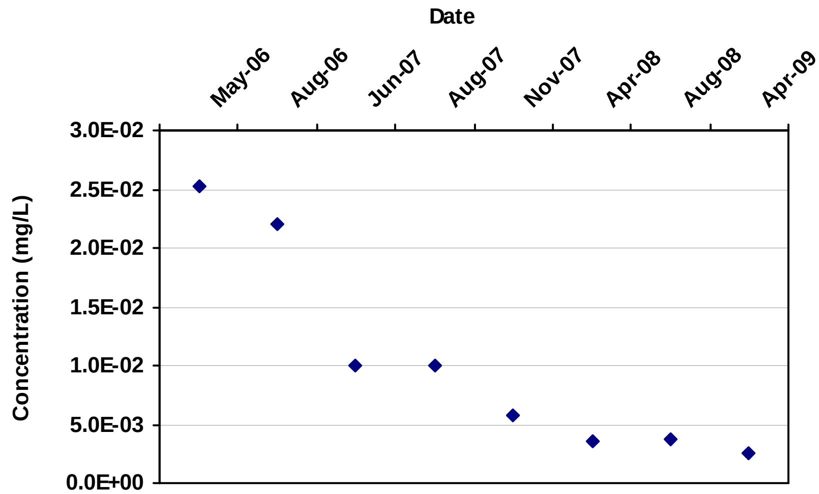
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
PZ4002	S	5/1/2006	1,1-DICHLOROETHENE	1.3E-02		3	3
PZ4002	S	8/21/2006	1,1-DICHLOROETHENE	1.1E-02		1	1
PZ4002	S	6/19/2007	1,1-DICHLOROETHENE	7.0E-03		1	1
PZ4002	S	8/15/2007	1,1-DICHLOROETHENE	7.3E-03		1	1
PZ4002	S	11/28/2007	1,1-DICHLOROETHENE	3.9E-03		1	1
PZ4002	S	4/17/2008	1,1-DICHLOROETHENE	3.1E-03		1	1
PZ4002	S	8/13/2008	1,1-DICHLOROETHENE	2.5E-03		1	1
PZ4002	S	4/30/2009	1,1-DICHLOROETHENE	2.0E-03		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: PZ4002
Well Type: S
COC: 1,1-DICHLOROETHANE

Time Period: 1/1/2006 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -25

Confidence in Trend: 100.0%

Coefficient of Variation: 0.85

Mann Kendall Concentration Trend: (See Note) D

Data Table:

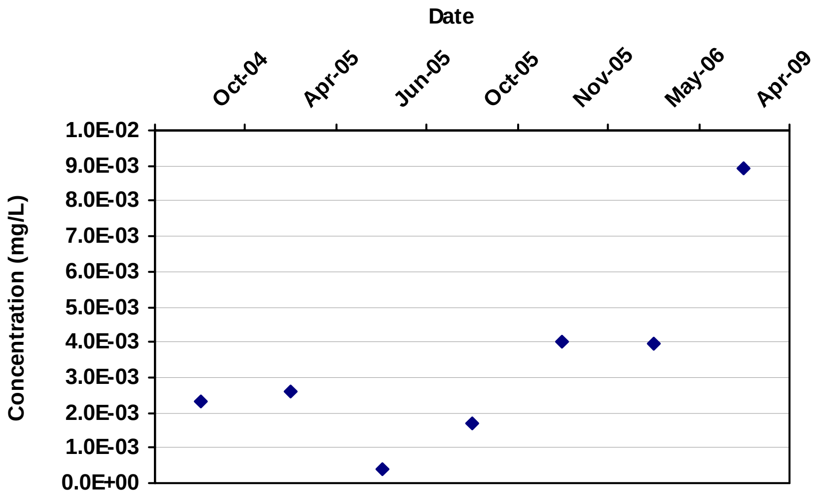
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
PZ4002	S	5/1/2006	1,1-DICHLOROETHANE	2.5E-02		3	3
PZ4002	S	8/21/2006	1,1-DICHLOROETHANE	2.2E-02		1	1
PZ4002	S	6/19/2007	1,1-DICHLOROETHANE	1.0E-02		1	1
PZ4002	S	8/15/2007	1,1-DICHLOROETHANE	1.0E-02		1	1
PZ4002	S	11/28/2007	1,1-DICHLOROETHANE	5.7E-03		1	1
PZ4002	S	4/17/2008	1,1-DICHLOROETHANE	3.5E-03		1	1
PZ4002	S	8/13/2008	1,1-DICHLOROETHANE	3.7E-03		1	1
PZ4002	S	4/30/2009	1,1-DICHLOROETHANE	2.5E-03		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3006
Well Type: T
COC: 1,1-DICHLOROETHENE

Time Period: 1/25/1983 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: 11

Confidence in Trend: 93.2%

Coefficient of Variation: 0.80

Mann Kendall Concentration Trend: (See Note) PI

Data Table:

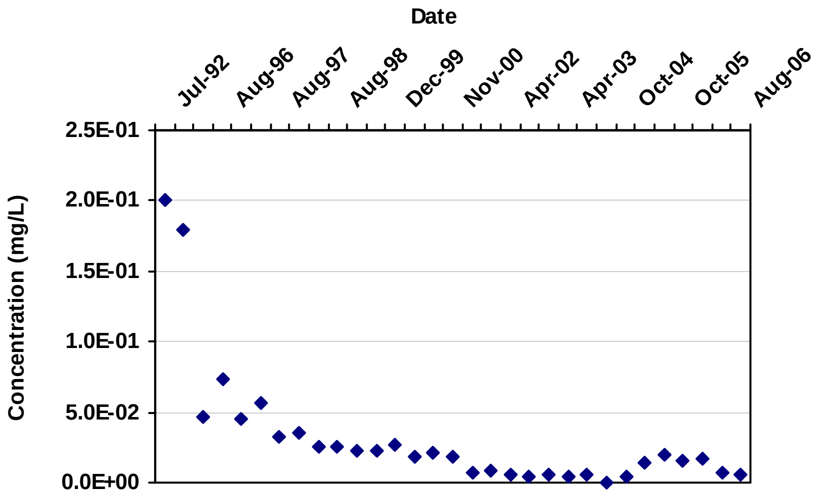
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3006	T	10/20/2004	1,1-DICHLOROETHENE	2.3E-03		1	1
MW3006	T	4/5/2005	1,1-DICHLOROETHENE	2.6E-03		1	1
MW3006	T	6/28/2005	1,1-DICHLOROETHENE	4.0E-04	ND	1	0
MW3006	T	10/27/2005	1,1-DICHLOROETHENE	1.7E-03		2	1
MW3006	T	11/30/2005	1,1-DICHLOROETHENE	4.0E-03		1	1
MW3006	T	5/1/2006	1,1-DICHLOROETHENE	4.0E-03		3	3
MW3006	T	4/30/2009	1,1-DICHLOROETHENE	8.9E-03		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW205
Well Type: S
COC: 1,1-DICHLOROETHENE

Time Period: 1/25/1983 **to** 4/30/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -314

Confidence in Trend: 100.0%

Coefficient of Variation: 1.45

Mann Kendall Concentration Trend: (See Note) D

Data Table:

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW205	S	7/6/1992	1,1-DICHLOROETHENE	2.0E-01		1	1
MW205	S	8/1/1995	1,1-DICHLOROETHENE	1.8E-01		1	1
MW205	S	4/3/1996	1,1-DICHLOROETHENE	4.7E-02		1	1
MW205	S	8/7/1996	1,1-DICHLOROETHENE	7.3E-02		1	1
MW205	S	12/3/1996	1,1-DICHLOROETHENE	4.5E-02		1	1
MW205	S	4/16/1997	1,1-DICHLOROETHENE	5.6E-02		1	1
MW205	S	8/29/1997	1,1-DICHLOROETHENE	3.3E-02		1	1
MW205	S	12/10/1997	1,1-DICHLOROETHENE	3.5E-02		1	1
MW205	S	3/30/1998	1,1-DICHLOROETHENE	2.6E-02		1	1
MW205	S	8/18/1998	1,1-DICHLOROETHENE	2.6E-02		1	1
MW205	S	3/31/1999	1,1-DICHLOROETHENE	2.2E-02		1	1
MW205	S	8/16/1999	1,1-DICHLOROETHENE	2.3E-02		1	1
MW205	S	12/31/1999	1,1-DICHLOROETHENE	2.7E-02		1	1
MW205	S	3/27/2000	1,1-DICHLOROETHENE	1.8E-02		1	1
MW205	S	8/16/2000	1,1-DICHLOROETHENE	2.1E-02		1	1
MW205	S	11/30/2000	1,1-DICHLOROETHENE	1.9E-02		1	1
MW205	S	8/1/2001	1,1-DICHLOROETHENE	7.2E-03		2	2
MW205	S	12/5/2001	1,1-DICHLOROETHENE	7.9E-03		1	1
MW205	S	4/3/2002	1,1-DICHLOROETHENE	6.0E-03		2	2
MW205	S	8/6/2002	1,1-DICHLOROETHENE	4.7E-03		2	2
MW205	S	12/4/2002	1,1-DICHLOROETHENE	5.0E-03		2	2
MW205	S	4/22/2003	1,1-DICHLOROETHENE	4.3E-03		1	1

MAROS Mann-Kendall Statistics Summary

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW205	S	8/6/2003	1,1-DICHLOROETHENE	5.2E-03		1	1
MW205	S	4/14/2004	1,1-DICHLOROETHENE	4.0E-04	ND	2	0
MW205	S	10/20/2004	1,1-DICHLOROETHENE	4.5E-03		2	2
MW205	S	4/5/2005	1,1-DICHLOROETHENE	1.4E-02		2	2
MW205	S	6/28/2005	1,1-DICHLOROETHENE	2.0E-02		2	2
MW205	S	10/27/2005	1,1-DICHLOROETHENE	1.5E-02		4	4
MW205	S	11/30/2005	1,1-DICHLOROETHENE	1.8E-02		2	2
MW205	S	5/1/2006	1,1-DICHLOROETHENE	7.3E-03		6	6
MW205	S	8/21/2006	1,1-DICHLOROETHENE	6.2E-03		2	2

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Zeroth Moment Analysis

Project: Kearsarge

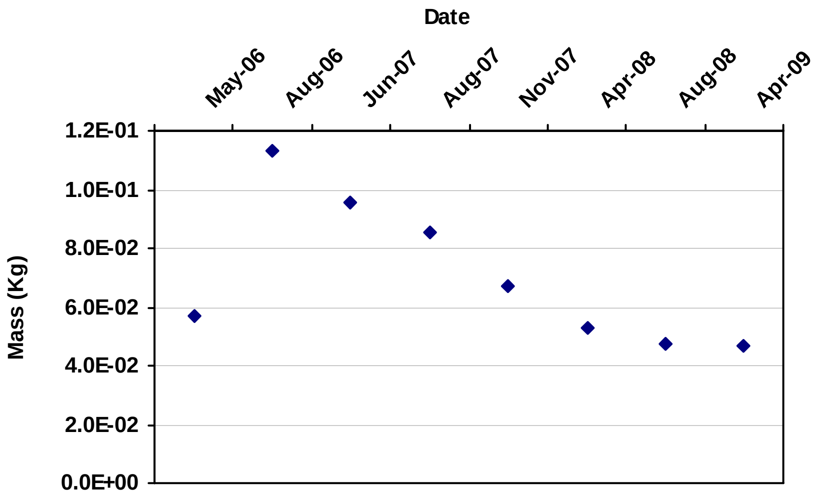
User Name: MV

Location: Conway

State: New Hampshire

COC: 1,1,1-TRICHLOROETHANE

Change in Dissolved Mass Over Time



Porosity: 0.30

Saturated Thickness:

Uniform: 12 ft

Mann Kendall S Statistic:

-20

Confidence in Trend:

99.3%

Coefficient of Variation:

0.35

Zeroth Moment Trend:

D

Data Table:

Effective Date	Constituent	Estimated Mass (Kg)	Number of Wells
5/1/2006	1,1,1-TRICHLOROETHANE	5.7E-02	10
8/21/2006	1,1,1-TRICHLOROETHANE	1.1E-01	20
6/19/2007	1,1,1-TRICHLOROETHANE	9.5E-02	27
8/15/2007	1,1,1-TRICHLOROETHANE	8.6E-02	27
11/28/2007	1,1,1-TRICHLOROETHANE	6.7E-02	28
4/17/2008	1,1,1-TRICHLOROETHANE	5.3E-02	28
8/13/2008	1,1,1-TRICHLOROETHANE	4.7E-02	27
4/30/2009	1,1,1-TRICHLOROETHANE	4.6E-02	29

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect. Moments are not calculated for sample events with less than 6 wells.

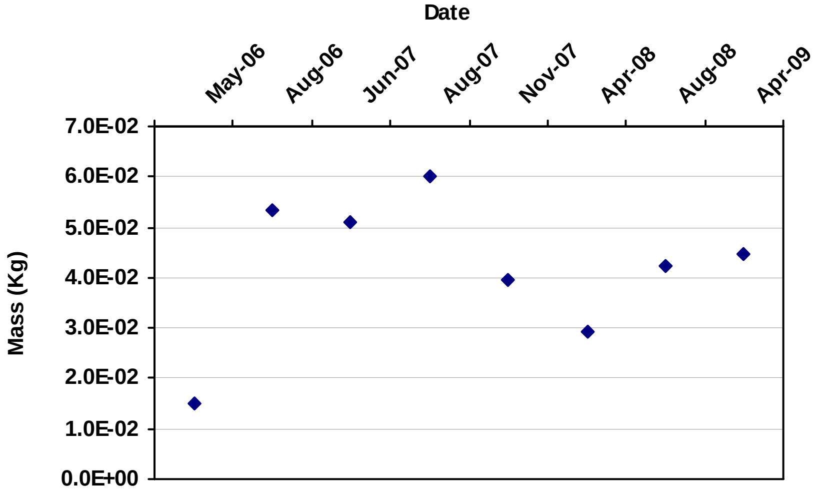
MAROS Zeroth Moment Analysis

Project: Kearsarge **User Name:** MV

Location: Conway **State:** New Hampshire

COC: 1,1-DICHLOROETHENE

Change in Dissolved Mass Over Time



Porosity: 0.30

Saturated Thickness:

Uniform: 12 ft

Mann Kendall S Statistic:

0

Confidence in Trend:

45.2%

Coefficient of Variation:

0.34

Zeroth Moment Trend:

S

Data Table:

Effective Date	Constituent	Estimated Mass (Kg)	Number of Wells
5/1/2006	1,1-DICHLOROETHENE	1.5E-02	10
8/21/2006	1,1-DICHLOROETHENE	5.3E-02	20
6/19/2007	1,1-DICHLOROETHENE	5.1E-02	27
8/15/2007	1,1-DICHLOROETHENE	6.0E-02	27
11/28/2007	1,1-DICHLOROETHENE	4.0E-02	28
4/17/2008	1,1-DICHLOROETHENE	2.9E-02	28
8/13/2008	1,1-DICHLOROETHENE	4.2E-02	27
4/30/2009	1,1-DICHLOROETHENE	4.5E-02	29

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect. Moments are not calculated for sample events with less than 6 wells.

