Comprehensive Long-term Environmental Action Navy

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Resource Conservation and Recovery Act Corrective Measures Study Report for SWMU 01 – Mustard Gas Burial Ground

Naval Surface Warfare Center
Crane Division
Crane, Indiana

Contract Task Order 0315
Revision 2
August 2005

NAVFAC
Naval Facilities Engineering Command
Southern Division
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IN REPLY REFER TO:

5090/S4.7.5
Ser RP3/4246

26 AUG 2004

U.S. Environmental Protection Agency, Region V
Waste, Pesticides, & Toxics Division
Waste Management Branch
Corrective Action Section
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Dear Mr. Ramanauskas:

Crane Division, Naval Surface Warfare Center submits the Draft Corrective Measures Study (CMS) for the Mustard Gas Burial Ground (MGBG), Solid Waste Management Unit 01 for review. Two copies are presented as enclosure (1). The permit required Certification Statement is provided as enclosure (2).

If you require any further information, my point of contact is Mr. Thomas J. Brent, Code RP3-TB, at 812-854-6160, email brent_t@crane.navy.mil.

Sincerely,

for JAMES M. HUNSICKER
Manager, Environmental Protection
By direction of the Commanding Officer

Encl: 1 Draft MGBG CMS
2 Certification Statement

Copy to:
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SOUTHNAVFACENGCOM (Code ES31) (w/o encl)
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I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

SIGNATURE

Acting

Manager, Environmental Protection — 8-26-04

TITLE — DATE

050418/P

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) CORRECTIVE MEASURES STUDY (CMS) REPORT FOR SWMU 01 – MUSTARD GAS BURIAL GROUND

NAVAL SURFACE WARFARE CENTER,
CRANE DIVISION
CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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AUGUST 2005

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ACRONYM LIST

°F	Degrees Fahrenheit
µg/L	micrograms per liter
ALPEC	Ammunition Loading and Production Engineering Center
AMSL	Above mean sea level
ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Ambient Water Quality Criteria
B&R	Brown & Root Environmental
BCF	Bioconcentration factor
BEHP	bis(2-Ethylhexyl)phthalate
bgs	below ground surface
CAAA	Crane Army Ammunition Activity
CAO	Corrective Action Objective
CASCO	Central Ammunition Supply Control Office
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CMA	Corrective Measures Alternative
CMD	Corrective Measures Design
CMS	Corrective Measures Study
COC	Chemical of concern
COPC	Chemical of potential concern
CTO	Contract Task Order
CWA	Clean Water Act
DCA	Dichloroethane
DCE	Dichloroethene
DNAPL	Dense non-aqueous phase liquid
DOT	Department of Transportation
DPT	Direct-push technology
f_{oc}	Fraction of Organic carbon
FOD	Frequency of detection
HHRA	Human health risk assessment
HI	Hazard Index
HSWA	Hazardous and Solid Waste Amendments
HWY	Highway

IAC	Indiana Administrative Code
IAL	Interim action level
IC	Indiana Code
IDEM	Indiana Department of Environmental Management
ILCR	Incremental Lifetime Cancer Risk
IR	Installation Restoration
IRIS	Integrated Risk Information System
IWQS	Indiana Water Quality Standard
K_d	Soil-water distribution coefficient
K_h	Hydraulic conductivity
K_{oc}	Organic Carbon Partition Coefficient
K_{ow}	Octanol/Water Partition Coefficient
LOAEL	Lowest-observed adverse effect level
LUC	Land Use Controls
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MCS	Media Cleanup Standard
MF	Modifying factor
mg/kg	milligram per kilogram
mg/L	milligram/liter
MGBG	Mustard Gas Burial Ground
MI	Mobility index
MK	Morrison Knudsen Corporation
MNA	Monitored natural attenuation
NAD	Naval Ammunition Depot
NAVFAC EFD South	Naval Facilities Engineering Field Division South
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NFA	No further action
NOAEL	No-observed adverse effect level
NPD	Nonrule Policy Document
NPDES	National Pollutant Discharge Elimination System
NSWC	Naval Surface Warfare Center
NWSCC	Naval Weapons Support Center Crane
O&M	Operations and Maintenance

ORP	Oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PAH	Polycyclic aromatic hydrocarbon
PBA	Primary Burial Area
PCA	Tetrachloroethane
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PPE	Personal protective equipment
PRB	Permeable reactive barrier
PRG	Preliminary Remediation Goal
PVC	Polyvinyl chloride
QAPP	Quality Assurance Project Plan
QC	Quality Control
RBC	Risk-Based Concentration
RBCL	Risk-based cleanup levels
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RfD	Reference Dose
RFI	RCRA Facility Investigation
RISC	Risk Integrated System of Closure
SDWA	Safe Drinking Water Act
SERA	Screening ecological risk assessment
SMCL	Secondary Maximum Contaminant Level
SOB	Statement of Basis
SWMU	Solid Waste Management Unit
TCA	Trichloroethane
TCE	Trichloroethene
TCR	Target cancer risk
TBC	To Be Considered
THI	Target hazard index
TOC	Total organic carbon
TSD	Treatment, Storage, or Disposal
TtNUS	Tetra Tech NUS, Inc.
UF	Uncertainty factor
US ACE	United States Army Corps of Engineers

U.S. EPA	United States Environmental Protection Agency
USC	United States Code
USGS	United States Geologic Survey
VOC	Volatile organic compound
WES	Waterways Experiment Station
ZVI	Zero-valent iron

EXECUTIVE SUMMARY

A Corrective Measures Study (CMS) Report has been prepared for the Naval Surface Warfare Center (NSWC) facility located in Crane, Indiana, for the United States Navy Southern Division Naval Facilities Engineering Command (NAVFAC) under Contract Task Order (CTO) 0315, for the Comprehensive Long-Term Environmental Action Navy (CLEAN) 3, Contract Number N62467-94-D-0888. This CMS report addresses one solid waste management unit (SWMU) identified as SWMU 01, Mustard Gas Burial Ground (MGBG).

The Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report [Tetra Tech NUS, Inc. (TtNUS), 2003] identified a need for conducting an evaluation of remedial options under a RCRA CMS. The objective of this CMS was to determine whether any additional corrective measures are required in order to provide long-term protection to human health and the environment.