Groundwater Monitoring Network Optimization
Kearsarge Metallurgical Corporation

Conway, New Hampshire

APPENDIX B

MAROS REPORTS

Supplemental Trend Reports 2006 – September 2009

MAROS Mann-Kendall Statistics Summary

Project: KMC

User Name: MV

Location: Conway

State: New Hampshire

Time Period: 1/1/2006 **to** 10/1/2009

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: Specified Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
1,1,1-TRICHLOROETHANE								
CB10+	T	2	0	0.00	0	0.0%	Yes	ND
CB7-8	T	3	1	0.00	0	0.0%	No	N/A
CB8-9	T	1	0	0.00	0	0.0%	Yes	ND
EW01	T	8	0	0.00	0	45.2%	Yes	ND
EW02	T	8	0	0.00	0	45.2%	Yes	ND
EW03	T	8	0	0.00	0	45.2%	Yes	ND
EW06	T	7	3	1.25	-11	93.2%	No	PD
EW09	T	8	8	0.65	-13	92.9%	No	PD
EW10	T	7	7	0.29	5	71.9%	No	NT
EW13B	S	9	0	0.00	0	46.0%	Yes	ND
MW11	T	1	0	0.00	0	0.0%	Yes	ND
MW115	T	1	0	0.00	0	0.0%	Yes	ND
MW202A	T	8	6	0.83	-3	59.4%	No	S
MW203A	T	8	5	0.88	-15	95.8%	No	D
MW205	S	2	2	0.00	0	0.0%	No	N/A
MW206	T	6	0	0.00	0	42.3%	Yes	ND
MW211	T	8	0	0.00	0	45.2%	Yes	ND
MW213	T	2	2	0.00	0	0.0%	No	N/A
MW3003	T	9	9	0.28	17	95.1%	No	I
MW3004	T	8	4	0.89	5	68.3%	No	NT
MW3005	T	8	0	0.00	0	45.2%	Yes	ND
MW3006	T	3	3	0.00	0	0.0%	No	N/A
MW3007	T	7	0	0.00	0	43.7%	Yes	ND
MW3008	S	9	9	0.69	-8	76.2%	No	S
MW3009	S	9	9	0.77	-8	76.2%	No	S
MW3010	S	8	8	0.42	-10	86.2%	No	S
MW3011	T	8	1	1.46	-3	59.4%	No	NT
MW5001	T	7	0	0.00	0	43.7%	Yes	ND
MW5002	T	7	0	0.00	0	43.7%	Yes	ND
MW5003	T	7	6	0.64	1	50.0%	No	NT
MW5004	T	7	0	0.00	0	43.7%	Yes	ND
MW8	T	2	2	0.00	0	0.0%	No	N/A
MW9	T	8	0	0.00	0	45.2%	Yes	ND
PZ4002	S	9	9	0.82	-35	100.0%	No	D
PZ4003	T	7	7	0.88	-13	96.5%	No	D
PZ4004	T	8	0	0.00	0	45.2%	Yes	ND
1,1-DICHLOROETHANE								

Project: KMC

User Name: MV

Location: Conway

State: New Hampshire

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
1,1-DICHLOROETHANE								
CB10+	T	2	0	0.00	0	0.0%	Yes	ND
CB7-8	T	3	0	0.00	0	0.0%	Yes	ND
CB8-9	T	1	0	0.00	0	0.0%	Yes	ND
EW01	T	8	0	0.00	0	45.2%	Yes	ND
EW02	T	8	0	0.00	0	45.2%	Yes	ND
EW03	T	8	0	0.00	0	45.2%	Yes	ND
EW06	T	7	4	1.09	-14	97.5%	No	D
EW09	T	8	6	0.67	-5	68.3%	No	S
EW10	T	7	0	0.00	0	43.7%	Yes	ND
EW13B	S	9	5	0.83	-20	97.8%	No	D
MW11	T	1	0	0.00	0	0.0%	Yes	ND
MW115	T	1	0	0.00	0	0.0%	Yes	ND
MW202A	T	8	8	0.57	-4	64.0%	No	S
MW203A	T	8	8	0.34	-5	68.3%	No	S
MW205	S	2	2	0.00	0	0.0%	No	N/A
MW206	T	6	0	0.00	0	42.3%	Yes	ND
MW211	T	8	0	0.00	0	45.2%	Yes	ND
MW213	T	2	0	0.00	0	0.0%	Yes	ND
MW3003	T	9	9	0.42	4	61.9%	No	NT
MW3004	T	8	0	0.00	0	45.2%	Yes	ND
MW3005	T	8	0	0.00	0	45.2%	Yes	ND
MW3006	T	3	1	0.00	0	0.0%	No	N/A
MW3007	T	7	5	0.53	-11	93.2%	No	PD
MW3008	S	9	9	0.64	16	94.0%	No	PI
MW3009	S	9	9	0.49	12	87.0%	No	NT
MW3010	S	8	8	0.67	10	86.2%	No	NT
MW3011	T	8	7	1.09	2	54.8%	No	NT
MW5001	T	7	0	0.00	0	43.7%	Yes	ND
MW5002	T	7	0	0.00	0	43.7%	Yes	ND
MW5003	T	7	7	0.35	-3	61.4%	No	S
MW5004	T	7	0	0.00	0	43.7%	Yes	ND
MW8	T	2	2	0.00	0	0.0%	No	N/A
MW9	T	8	0	0.00	0	45.2%	Yes	ND
PZ4002	S	9	9	0.91	-32	100.0%	No	D
PZ4003	T	7	6	0.86	-20	100.0%	No	D
PZ4004	T	8	0	0.00	0	45.2%	Yes	ND
1,1-DICHLOROETHENE								
CB10+	T	2	0	0.00	0	0.0%	Yes	ND
CB7-8	T	3	1	0.00	0	0.0%	No	N/A
CB8-9	T	1	0	0.00	0	0.0%	Yes	ND
EW01	T	8	0	0.00	0	45.2%	Yes	ND
EW02	T	8	0	0.00	0	45.2%	Yes	ND
EW03	T	8	0	0.00	0	45.2%	Yes	ND
EW06	T	7	3	0.95	-11	93.2%	No	PD
EW09	T	8	6	0.71	-11	88.7%	No	S
EW10	T	7	0	0.00	0	43.7%	Yes	ND
EW13B	S	9	2	1.77	-13	89.0%	No	NT
MW11	T	1	0	0.00	0	0.0%	Yes	ND
MW115	T	1	0	0.00	0	0.0%	Yes	ND

Project: KMC

User Name: MV

Location: Conway

State: New Hampshire

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
1,1-DICHLOROETHENE								
MW202A	T	8	5	0.82	-3	59.4%	No	S
MW203A	T	8	8	0.43	-5	68.3%	No	S
MW205	S	2	2	0.00	0	0.0%	No	N/A
MW206	T	6	0	0.00	0	42.3%	Yes	ND
MW211	T	8	0	0.00	0	45.2%	Yes	ND
MW213	T	2	0	0.00	0	0.0%	Yes	ND
MW3003	T	9	9	0.29	28	99.9%	No	I
MW3004	T	8	1	0.94	1	50.0%	No	NT
MW3005	T	8	0	0.00	0	45.2%	Yes	ND
MW3006	T	3	3	0.00	0	0.0%	No	N/A
MW3007	T	7	0	0.00	0	43.7%	Yes	ND
MW3008	S	9	9	0.77	22	98.8%	No	I
MW3009	S	9	9	0.75	-4	61.9%	No	S
MW3010	S	8	8	0.61	6	72.6%	No	NT
MW3011	T	8	6	1.08	6	72.6%	No	NT
MW5001	T	7	0	0.00	0	43.7%	Yes	ND
MW5002	T	7	0	0.00	0	43.7%	Yes	ND
MW5003	T	7	7	0.48	0	43.7%	No	S
MW5004	T	7	0	0.00	0	43.7%	Yes	ND
MW8	T	2	0	0.00	0	0.0%	Yes	ND
MW9	T	8	0	0.00	0	45.2%	Yes	ND
PZ4002	S	9	9	0.71	-32	100.0%	No	D
PZ4003	T	7	2	1.18	-11	93.2%	No	PD
PZ4004	T	8	0	0.00	0	45.2%	Yes	ND
CHLOROETHANE								
CB10+	T	2	0	0.00	0	0.0%	Yes	ND
CB7-8	T	3	0	0.00	0	0.0%	Yes	ND
CB8-9	T	1	0	0.00	0	0.0%	Yes	ND
EW01	T	8	0	0.00	0	45.2%	Yes	ND
EW02	T	8	0	0.00	0	45.2%	Yes	ND
EW03	T	8	0	0.00	0	45.2%	Yes	ND
EW06	T	7	0	0.00	0	43.7%	Yes	ND
EW09	T	8	0	0.00	0	45.2%	Yes	ND
EW10	T	7	0	0.00	0	43.7%	Yes	ND
EW13B	S	9	6	0.35	-27	99.8%	No	D
MW11	T	1	0	0.00	0	0.0%	Yes	ND
MW115	T	1	0	0.00	0	0.0%	Yes	ND
MW202A	T	8	4	0.22	-4	64.0%	No	S
MW203A	T	8	8	0.47	-4	64.0%	No	S
MW205	S	2	1	0.00	0	0.0%	No	N/A
MW206	T	6	0	0.00	0	42.3%	Yes	ND
MW211	T	8	0	0.00	0	45.2%	Yes	ND
MW213	T	2	0	0.00	0	0.0%	Yes	ND
MW3003	T	9	0	0.00	0	46.0%	Yes	ND
MW3004	T	8	0	0.00	0	45.2%	Yes	ND
MW3005	T	8	0	0.00	0	45.2%	Yes	ND
MW3006	T	3	0	0.00	0	0.0%	Yes	ND
MW3007	T	7	0	0.00	0	43.7%	Yes	ND
MW3008	S	9	9	0.67	20	97.8%	No	I

Project: KMC

Location: Conway

User Name: MV

State: New Hampshire

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
CHLOROETHANE								
MW3009	S	9	5	0.34	-3	58.0%	No	S
MW3010	S	8	5	0.97	15	95.8%	No	I
MW3011	T	8	3	0.80	10	86.2%	No	NT
MW5001	T	7	0	0.00	0	43.7%	Yes	ND
MW5002	T	7	0	0.00	0	43.7%	Yes	ND
MW5003	T	7	0	0.00	0	43.7%	Yes	ND
MW5004	T	7	0	0.00	0	43.7%	Yes	ND
MW8	T	2	0	0.00	0	0.0%	Yes	ND
MW9	T	8	0	0.00	0	45.2%	Yes	ND
PZ4002	S	9	0	0.00	0	46.0%	Yes	ND
PZ4003	T	7	0	0.00	0	43.7%	Yes	ND
PZ4004	T	8	0	0.00	0	45.2%	Yes	ND
TRICHLOROETHYLENE (TCE)								
CB10+	T	2	0	0.00	0	0.0%	Yes	ND
CB7-8	T	3	0	0.00	0	0.0%	Yes	ND
CB8-9	T	1	0	0.00	0	0.0%	Yes	ND
EW01	T	8	0	0.00	0	45.2%	Yes	ND
EW02	T	8	0	0.00	0	45.2%	Yes	ND
EW03	T	8	1	1.02	-7	76.4%	No	NT
EW06	T	7	0	0.00	0	43.7%	Yes	ND
EW09	T	8	0	0.00	0	45.2%	Yes	ND
EW10	T	7	0	0.00	0	43.7%	Yes	ND
EW13B	S	9	0	0.00	0	46.0%	Yes	ND
MW11	T	1	0	0.00	0	0.0%	Yes	ND
MW115	T	1	0	0.00	0	0.0%	Yes	ND
MW202A	T	8	0	0.00	0	45.2%	Yes	ND
MW203A	T	8	0	0.00	0	45.2%	Yes	ND
MW205	S	2	0	0.00	0	0.0%	Yes	ND
MW206	T	6	0	0.00	0	42.3%	Yes	ND
MW211	T	8	0	0.00	0	45.2%	Yes	ND
MW213	T	2	0	0.00	0	0.0%	Yes	ND
MW3003	T	9	0	0.00	0	46.0%	Yes	ND
MW3004	T	8	0	0.00	0	45.2%	Yes	ND
MW3005	T	8	0	0.00	0	45.2%	Yes	ND
MW3006	T	3	0	0.00	0	0.0%	Yes	ND
MW3007	T	7	0	0.00	0	43.7%	Yes	ND
MW3008	S	9	0	0.00	0	46.0%	Yes	ND
MW3009	S	9	0	0.00	0	46.0%	Yes	ND
MW3010	S	8	0	0.00	0	45.2%	Yes	ND
MW3011	T	8	0	0.00	0	45.2%	Yes	ND
MW5001	T	7	0	0.00	0	43.7%	Yes	ND
MW5002	T	7	0	0.00	0	43.7%	Yes	ND
MW5003	T	7	0	0.00	0	43.7%	Yes	ND
MW5004	T	7	0	0.00	0	43.7%	Yes	ND
MW8	T	2	0	0.00	0	0.0%	Yes	ND
MW9	T	8	0	0.00	0	45.2%	Yes	ND
PZ4002	S	9	0	0.00	0	46.0%	Yes	ND
PZ4003	T	7	0	0.00	0	43.7%	Yes	ND
PZ4004	T	8	0	0.00	0	45.2%	Yes	ND

Project: KMC

User Name: MV

Location: Conway

State: New Hampshire

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
TRICHLOROETHYLENE (TCE)								

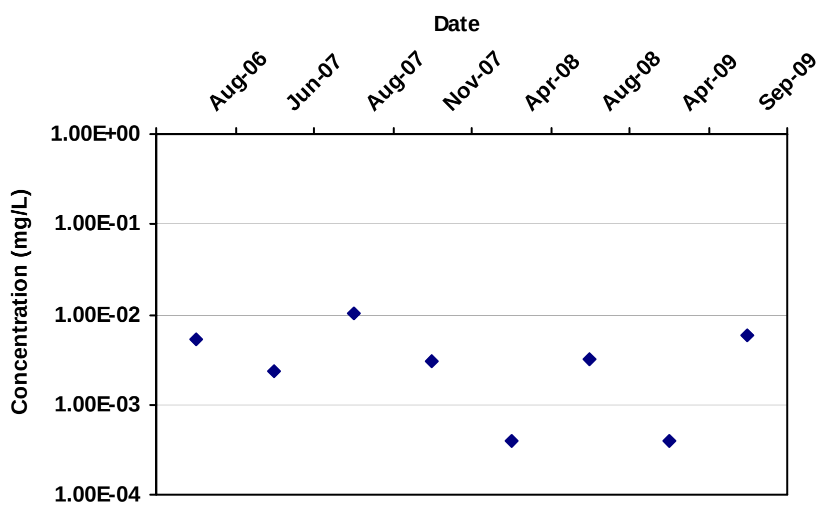
Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)- Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Well: MW202A
Well Type: T
COC: 1,1,1-TRICHLOROETHANE