SITE DESCRIPTION

The currently inactive MGBG was used at least until the late 1960s as a chemical dumping ground for laboratory chemicals, radioactive thorium or thorium compounds related to research and development of military illuminant materials, and mustard gas bombs. The historical record indicates that the volumes of laboratory chemicals disposed at the MGBG were on the order of ounces. Thorium and related compounds as well as mustard gas bombs were exhumed in 1974 and 1980 and properly disposed off site. The site was ultimately considered to be safe for general use with regard to the levels of radioactivity.

PHASE III RFI

Various investigations have been performed at SWMU 01 to characterize site conditions, nature and extent of contamination, and evaluate human health and ecological risk. Initial studies in the 1980s indicated that ground water was contaminated with volatile organic compounds (VOCs). The VOC plume had migrated approximately 700 feet northwest of the MGBG. The greatest concentrations of VOCs in ground water were detected downgradient of but near to the Primary Burial Area (PBA). The PBA is approximately 0.2 acres in size and is located within the 12-acre (formerly 2-acre) MGBG. The MGBG was recommended for further study to refine estimates of nature and extent of contamination and to conduct both ecological and human health risk assessments. From 2001 to 2004, soil (surface and subsurface), ground water, surface water, and sediment samples were collected from the MGBG and analyzed for the presence of VOCs and several other classes of chemicals during the investigation phase of the RFI

(TtNUS, 2003). The following discussion summarizes the nature and extent of contamination from the RFI at the MGBG:

- The soils, ground water, surface water, and sediment data collected during the RFI were adequate to support the development of baseline human health and screening-level ecological risk assessments for the MGBG.

- VOCs, that were the primary constituents of concern at SWMU 01, were detected in soil, ground water, surface water, or sediment, but most of the contamination is confined to ground water.

- Several other chemicals were detected infrequently and at low concentrations in several of the environmental media investigated. Details are provided in TtNUS, 2003.

SITE RISK

A baseline human health risk assessment was performed for SWMU 01 to characterize the potential risks to likely human receptors under current and potential future land use. The human receptors evaluated for SWMU 01 were the construction worker, maintenance worker, occupational worker, adolescent trespasser, adult recreational user, and future adult and child residents. The following conclusions resulted from the human health risk assessment:

- The soils, ground water, surface water, and sediment data collected during the RFI were adequate to support the development of baseline human health and screening-level ecological risk assessments for the MGBG.

- Mustard gas, mustard gas degradates, and radiological contamination were not detected, although background concentrations of radionuclides were observed.

- The MGBG reasonable maximum and central tendency exposure incremental lifetime cancer risks for the future adult and child residents were estimated to exceed the range of 10^{-6} to 10^{-4} established by the U.S. Environmental Protection Agency (U.S. EPA) as acceptable; therefore, the risk is unacceptable. The environmental medium contributing the only significant risk to these estimates is ground water and the chemicals that contribute the greatest risk in that medium are VOCs. Table ES-1 of the RFI report (TtNUS, 2003) contains a summary of receptor-specific human risks and hazards, ecological risks, identifies critical pathways, and chemicals of concern, for the MGBG.

- Non-carcinogenic reasonable maximum and central tendency exposure hazard estimates for the construction worker, the future child resident, and the future adult resident for the ground water exposure pathway were greater than unity for the MGBG; therefore, the risk is unacceptable [Table ES-1 of the RFI report (TtNUS, 2003)]. The environmental medium contributing the only significant risk to these estimates is ground water and the chemicals that contribute the greatest risk in that medium are VOCs.

A screening ecological risk assessment (SERA) was performed for the MGBG. The ecological receptors evaluated in the screening assessment included receptors directly exposed to chemicals in the surface water and surface soil (i.e., plants and soil invertebrates), and indirectly exposed to chemicals via the food chain (i.e., through the ingestion of plants and invertebrates) and via the aquatic invertebrates that could be exposed to chemicals in the surface water and sediment in streams. The following conclusions resulted from the SERA:

- Risks to terrestrial plants, invertebrates, birds, and mammals from organic and inorganic chemicals in the surface soil in the MGBG were estimated to be low to negligible.

- Risk to aquatic receptors from organic and inorganic chemicals in surface water and sediments were estimated to be low to negligible. No significant aquatic habitat exists in drainage channels associated with the MGBG.

The RFI report concluded with a recommendation to proceed to a CMS because of the human health risk posed to future residents and construction workers as a result of potential exposure to contaminated ground water.

REMEDIAL ALTERNATIVES

Three corrective measure alternatives were developed for the MGBG. These alternatives include the following:

Alternative No. 1 – No Action. The No Action alternative maintains the site as is and is retained to provide a baseline for comparison to other alternatives.

Alternative No. 2 – Natural Attenuation with Monitoring and Institutional Controls. This alternative includes two major components: (1) Institutional Controls and (2) Ground Water Monitoring. Institutional controls would consist of formulating and implementing controls that would restrict future site

development and ground water use. Institutional controls would also include the performance of regular site inspections to verify the continued implementation of the controls. Ground water monitoring would consist of periodically collecting and analyzing ground water samples from monitoring wells located at the site to assess site conditions, especially the contaminant concentrations.

Alternative No. 3 – *In-Situ* Anaerobic Reductive Dechlorination with Institutional Controls and Monitoring. An aggressive treatment strategy was developed to reduce contaminant concentrations to acceptable levels. The strategy involves active treatment of the entire VOC plume to attain Media Cleanup Standards (MCSs) within 1 year followed by repeat treatments and monitoring over the ensuring 15 years to mitigate potential concentration rebound. Monitoring would continue until cleanup goals are attained.

There is no cost associated with Alternative 1; relative estimated costs of Alternatives 2 and 3 are:

Cost Item	Alternative 2	Alternative 3
Present-Worth	$350,000 (30 years)	$9,402,000

RECOMMENDED CORRECTIVE ACTION

Alternative 1 would not be sufficiently protective of human health and the environment because it would not prevent potential future exposure to contaminated ground water, or warn of potential migration of ground water chemicals of concern (COCs). Alternative 2 is much less costly than Alternative 3, but the time required to attain MCSs is very uncertain. Alternative 3 is cost-prohibitive, when the limited risk potential posed by the MGBG is considered. Therefore, Alternative 2 is the recommended remedial alternative. This alternative facilitates additional data collection to better project the time necessary to attain cleanup goals. Best projections to date (based on mean VOC concentrations for several wells over 25 years) indicate that these goals could be attained in as little as 30 years throughout the plume. The current and projected future land use (no change in land use for the foreseeable future) for this remote area supports this selection.

1.0 INTRODUCTION

This CMS report was prepared for the NSWC facility located in Crane, Indiana, for the NAVFAC EFD SOUTH under CTO 0315 for the CLEAN 3, Contract N62467-94-D-0888. This CMS report addresses one SWMU identified as SWMU 01 - MGBG.

1.1 SCOPE AND OBJECTIVES

This work is part of the Navy's Installation Restoration (IR) Program, which is designed to identify contamination of Navy and Marine Corps lands/facilities resulting from past operations, to assess the risks from the contaminants, and to institute corrective measures as needed. The IR Program typically consists of four distinct phases. Phase 1 is the Preliminary Assessment (formerly known as the Initial Assessment Study). Phase 2 is a RCRA Facility Assessment (RFA), which augments the information collected in the Preliminary Assessment. Phase 3 is the RFI/CMS, which characterizes the contamination at a facility and develops options for remediation of the site. Phase 4 is the Corrective Measure Implementation (also known as a Remedial Action), which results in the control or cleanup of contamination at the site. This report has been prepared under Phase 3 (RFI/CMS). The Indiana Department of Environmental Management (IDEM) is the lead oversight agency. However, under a work-sharing agreement, U.S. EPA Region 5 is responsible for oversight of all phases of the IR Program at SWMU 01.

The objectives of this CMS are as follows:

- Identify Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) criteria.
- Identify risk-based action levels that are protective of human health and the environment.
- Develop Corrective Action Objectives (CAOs), which identify COCs, receptors, pathways, and Preliminary Remediation Goals (PRGs). The PRGs are based on chemical-specific ARARs, TBCs, and risk-based action levels.
- Identify and screen corrective measures technologies.

- Develop Corrective Measures Alternatives (CMAs).

- Conduct detailed analysis of CMAs.

1.2 ORGANIZATION OF CORRECTIVE MEASURES STUDY REPORT

This CMS report consists of six sections. Section 1.0 is the introduction. It also provides a description of current conditions at SWMU 01. Section 2.0 presents recently collected data, a discussion of data quality, and a conceptual model for the site, including discussions of contaminant source(s), nature and extent of contamination, migration pathways and rates of migration, attenuation mechanisms, potential receptors, and associated human health and ecological risks. Section 3.0 identifies the ARARs, TBCs, COCs, and CAOs. Section 4.0 provides the identification and screening of corrective measure technologies for soil and ground water. Sections 5.0 and 6.0 present the development and evaluation/comparative analysis of CMAs, respectively. Section 6.0 also presents the recommended corrective measure for SMWU 01.

1.3 ACTIVITY BACKGROUND INFORMATION

1.3.1 Facility Location

NSWC Crane is located in the southern portion of Indiana, immediately east of Crane Village and Burns City (Figures 1-1 and 1-2). The facility is approximately 75 miles southwest of Indianapolis and 71 miles northwest of Louisville, Kentucky (Figure 1-1). NSWC Crane encompasses approximately 100 square miles (62,463 acres). The majority of the facility is located in the northern portion of Martin County. Smaller portions of the facility are located in Greene, Daviess, and Lawrence Counties.

NSWC Crane is located in a rural, sparsely populated area. Most of the facility is forested, and the surrounding area is wooded or farmed land. NSWC Crane provides naval support for equipment, shipboard weapons systems, and ordnance. In addition, NSWC Crane supports the Crane Army Ammunition Activity (CAAA) with production and renovation of conventional ammunition and storage, shipment, demilitarization, and disposal of conventional ammunition (Murphy et al., 1995). More detailed descriptions of NSWC Crane and SWMU 01 are provided in Section 1.0 of the RFI Report (TtNUS, 2003). The MGBG is located in the remote, southeastern area of NSWC Crane (Figure 1-2).

1.3.2 Facility History

1.3.2.1 History of Ownership and Operation

In 1940, the United States Congress authorized construction of a Naval Ammunition Depot (NAD) in southern Indiana, and the NAD Burns City was commissioned in late 1941. In 1943, NAD Burns City was renamed NAD Crane, and the town of Crane was built to house the rapidly growing number of civil service employees working at the facility. NAD Crane's overall mission was to load, prepare, renovate, receive, store, and issue ammunition to the U.S. Naval fleet.

During World War II, NAD Crane's mission expanded to include pyrotechnics production, mine filling, rocket assembly, field storage, torpedo storage, and ordnance spare parts and mobile equipment storage. During the 1950s, several new departments were created, the Ammunition Loading and Production Engineering Center (ALPEC) was transferred to Crane, and the Central Ammunition Supply Control Office (CASCO) was established. NAD Crane supplied ammunition to the fleet during the Korean and Vietnam conflicts. During the Southeast Asia crisis, the number of full-time employees at NAD Crane grew to 6,800.

In 1975, NAD Crane was designated the Naval Weapons Support Center Crane (NWSCC). Its new mission was to provide support for ships, aircraft, equipment, shipboard weapons systems and assigned ordnance items and to perform additional functions as directed.

In 1977, the Single Manager Concept was implemented. The CAAA was created, and the Army assumed ordnance production, storage, and related responsibilities as a tenant organization. In 1992, the facility was designated as NSWC Crane. Other functions at NSWC Crane remain the responsibility of the Navy, and currently the Navy retains ownership of all real estate and facilities at NSWC Crane. Responsibility for overall station safety, security, and environmental protection remains with the Commanding Officer, NSWC Crane. Approximately 4,000 people are currently employed at this facility.

1.3.2.2 History of Regulatory Action

Following promulgation of the U.S. EPA RCRA hazardous waste regulatory program, NSWC Crane filed notification and application in October 1980 to operate as a RCRA hazardous waste treatment, storage, or disposal (TSD) facility. Interim status was granted subject to operating requirements and applicable technical standards found in 40 Code of Federal Regulations (CFR) Part 265. Corrective action programs, established as part of the 1984 RCRA Hazardous and Solid Waste Amendments (HSWA), required NSWC Crane to address past releases of hazardous wastes or hazardous constituents at all

SWMUs. Accordingly, NSWC Crane submitted a Hazardous Waste Management Report to the U.S. EPA in January 1985. Following the Hazardous Waste Management Report, an RFA (A.T. Kearney, Inc., 1987) was conducted to characterize the potential for releases of hazardous wastes or constituents from 100 SWMUs identified during the RFA.