Time Period: 1/1/2006 **to** 10/1/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic:

-3

Confidence in Trend:

59.4%

Coefficient of Variation:

0.83

Mann Kendall Concentration Trend: (See Note)

S

Data Table:

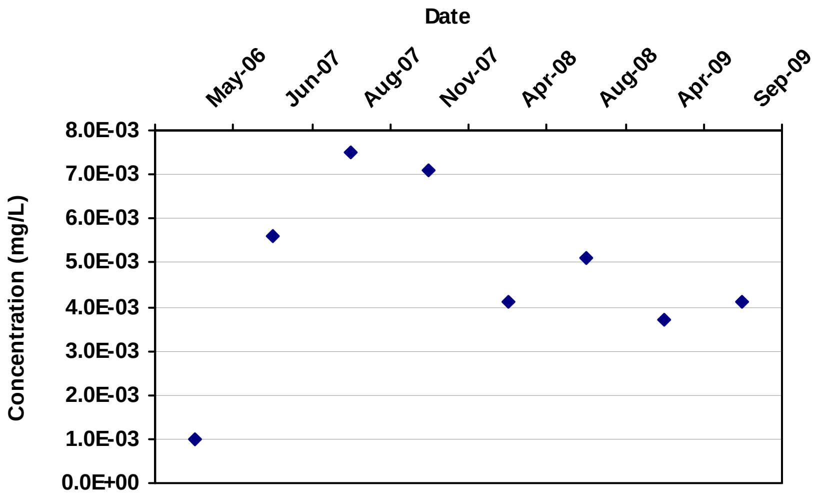
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW202A	T	8/21/2006	1,1,1-TRICHLOROETHANE	5.4E-03		1	1
MW202A	T	6/19/2007	1,1,1-TRICHLOROETHANE	2.4E-03		1	1
MW202A	T	8/15/2007	1,1,1-TRICHLOROETHANE	1.0E-02		1	1
MW202A	T	11/28/2007	1,1,1-TRICHLOROETHANE	3.1E-03		1	1
MW202A	T	4/17/2008	1,1,1-TRICHLOROETHANE	4.0E-04	ND	1	0
MW202A	T	8/13/2008	1,1,1-TRICHLOROETHANE	3.2E-03		1	1
MW202A	T	4/30/2009	1,1,1-TRICHLOROETHANE	4.0E-04	ND	1	0
MW202A	T	9/15/2009	1,1,1-TRICHLOROETHANE	5.8E-03		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW203A
Well Type: T
COC: 1,1-DICHLOROETHENE

Time Period: 1/1/2006 **to** 9/15/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -5

Confidence in Trend: 68.3%

Coefficient of Variation: 0.43

Mann Kendall Concentration Trend: (See Note) S

Data Table:

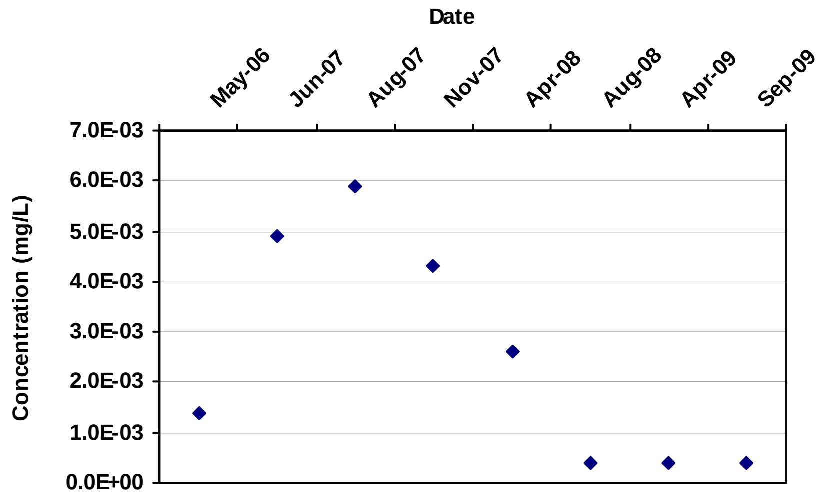
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW203A	T	5/1/2006	1,1-DICHLOROETHENE	1.0E-03		3	1
MW203A	T	6/19/2007	1,1-DICHLOROETHENE	5.6E-03		1	1
MW203A	T	8/15/2007	1,1-DICHLOROETHENE	7.5E-03		1	1
MW203A	T	11/28/2007	1,1-DICHLOROETHENE	7.1E-03		1	1
MW203A	T	4/17/2008	1,1-DICHLOROETHENE	4.1E-03		1	1
MW203A	T	8/13/2008	1,1-DICHLOROETHENE	5.1E-03		1	1
MW203A	T	4/30/2009	1,1-DICHLOROETHENE	3.7E-03		1	1
MW203A	T	9/15/2009	1,1-DICHLOROETHENE	4.1E-03		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW203A
Well Type: T
COC: 1,1,1-TRICHLOROETHANE

Time Period: 1/1/2006 **to** 10/1/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -15

Confidence in Trend: 95.8%

Coefficient of Variation: 0.88

Mann Kendall Concentration Trend: (See Note) D

Data Table:

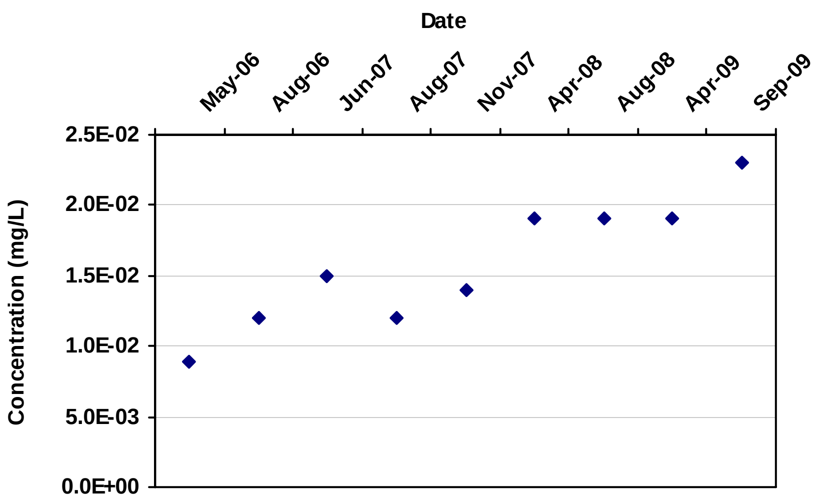
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW203A	T	5/1/2006	1,1,1-TRICHLOROETHANE	1.4E-03		3	1
MW203A	T	6/19/2007	1,1,1-TRICHLOROETHANE	4.9E-03		1	1
MW203A	T	8/15/2007	1,1,1-TRICHLOROETHANE	5.9E-03		1	1
MW203A	T	11/28/2007	1,1,1-TRICHLOROETHANE	4.3E-03		1	1
MW203A	T	4/17/2008	1,1,1-TRICHLOROETHANE	2.6E-03		1	1
MW203A	T	8/13/2008	1,1,1-TRICHLOROETHANE	4.0E-04	ND	1	0
MW203A	T	4/30/2009	1,1,1-TRICHLOROETHANE	4.0E-04	ND	1	0
MW203A	T	9/15/2009	1,1,1-TRICHLOROETHANE	4.0E-04	ND	1	0