On December 23, 1989, the U.S. EPA issued the federal portion of the Final RCRA Part B permit for NSWC Crane to the Navy. The U.S. EPA renewed the RCRA Part B permit in 1995. The IDEM now has responsibility for the Federal Corrective Action Program. In October 2001, the IDEM renewed the Corrective Action Permit. However, ongoing corrective actions, including those concerning the MGBG, will continue under the U.S. EPA-IDEM Work Sharing Agreement for Corrective Action Activities at the NSWC.

1.3.3 Mustard Gas Burial Ground Location and Description

Until August, 2004, the MGBG was delineated as an approximately rectangular area of approximately 2 acres. The new MGBG boundary shown on Figure 1-3 encompasses approximately 12 acres and reflects the latest understanding of site activities and extent of contamination. The original 2-acre site was surrounded by a fence until 1995 at which time the United States Army Corps of Engineers (USACE) removed the fencing in preparation for a geophysical survey. When the fencing was removed, a creosote soaked fence post was installed at each of the four corners of the site to mark the original MGBG boundaries. Those four corner posts were still present as of June 2002 and at least three of the posts were present in February 2004. Within the original MGBG is a smaller, approximately rectangular area where waste materials were reported to have been buried. This area of approximately 0.2 acre size is referred to as the PBA (Figures 1-3 and 1-4). There are no records of waste material burials outside of the PBA.

The MGBG was used between the end of World War II and 1956 for disposal of hazardous materials (USACE WES, 1991). Disposal was in the form of shallow burials (pits), typically within 6 feet of the surface. Three types of hazards or potential hazards were identified at the site as follows:

- Aerial mustard gas bombs (without explosives)
- Thorium nitrate powder (in pyrotechnic flares)
- Small quantities of unspecified chemical laboratory wastes

The thorium nitrate and illuminant material containing thorium or thorium compounds were buried as waste from a research and development effort related to pyrotechnic devices. The unspecified chemical

waste releases are documented to have comprised "some ninety (few ounces each) quantities of aged laboratory chemicals on May 18, 1967" (Fitch, 1974). No further information is available on the quantities or identities of the unspecified chemicals. The disposal was designed to encourage decomposition of the small amounts of chemical wastes by effecting close contact with soil and moisture.

1.3.3.1 Waste Exhumations

A chemical safety survey was conducted in March 1973 by the United States Department of Defense Explosive Safety Board, which recommended that all hazards buried at the site be excavated so that the site could be certified safe (USACE WES, 1991). Two exhumations (in 1974 and 1980) were undertaken to remove all buried hazards at the MGBG (U.S. Navy, 1980). Field testing for mustard gas and soil screening for gamma radiation were performed during the exhumations. In addition, gamma spectrometric analyses were conducted on representative soil samples. In 1975, all of the radioactive material from the first exhumation was sent to a United States Nuclear Regulatory Commission-licensed burial ground in Barnwell, South Carolina. In 1980, three additional locations within the MGBG were identified to be thorium nitrate burial areas, and the wastes from those areas were exhumed (U.S. Navy, 1980). During this effort, a magnetometer survey was completed, and six additional bomb casings devoid of mustard gas, one mustard gas identification kit, an unspecified quantity of thorium nitrate, and illumination candle debris were found. The six newly exhumed bomb casings and original 10 aerial bombs exhumed in 1974 were dismantled, decontaminated using a steam cleaning and chemical soaking process, burned with thermite, and prepared for transport and disposal (U.S. Navy, 1980). Ultimate disposal was at the NSWC Crane landfill.

As a result of these exhumation efforts, the MGBG was cleared with the assurance that all ordnance items had been removed from the site. The risk of exposure to live mustard agent was declared to be extremely small, and the site was cleared for unrestricted use with regard to radioactive contamination (U.S. Navy, 1980). Further details regarding geophysical investigations and exhumations are presented in the MGBG RFI report, Section 1.3.3 (TtNUS, 2003).

1.3.3.2 History of Environmental Investigations

In 1981, a ground water monitoring program was undertaken involving the installation and sampling of five monitoring wells. Chlorinated VOC contamination was detected in ground water, and between 1982 and 1983, 12 additional wells were installed in the bedrock and sampled. In 1983, 10 more wells were installed and sampled. Another well was added prior to 1993, bringing the total number of monitoring wells at the MGBG to 28 as of 1993. Select wells were sampled at various times between 1980 and

1986, and the ground water contaminant plume was found to extend several hundred feet to the northwest of the MGBG with concentrations of total organic halogens of hundreds of milligrams per liter (mg/L) near the PBA (TtNUS, 2003).

RFI Phase III field investigations were conducted in 2001 (Round 1) and 2002 (Round 2) according to the RFI Quality Assurance Project Plan (QAPP) and the Round 2 Sampling and Analysis Plan (TtNUS, 2001 and 2002). During this time span, four new monitoring wells were installed. One of these wells (01T02) was designated as an upgradient well based on local topography. Twenty-one soil cores were installed from which 59 samples were collected within and around the MGBG using direct-push technology (DPT). Several cores were collected down to the bedrock surface. In addition, surface water and sediment samples were collected from drainage gullies leading north-northwest and southwest from the MGBG. Figure 1-3 shows all of the monitoring well, soil boring, surface water, and sediment sampling locations.