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3003
Well Type: T
COC: 1,1-DICHLOROETHENE

Time Period: 1/1/2006 **to** 9/15/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: 28

Confidence in Trend: 99.9%

Coefficient of Variation: 0.29

Mann Kendall Concentration Trend: (See Note) I

Data Table:

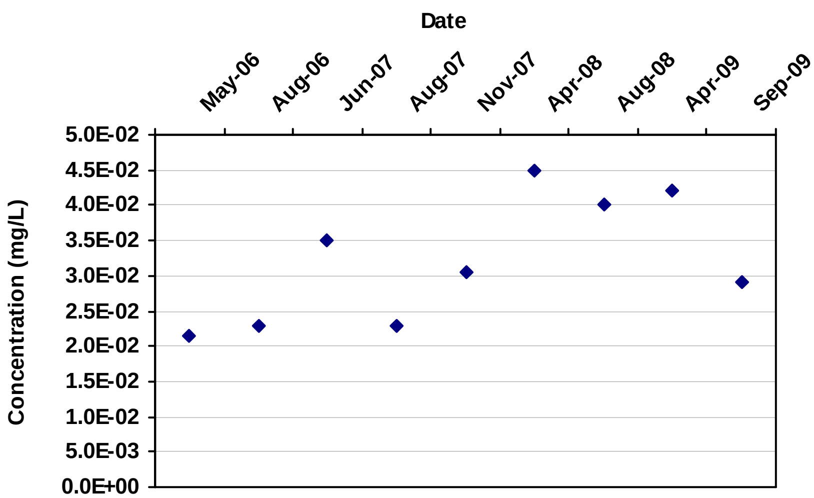
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3003	T	5/1/2006	1,1-DICHLOROETHENE	8.9E-03		3	3
MW3003	T	8/21/2006	1,1-DICHLOROETHENE	1.2E-02		1	1
MW3003	T	6/19/2007	1,1-DICHLOROETHENE	1.5E-02		1	1
MW3003	T	8/15/2007	1,1-DICHLOROETHENE	1.2E-02		1	1
MW3003	T	11/28/2007	1,1-DICHLOROETHENE	1.4E-02		2	2
MW3003	T	4/17/2008	1,1-DICHLOROETHENE	1.9E-02		2	2
MW3003	T	8/13/2008	1,1-DICHLOROETHENE	1.9E-02		2	2
MW3003	T	4/30/2009	1,1-DICHLOROETHENE	1.9E-02		1	1
MW3003	T	9/15/2009	1,1-DICHLOROETHENE	2.3E-02		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3003
Well Type: T
COC: 1,1,1-TRICHLOROETHANE

Time Period: 1/1/2006 **to** 10/1/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: 17

Confidence in Trend: 95.1%

Coefficient of Variation: 0.28

Mann Kendall Concentration Trend: (See Note) I

Data Table:

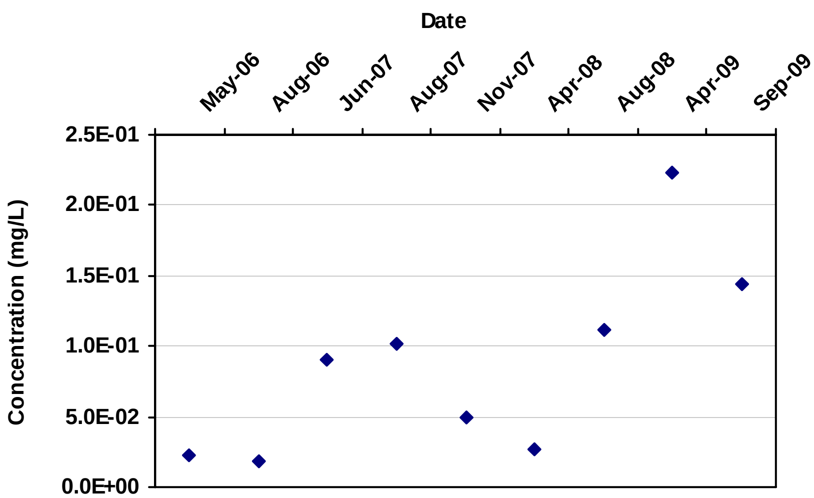
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3003	T	5/1/2006	1,1,1-TRICHLOROETHANE	2.1E-02		3	3
MW3003	T	8/21/2006	1,1,1-TRICHLOROETHANE	2.3E-02		1	1
MW3003	T	6/19/2007	1,1,1-TRICHLOROETHANE	3.5E-02		1	1
MW3003	T	8/15/2007	1,1,1-TRICHLOROETHANE	2.3E-02		1	1
MW3003	T	11/28/2007	1,1,1-TRICHLOROETHANE	3.1E-02		2	2
MW3003	T	4/17/2008	1,1,1-TRICHLOROETHANE	4.5E-02		2	2
MW3003	T	8/13/2008	1,1,1-TRICHLOROETHANE	4.0E-02		2	2
MW3003	T	4/30/2009	1,1,1-TRICHLOROETHANE	4.2E-02		1	1
MW3003	T	9/15/2009	1,1,1-TRICHLOROETHANE	2.9E-02		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3008
Well Type: S
COC: 1,1-DICHLOROETHENE

Time Period: 1/1/2006 **to** 9/15/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: 22

Confidence in Trend: 98.8%

Coefficient of Variation: 0.77

Mann Kendall Concentration Trend: (See Note) I

Data Table:

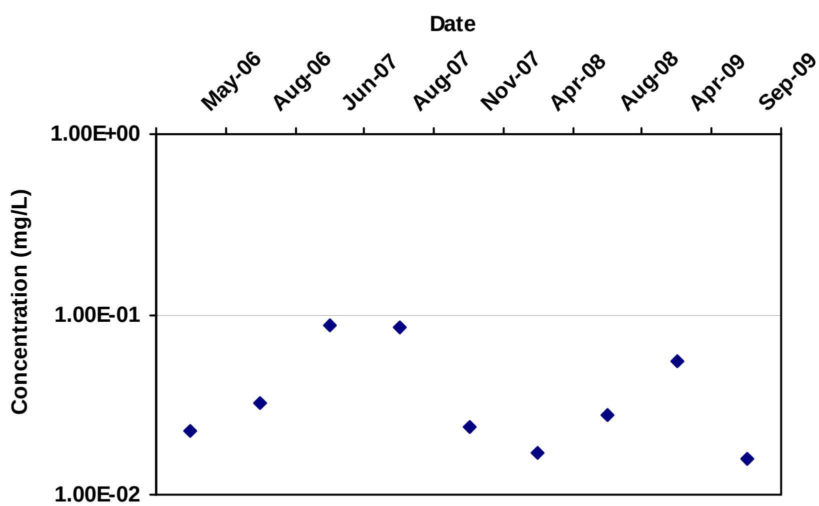
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3008	S	5/1/2006	1,1-DICHLOROETHENE	2.3E-02		3	3
MW3008	S	8/21/2006	1,1-DICHLOROETHENE	1.8E-02		1	1
MW3008	S	6/19/2007	1,1-DICHLOROETHENE	9.0E-02		1	1
MW3008	S	8/15/2007	1,1-DICHLOROETHENE	1.0E-01		1	1
MW3008	S	11/28/2007	1,1-DICHLOROETHENE	5.0E-02		2	2
MW3008	S	4/17/2008	1,1-DICHLOROETHENE	2.7E-02		2	2
MW3008	S	8/13/2008	1,1-DICHLOROETHENE	1.1E-01		2	2
MW3008	S	4/30/2009	1,1-DICHLOROETHENE	2.2E-01		2	2
MW3008	S	9/15/2009	1,1-DICHLOROETHENE	1.4E-01		2	2