At the conclusion of the RFI, a specific location within the MGBG had not been definitively identified as a source area for the VOCs detected in ground water. Based on the site history and available data, the PBA was identified as the likely source area. Only one out of 59 soil samples collected during the RFI contained detectable concentrations of COCs. This sample, collected in the 2 to 4 foot depth interval at the western edge of the PBA, contained both 1,1,2,2-tetrachloroethane (PCA) and chloroform at 2 and 4 µg/kg, respectively. None of the other soil samples had detectable concentrations of any of the prevalent ground water contaminants, tetrachloroethene (PCE), 1,1,2-trichloroethane (TCA), or trichloroethene (TCE). As a result, another approach for soil sampling (digging test pits) was used during the early part of the CMS (February 2004) in hopes of more conclusively identifying a source area for the VOCs. Also, two shallow monitoring wells were installed. One well, 01T06, was located near the center of the MGBG, southeast of the PBA. The other, 01T07, was located on the western side of the PBA. These wells were the first monitoring wells to be installed within the formal 2-acre MGBG boundary. They were used to determine whether or not VOC concentrations were higher in the shallow ground water directly beneath the MGBG compared to wells 01-02 and 01-05 on the northern side (i.e., downgradient) of the MGBG. Figure 1-4 shows the locations of the eight test pits and the two new monitoring wells installed at the beginning of the CMS. The field work was performed according to the MGBG QAPP Addendum No. 1 (TtNUS, 2004).

A detailed description of the 2001 and 2002 field work is provided in Section 2.0 of the RFI report (TtNUS, 2003). A detailed description of the CMS field work is presented in Appendix A of this CMS report. The associated data are described and interpreted in detail in Section 2.0 of this report. Some deviations from the QAPP occurred (see Section 2.1.2), but they did not preclude the attainment of project objectives.

1.4 PHYSICAL CHARACTERISTICS OF SWMU 01 STUDY AREA

1.4.1 Climate and Meteorology

SMWU 01 is located in a warm, temperate climatic zone. In general, the summers are warm and humid, and winters are mild with occasional short cold periods. The temperature ranges from an average maximum July temperature of 89°F to an average minimum January temperature of 26 degrees Fahrenheit (°F). Precipitation is fairly evenly distributed throughout the calendar year; the maximum precipitation is during the spring and early summer. The average annual precipitation at the facility is 44 inches (liquid equivalent), consisting of 42 inches of rain and 15 inches of snow. Relative humidity for the local area is generally highest in the early morning hours of the monthly period June through September and generally ranges between 80 to 88 percent on average. The lowest values of relative humidity, historically, have occurred during the period March through October, when values average between 54 and 58 percent. The annual prevailing wind direction for the region is from the southwest, and the annual average wind speed for the area is about 9.6 miles per hour.

1.4.2 Topography and Surface Drainage

NSWC Crane is located in the unglaciated area of the Crawford Uplands physiographic division. This division is described as a rugged, dissected plateau that is bounded by the Mitchell Plain Physiographic Province to the east and the Wabash Lowland Physiographic Province to the west. The terrain is predominantly rolling, with moderately incised stream valleys throughout and occasional flat areas in the central and northern portions of NSWC Crane. Lake Greenwood extends in an east-west direction across the northern part of the facility (Figure 1-2). The elevations across the facility range from about 500 feet above mean sea level (amsl) to about 850 feet amsl. Topographic relief in the Crawford Upland ranges from 100 to 350 feet (see Figure 1-5). Greater relief exists in the eastern part of NSWC Crane.

SWMU 01 lies on a northwest/southeast-trending ridge crest that has surface elevations ranging from approximately 660 to 680 feet amsl (Figure 1-3). The crest of the gently crowned MGBG is estimated to be 5 to 10 feet higher than Highway-251. A deeply incised drainage channel lies about 500 feet north of the MGBG. The elevation along this channel is approximately 540 to 580 feet amsl. Another deeply incised channel lies about 1,200 feet south-southwest of the MGBG, and its elevation is about 520 to 570 feet amsl as it passes south of the MGBG. Total relief in the immediate vicinity of the MGBG therefore is approximately 150 feet. The steepest slopes near the MGBG occur on the northern side and are estimated to be about 30 percent.

Seven primary creeks in five drainage basins carry surface water off the NSWC Crane property and eventually drain into the East Fork of the White River and then to the Wabash River to the southwest. Figure 1-2 shows the drainage basins and surface drainage features of NSWC Crane. The MGBG is located in the Boggs Creek Basin.

Runoff from the MGBG ridge top drains into several small gullies that run down the side slopes and into two unnamed tributaries of Goldsberry Hollow (Figures 1-3 and 1-5). Goldsberry Hollow drains west-southwest about 1.2 miles before it enters Boggs Creek. Boggs Creek then flows southward into a 34-acre reservoir (Lake Gallimore) located at the southern boundary of NSWC Crane (Figure 1-5). From the reservoir, Boggs Creek continues to flow southward about 6 miles where it joins the East Fork of the White River. The Boggs Creek watershed drains approximately 70 percent of NSWC Crane (Figure 1-2).

1.4.3 Geology and Soils

The ridge on which the MGBG is located is underlain by Lower Pennsylvanian and Upper Mississippian bedrock formations (Figure 1-6), with a thin veneer (less than10 feet thick in places) of residual soils and loess overlying the bedrock. The residual soils are the result of chemical and physical weathering of the underlying Pennsylvanian shales, siltstones, and sandstones. Sols of the well-drained, Wells-Berks-Gilpin complex are found on all of the hillsides near the MGBG (McElrath, 1988). In a typical profile, 1 to 2 inches of dark gray to brown silt loam are found at the surface. The subsurface soil is composed of light to dark yellowish-brown, silty loam to silty clay loam. All soils in the Wells-Berks-Gilpin complex contain about 15 to 35 percent clay. Most of the soils encountered during the RFI were damp to moist and contained some roots.

A total of 34 monitoring wells have been installed in and around the MGBG site since 1981. All of these wells are located along the crest or on the upper slopes of the ridge (Figure 1-3). All of the monitoring wells penetrate through the overburden soils and are screened in bedrock, although in different stratigraphic positions. Table 1-1 lists all of the monitoring wells with physical characteristics of each well. Figure 1-3 shows the locations of all monitoring wells and traces of geologic cross sections prepared for the site. Cross sections A-A', B-B', and C-C' are presented in Figures 1-7, 1-8, and 1-9, respectively.

Bedrock underlying the MGBG consists of sedimentary rocks from the Lower Pennsylvanian-age Mansfield Formation (Raccoon Creek Group) and the underlying Upper Mississippian-age Stephensport and West Baden Groups (Figure 1-6). Monitoring wells 01T03 and 01T04 are the deepest wells drilled at the MGBG (155 and 153 feet deep, respectively)(Figures 1-8 and 1-9). These deepest wells penetrated

approximately 5 feet of residual soil, 134 feet of Mansfield Formation (Lower Pennsylvanian), and 15 feet of Mississippian limestone.