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3008
Well Type: S
COC: 1,1,1-TRICHLOROETHANE

Time Period: 1/1/2006 **to** 10/1/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -8

Confidence in Trend: 76.2%

Coefficient of Variation: 0.69

Mann Kendall Concentration Trend: (See Note) S

Data Table:

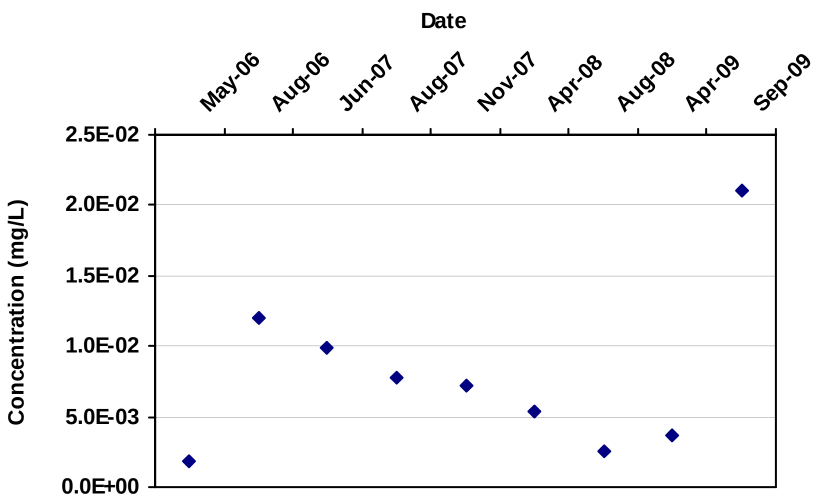
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3008	S	5/1/2006	1,1,1-TRICHLOROETHANE	2.2E-02		3	3
MW3008	S	8/21/2006	1,1,1-TRICHLOROETHANE	3.2E-02		1	1
MW3008	S	6/19/2007	1,1,1-TRICHLOROETHANE	8.8E-02		1	1
MW3008	S	8/15/2007	1,1,1-TRICHLOROETHANE	8.4E-02		1	1
MW3008	S	11/28/2007	1,1,1-TRICHLOROETHANE	2.4E-02		2	2
MW3008	S	4/17/2008	1,1,1-TRICHLOROETHANE	1.7E-02		2	2
MW3008	S	8/13/2008	1,1,1-TRICHLOROETHANE	2.8E-02		2	2
MW3008	S	4/30/2009	1,1,1-TRICHLOROETHANE	5.5E-02		2	2
MW3008	S	9/15/2009	1,1,1-TRICHLOROETHANE	1.6E-02		2	2

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3009
Well Type: S
COC: 1,1-DICHLOROETHENE

Time Period: 1/1/2006 **to** 9/15/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -4

Confidence in Trend: 61.9%

Coefficient of Variation: 0.75

Mann Kendall Concentration Trend: (See Note) S

Data Table:

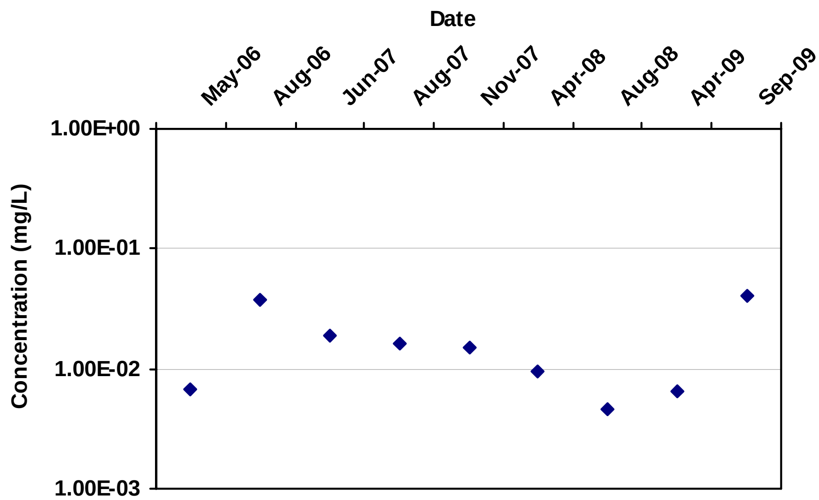
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3009	S	5/1/2006	1,1-DICHLOROETHENE	1.8E-03		3	2
MW3009	S	8/21/2006	1,1-DICHLOROETHENE	1.2E-02		1	1
MW3009	S	6/19/2007	1,1-DICHLOROETHENE	9.9E-03		1	1
MW3009	S	8/15/2007	1,1-DICHLOROETHENE	7.8E-03		2	2
MW3009	S	11/28/2007	1,1-DICHLOROETHENE	7.2E-03		1	1
MW3009	S	4/17/2008	1,1-DICHLOROETHENE	5.3E-03		1	1
MW3009	S	8/13/2008	1,1-DICHLOROETHENE	2.6E-03		1	1
MW3009	S	4/30/2009	1,1-DICHLOROETHENE	3.7E-03		1	1
MW3009	S	9/15/2009	1,1-DICHLOROETHENE	2.1E-02		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3009
Well Type: S
COC: 1,1,1-TRICHLOROETHANE

Time Period: 1/1/2006 **to** 10/1/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: -8

Confidence in Trend: 76.2%

Coefficient of Variation: 0.77

Mann Kendall Concentration Trend: (See Note) S

Data Table:

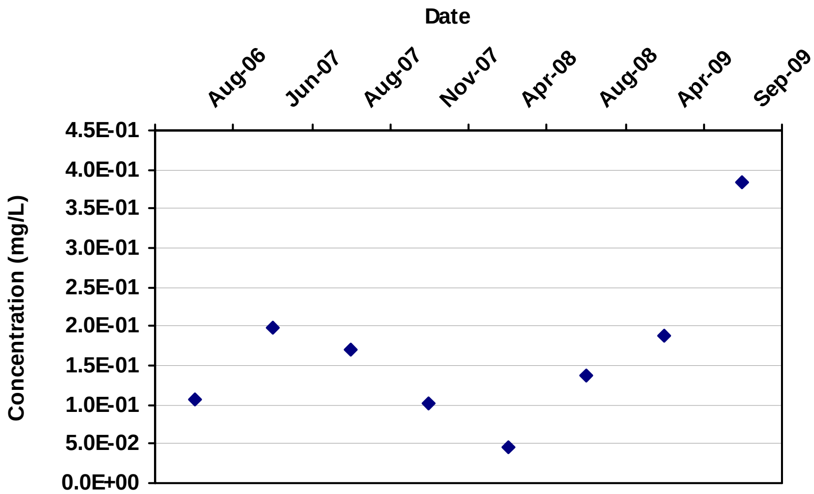
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3009	S	5/1/2006	1,1,1-TRICHLOROETHANE	6.9E-03		3	3
MW3009	S	8/21/2006	1,1,1-TRICHLOROETHANE	3.7E-02		1	1
MW3009	S	6/19/2007	1,1,1-TRICHLOROETHANE	1.9E-02		1	1
MW3009	S	8/15/2007	1,1,1-TRICHLOROETHANE	1.6E-02		2	2
MW3009	S	11/28/2007	1,1,1-TRICHLOROETHANE	1.5E-02		1	1
MW3009	S	4/17/2008	1,1,1-TRICHLOROETHANE	9.4E-03		1	1
MW3009	S	8/13/2008	1,1,1-TRICHLOROETHANE	4.6E-03		1	1
MW3009	S	4/30/2009	1,1,1-TRICHLOROETHANE	6.6E-03		1	1
MW3009	S	9/15/2009	1,1,1-TRICHLOROETHANE	4.1E-02		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3010
Well Type: S
COC: 1,1-DICHLOROETHENE