The Mansfield Formation (uppermost bedrock) consists primarily of alternating beds of shales (e.g., black shale and carbonaceous shale), sandstone, and siltstone but also includes thin discontinuous coal seams and limestone lenses. An erosional unconformity separates the Pennsylvanian strata above from the Stephensport strata below (Figure 1-6). Depending on the location at NSWC Crane, pre-Pennsylvanian erosion has removed a significant portion of the Stephensport strata. At these locations, the paleovalleys were filled with shales and sandstones of Pennsylvanian age. The base of the Mansfield Formation is estimated to be at about 530 to 540 feet amsl at the MGBG. Therefore, the Mansfield Formation is about 120 to 135 feet thick at the MGBG. Barnhill and Hansley (1993) interpret the Pennsylvanian strata at the MGBG area to represent an interfluve area that lies between two major paleovalleys. According to their interpretations, the Pennsylvanian strata at the MGBG are relatively thin and consist of more fine-grained deposits (i.e., shale and siltstone) compared to other sites at NSWC Crane. Pennsylvanian rock units encountered during the RFI at the MGBG are consistent with this interpretation.

The uppermost bedrock unit located at the top of the ridge is sandstone that has small amounts of interbedded shale and siltstone. This sandstone is situated between approximately 620 and 665 feet amsl in the vicinity of the MGBG (Figures 1-7 and 1-9). In general, this sandstone is approximately 30 to 40 feet thick. It is fractured, chemically weathered, oxidized in many locations (pale orange to grayish orange in color), and friable to a small extent. Twenty of the 34 monitoring wells installed at the site are screened in this sandstone. The wells that have the highest concentrations of VOCs are screened in this uppermost sandstone unit (discussed in Sections 2.1 through 2.3).

Between 560 and 620 feet amsl, the Pennsylvanian bedrock consists mostly of thin, alternating sandstone, shale, and siltstone units and discontinuous coal seams (Figures 1-7 through 1-9). Barnhill and Hensley (1993) classified most of the rock as siltstone and shale, with minor amounts of sandstone. Ten monitoring wells located on the northern side of the ridge on the side slope are screened between 570 to 619 feet amsl (Table 1-1 and Figure 1-3). The screens in these monitoring wells are all relatively shallow [less than 40 feet below ground surface (bgs)]. These wells are included in the group described above (the shallow monitoring interval) because the wells are shallow, even though they are screened in different lithologic units. The conceptual flow model described in Section 2.5 presents the reasons for combining these two groups of wells.

The deepest portion of the Pennsylvanian strata consists of 30 feet of sandstone situated between approximately 530 and 560 feet amsl (Figures 1-7 through 1-9). The average grain size of the sandstone

is about the same as the upper sandstone. However, there appears to be more clay (detrital and authigenic) filling in the interstices between sand grains, thereby reducing the effective porosity and permeability of this sandstone (Barnhill and Hansley, 1993).

The lowermost sandstone described above represents the base of the Pennsylvanian strata and rests on a major erosional unconformity. The limestone below represents the top of the Mississippian strata. Across NSWC Crane, the Stephensport Group (Upper Mississippian) is generally 130 to 190 feet thick. It includes a number of sandstone and limestone units such as the Big Clifty Sandstone and the Beech Creek Limestone (Figure 1-6). Based on structural mapping of the Beech Creek Limestone, the base of the Stephensport Group is estimated to be at 400 to 420 feet amsl near the MGBG [Naval Energy and Environmental Support Activity (NEESA), 1983]. The top of the Stephensport Group occurs at approximately 525 to 540 feet amsl, as discussed above (see Figures 1-7 through 1-9). Therefore, the Stephensport Group (Upper Mississippian age) is about 100 to 140 feet thick at the MGBG.

The four deep monitoring wells at the site (01C01, 01-06, 01T03, and 01T04) and the boring for monitoring well 01-10 penetrated 3 to 37 feet of Stephensport limestone and shale (Figures 1-7 through 1-9). According to Barnhill and Hansley (1993), the limestone encountered at the bottom of the deep monitoring wells might be the Glen Dean Limestone Formation. The logs of borings for 01-06, 01-10, 01T03, and 01T04 indicate that the limestone is hard, gray, fossiliferous, and jointed.

The Upper Mississippian bedrock crops out near the bottom of the major stream channels a short distance northwest of the MGBG area (Figure 1-10 of the RFI report, TtNUS, 2003). Near the MGBG, the bedrock exposed at the bottom of the drainage channels is the lowermost Mansfield Group sandstone and siltstone.

1.4.4 Hydrogeology

Rainfall and snowmelt infiltrates the soil materials on the top and sides of the ridge at the MGBG throughout the year. However, during the summer and fall, the trees, understory vegetation, and grasses consume a large proportion of the recharge water and return it to the atmosphere as evapotranspiration. The soil materials on top of the ridge are unsaturated and the overburden is less than 10 feet deep near the PBA.

As described in Section 1.4.3, the uppermost bedrock unit is a Pennsylvanian-age sandstone that is 30 to 40 feet thick. Twenty monitoring wells are screened in this sandstone. In addition, another 10 monitoring wells are screened in sandstone, siltstone, and shale units to the north and slightly downhill of the MGBG

area. Because these wells are located down the side of the slope and at a lower elevation, they are not screened in the same sandstone unit as the 20 wells mentioned above. However, the upper sandstone is not present (because of erosion) or is not saturated where the group of 10 wells is located. For reasons explained in Section 2.0, these 30 wells are grouped together and are referred to as the shallow monitoring zone for purposes of mapping the potentiometric surface, mapping the lateral distribution of contaminants in the shallow ground water, and for evaluating fate and transport of contamination.

During the 2001 and 2002 field efforts, an attempt was made to visually identify seeps around the MGBG. None were found, although presumably, seeps do exist. Likely locations for seeps are those places where the ground water elevation is the same as the topographical elevation (see Figure 1-10).

Water levels were measured in the monitoring wells on August 2001 and June 2002 during the RFI (Table 1-1). Boring logs for those wells and potentiometric surface maps for these two monitoring events are presented in the RFI report (Appendix A and Figures 1-16 and 1-17, TtNUS, 2003). Boring, test pit, and well completion logs for the most recently installed test pits and wells (01T06 and 01T07) are included in Appendix B of this report. In late January 2004, a third set of ground water elevations were measured (Table 1-1).

The potentiometric surface based on the latest set of measured water levels is presented in Figure 1-10. The potentiometric contours of the shallow monitoring zone form a ridge that generally follows the topographic ridge (in a northwest-southeast direction). The highest ground water elevations were measured in wells 01-03 (located on the southern side of the MGBG), 01-01 (located on the southeastern side of the MGBG), and 01T07 (located in the center of the MGBG). The ground water elevations at the MGBG ranged from 654 to 664 feet amsl and decreased to the north and northwest of the MGBG. The elevations in the wells in the far northern line of monitoring wells ranged from 590 to 600 feet amsl. There is a total head loss of 73 feet between well 01-03 and 01-24 (Figure 1-10). The lateral hydraulic gradient (0.182) from well 01T07 is steepest toward well 01-08. The lateral gradient between 01T07 and 01-25 (0.033) is relatively gentle. Based on the potentiometric surface map presented in Figure 1-10, shallow ground water flows from the MGBG northward, and northwestward to a lesser degree. The shallow ground water on the south and west sides of the MGBG is flowing southwestward. The flow divide between ground water flowing northward and ground water flowing southwestward lies close to well 01-03 (Figure 1-10).

The middle portion of the Pennsylvanian strata, from about 560 to about 620 feet amsl, consists primarily of irregular beds and lenses of sandstone, siltstone, and shale. Two thin coal seams (each less than 1 foot thick) were encountered at elevations of approximately 610 and 565 feet amsl. The abundance of

shale, siltstone, and clay lenses in this interval reduces the likelihood that water or contaminants are moving downward through this interval of Pennsylvanian strata. This is discussed in greater detail in Section 2.5.

The sandstone at the base of the Mansfield Formation (Pennsylvanian) is more cemented than the uppermost sandstone and does not appear to as permeable as the upper sandstone. Drilling logs indicate that the sandstone is weathered and appears to be orange, tan, or brown and dry near its base. The oxidized conditions and the lack of ground water in the sandstone suggest that the sandstone is partially dewatered. This could occur if ground water drains from the sandstone into the Mississippian limestone below faster than it is recharged.

Mississippian limestone beds were encountered in wells 01-06, 01-10, 01-C01, 01T03, and 01T04 below an elevation of approximately 540 feet amsl (Figures 1-7 through 1-9). The limestone is thought to represent the uppermost Mississipian-age rock at this location and is probably part of the Glen Dean or Golconda Limstones of the Stephensport Group. Based on cores taken at wells 01T03 and 01T04, the limestone was fractured and contained several horizontal and few high angle joints and was water stained at several of the joints. The uppermost Mississipian limestone is considered to be a separate aquifer from the overlying Pennsylvanian rocks.

Ground water elevations measured in January 2004 in the four deep monitoring wells (Upper Mississipian) were between 527 and 530 feet amsl. The water level elevations in the Mississippian limestone were approximately 110 to 127 feet deeper than the ground water elevations in the shallow sandstone directly above. The very large difference in hydraulic head between the upper sandstone and the deep monitoring wells strongly suggests that the shale, siltstone, and clay beds in the middle portion of the Pennsylvanian strata form effective aquitards that minimize the downward movement of water to the underlying limestone aquifer.

A potentiometric surface map for the ground water elevations measured in deep wells completed in the limestone aquifer in January 2004 is presented in Figure 1-11. The deep ground water elevation is highest (529.36 feet amsl) in well 01-06 located north of the PBA. Ground water elevations in the Mississippian aquifer decline to the southwest toward well 01C01. Based on limited deep well information, it appears that ground water in the deep aquifer flows to the southwest, which is the general direction of the dip of Mississippian bedrock in this area. The hydraulic gradient of the deep aquifer is approximately 0.0033. As a group, the deep wells are characteristically not contaminated (TtNUS, 2003). Therefore, the deep wells are not discussed in detail for this CMS.

The channel elevation near 01SD04 is about 560 feet amsl (Figure 1-3). The elevation of the top of the lowest Pennsylvanian sandstone unit (at well 01-06, see Figure 1-9) is about 540 feet amsl. Thus, erosion in the stream channel has cut into the lower Pennsylvanian sandstone, which lies immediately above the Mississippian limestone. The lower sandstone was dry in well 01-06, and the ground water elevation in the limestone was at 529.36 feet amsl in January 2004. Therefore, when surface water is flowing in the ephemeral channel during storm events, it is about 20 feet higher than the ground water elevation in the limestone. As a result, the limestone aquifer is probably being recharged by surface water from the channel during storm events.

Horizontal hydraulic conductivities (Kh) were calculated from drawdown data collected when the monitoring wells underwent low-flow purging during the RFI (see TtNUS, 2003, Appendix B.5). These hydraulic conductivity values are summarized in Table 1-2. The calculated Kh values for the shallow sandstone ranged from 0.003 to 0.13 foot per day; the geometric mean value was 0.022 foot per day. These values are relatively low and suggest that the sandstone exhibits low permeability. Fractures and jointing in the sandstone are present and may be present to a greater degree in some areas not represented by the monitoring wells that have been hydraulically tested. Therefore, the Kh of the upper sandstone is probably higher in some areas along the length of the plume than the values reported in Table 1-2.

The Kh for the interbedded shale/siltstone/sandstone/coal lenses in the middle portion of the Pennsylvanian rock column ranged from 0.005 to 0.60 foot per day; the geometric mean Kh value was 0.024 foot per day (Table 1-2). The geometric mean value for the intermediate rock units was nearly the same as the Kh for the upper sandstone. However, an anomalously high Kh value of 0.60 foot per day was determined for monitoring well 01-13. The remainder of the Kh values for the intermediate monitoring wells were less than 0.047 foot per day.

The calculated Kh values for Mississippian limestone wells 01-06 and 01T03 were 0.42 and 0.17 foot per day, respectively, which are about ten times greater than the Kh values determined for the overlying Pennsylvanian strata.