Time Period: 1/1/2006 **to** 9/15/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: 6

Confidence in Trend: 72.6%

Coefficient of Variation: 0.61

Mann Kendall Concentration Trend: (See Note) NT

Data Table:

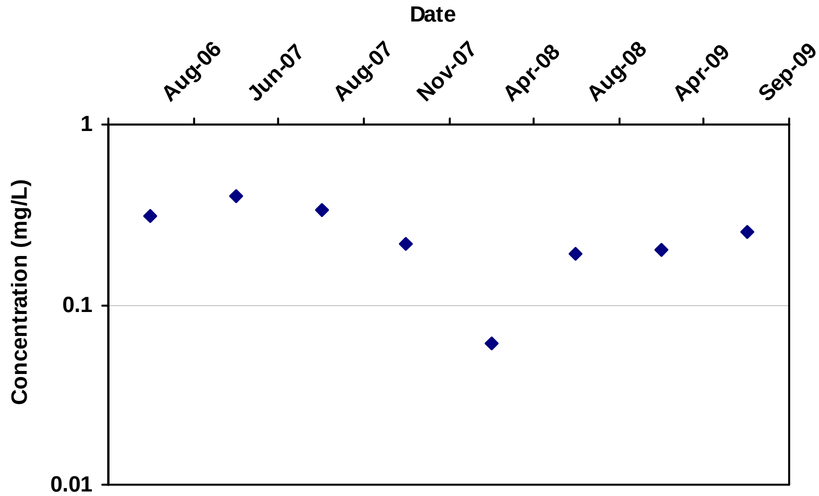
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3010	S	8/21/2006	1,1-DICHLOROETHENE	1.1E-01		3	3
MW3010	S	6/19/2007	1,1-DICHLOROETHENE	2.0E-01		2	2
MW3010	S	8/15/2007	1,1-DICHLOROETHENE	1.7E-01		2	2
MW3010	S	11/28/2007	1,1-DICHLOROETHENE	1.0E-01		2	2
MW3010	S	4/17/2008	1,1-DICHLOROETHENE	4.5E-02		2	2
MW3010	S	8/13/2008	1,1-DICHLOROETHENE	1.4E-01		2	2
MW3010	S	4/30/2009	1,1-DICHLOROETHENE	1.9E-01		1	1
MW3010	S	9/15/2009	1,1-DICHLOROETHENE	3.8E-01		2	2

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3010
Well Type: S
COC: 1,1,1-TRICHLOROETHANE

Time Period: 1/1/2006 **to** 10/1/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic:
-10

Confidence in Trend:
86.2%

Coefficient of Variation:
0.42

Mann Kendall Concentration Trend: (See Note)
S

Data Table:

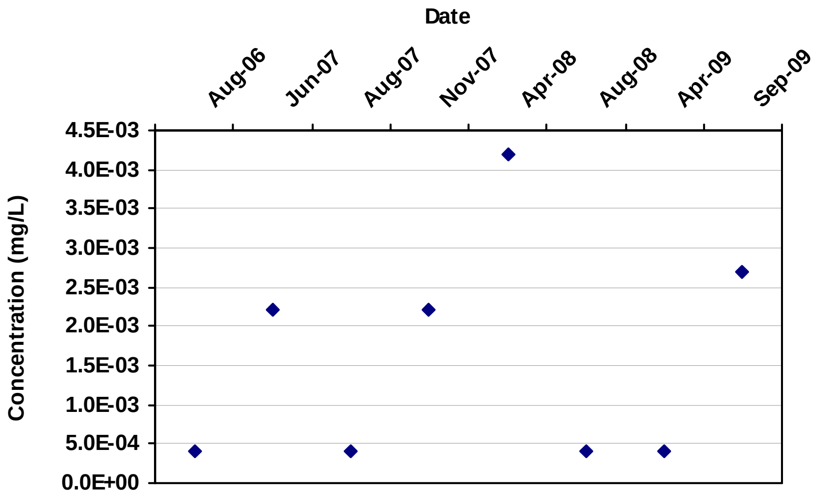
Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3010	S	8/21/2006	1,1,1-TRICHLOROETHANE	3.1E-01		3	3
MW3010	S	6/19/2007	1,1,1-TRICHLOROETHANE	4.0E-01		2	2
MW3010	S	8/15/2007	1,1,1-TRICHLOROETHANE	3.3E-01		2	2
MW3010	S	11/28/2007	1,1,1-TRICHLOROETHANE	2.2E-01		2	2
MW3010	S	4/17/2008	1,1,1-TRICHLOROETHANE	6.2E-02		2	2
MW3010	S	8/13/2008	1,1,1-TRICHLOROETHANE	1.9E-01		2	2
MW3010	S	4/30/2009	1,1,1-TRICHLOROETHANE	2.0E-01		1	1
MW3010	S	9/15/2009	1,1,1-TRICHLOROETHANE	2.6E-01		2	2

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Well: MW3004
Well Type: T
COC: 1,1,1-TRICHLOROETHANE

Time Period: 1/1/2006 **to** 10/1/2009
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Average
ND Values: Specified Detection Limit
J Flag Values : Actual Value



Mann Kendall S Statistic: 5

Confidence in Trend: 68.3%

Coefficient of Variation: 0.89

Mann Kendall Concentration Trend: (See Note) NT

Data Table:

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW3004	T	8/21/2006	1,1,1-TRICHLOROETHANE	4.0E-04	ND	1	0
MW3004	T	6/19/2007	1,1,1-TRICHLOROETHANE	2.2E-03		1	1
MW3004	T	8/15/2007	1,1,1-TRICHLOROETHANE	4.0E-04	ND	2	0
MW3004	T	11/28/2007	1,1,1-TRICHLOROETHANE	2.2E-03		1	1
MW3004	T	4/17/2008	1,1,1-TRICHLOROETHANE	4.2E-03		1	1
MW3004	T	8/13/2008	1,1,1-TRICHLOROETHANE	4.0E-04	ND	1	0
MW3004	T	4/30/2009	1,1,1-TRICHLOROETHANE	4.0E-04	ND	1	0
MW3004	T	9/15/2009	1,1,1-TRICHLOROETHANE	2.7E-03		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

APPENDIX C

HOW TO READ A TRILATERAL DIAGRAM

How to Read a Trilateral Diagram

Ternary diagrams are designed to graphically represent proportions of three related components in a system.

Axes are scaled so they increase in a clockwise direction around the diagram. Points within the diagram represent the relative proportions of three classes and always sum to 1.

Data from well sampling in ug/L is converted to molar concentrations (moles/L).

Concentrations for each component are converted to fractions (%) of the total (i.e.[moles 1,1,1TCA]/[moles Total Chlorinated Solvent]) and plotted on the diagram.

For example, in the adjacent diagram, the fractions of 1,1,1-TCA, 1,1-DCA, and
1,1-DCE are illustrated for data from three different locations.