The average intergranular porosity for the upper sandstone was determined to be about 21 percent based on four rock thin sections (Barnhill and Hansley, 1993). It is believed that the sandstone is well cemented in areas and that preferential migration pathways exist along small fractures and joints in the sandstone. Thus, the overall permeability of the sandstone might be greater than indicated by the slow-purge tests, and the intergranular porosity might be relatively low because of cementation. Calculations of hydraulic conductivity, assumptions for porosity, and calculations for ground water seepage velocity are presented

in the RFI report (TtNUS, 2003, Appendix B). Because of the potential (and even likelihood) for preferential pathways to exist, a computation of average migration rates and seepage velocities seems to be most appropriate for characterizing the plume as a whole. In the RFI, lateral groundwater seepage velocities were calculated and ranged from 0.225 to 1.35 feet per day (82 to 493 feet per year).

The 1,1,2,2-PCA and TCE plume lengths in 1982 were about 660 feet in the westward direction. If the solvent disposal at the MGBG occurred around 1960, then the contaminants traveled about 660 feet in 22 years, or 30 feet per year. The contaminants cannot travel faster than ground water, therefore the ground water seepage velocity must be at least 30 feet per year based on contaminant data.

1.4.5 Water Supply

Lake Greenwood at the northern end of the NSWC Crane facility (Figure 1-2) is the main source of drinking water at NSWC Crane, and it is also used for recreation. Ground water in the vicinity of SWMU 01 is not currently being used for any purpose.

Surface and subsurface drainage from the vicinity of MGBG ultimately ends up in Goldsberry Hollow followed by Boggs Creek (Figures 1-2 and 1-5). Boggs Creek drains into Lake Gallimore, a 34-acre flood control impoundment at the far southern end of NSWC Crane. Lake Gallimore is considered a fishery, but is not used for water supply.

1.4.6 Surrounding Land Use

NSWC Crane is situated in a rural area of south-central Indiana. The surrounding communities that form the region are in a period of transition from an economic base of agriculture, mining, and quarrying to an economy built on manufacturing and service industries. The patterns of settlement, population statistics, and median income are similar throughout the region.

There is no state or local planning within the vicinity of NSWC Crane. The only zoning and land use regulations are found in the municipalities within the region. None of these municipalities are close enough to have an impact on NSWC Crane. The MGBG is about 1 mile from the southeastern boundary of NSWC Crane, which is the closest boundary. None of the areas adjacent to NSWC Crane are zoned, and zoning is not anticipated in the near future. There are no known land use or community actions under consideration or proposed at this time that might be affected by remedial actions at the MGBG.

1.4.7 Ecology

NSWC Crane is a heavily forested facility situated within the Western Mesophytic Forest Region, Hill Section, and Beech-Maple Forest Region (Braun, 1950). Deciduous trees and shrubs cover most of the region. NSWC Crane also contains old agricultural fields in various stages of biological succession. The areas to the north of the MGBG (including the northeastern corner of the site) and to the south of Highway-251 are heavily wooded with mature deciduous trees including oaks, maples, sycamore, and American beech. The forest understory north of the MGBG consists of sparse patches of ground vegetation (i.e., ferns, grasses, moss). The forest understory south of Highway-251 consists of vegetation including vines with thorns.

The white-tailed deer is the most conspicuous large wild mammal at the installation. Other mammals include opossum, raccoon, rabbits, mice, bats, chipmunks, squirrels, beaver, groundhogs, gray fox, coyotes, and long-tailed weasel. Fox, coyotes, and hawks are carnivores whose presence indicates a healthy ecosystem because smaller mammals are present to provide a food source (NEESA, 1983). The threatened and endangered Indiana Bat may be present in the vicinity of the MGBG.

Over 100 avian species have been identified at NSWC Crane during breeding seasons (Hengeveld, 1987). The bird population includes a number of threatened, endangered, or species of special concern that use NSWC Crane as their home range. These species include the bald eagle, osprey, sharp-shinned hawk, red-shouldered hawk, broad-winged hawk, black and white warbler, hooded warbler, and the worm-eating warbler [Brown & Root (B&R) Environmental, 1997].

Previous studies conducted at NSWC Crane (Nelson, et al., 1987) identified 21 amphibian species and 22 reptile species (including skinks, lizards, snakes, and turtles). A total of 46 distinct fish species were collected from the installation during a 1987 inventory of the fish fauna at NSWC Crane. The 1987 study observed that, other than Greenwood Lake, the greatest number of individual fish species were recorded from the largest stream (Boggs Creek) and that the smallest number of species were recorded from Turkey Creek.

TABLE 1-1

MONITORING WELL CONSTRUCTION INFORMATION AND WATER LEVEL MEASUREMENTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Ground Elevation (ft amsl)	Top of Riser Elevation (ft amsl)	Total Depth (ft bgs)[1]	Screened Interval				Aquifer	August 17, 2001		June 17, 2002		January 28, 2004	
					Top (ft bgs)	Bottom (ft bgs)	Top (ft amsl)	Bottom (ft amsl)		Depth to Water (ft btor)	Ground Water Elevation (ft amsl)	Depth to Water (ft btor)	Ground Water Elevation (ft amsl)	Depth to Water (ft btor)	Ground Water Elevation (ft amsl)
01-01	1981	682.46	685.22	48	33.14	42.77	649.32	639.69	Upper Pennyslvanian	28.9	656.32	27.13	658.09	28.30	656.92
01-02	1981	663.56	666.03	23.8	8.24	17.6	655.32	645.96	Upper Pennyslvanian	15.59	650.44	11.17	654.86	11.63	654.40
01-03	1981	666.85	669.55	18.6	3.99	13.41	662.86	653.44	Upper Pennyslvanian	12.83	656.72	5.27	664.28	5.49	664.06
01-04	1981	669.05	671.99	31	16.47	25.68	652.58	643.37	Upper Pennyslvanian	20.01	651.98	15.39	656.60	16.8	655.19
01-05	1981	665.07	667.79	30	16.18	25.3	648.89	639.77	Upper Pennyslvanian	17.83	649.96	14.17	653.62	15.52	652.27
01-06[2]	11/10/1982	595.38	598.41	90	75.02	84.4	520.36	510.98	Upper Mississipplan	71.12	527.29	68.77	529.64	69.05	529.36
01-07[2]	11/14/1982	602.95	605.81	28.5	12.61	21.99	590.34	580.96	Upper Pennyslvanian	17.55	588.26	14.71	591.10	15.78	590.03
01-08	11/15/1982	601.25	604.09	31	13.63	22.95	587.62	578.30	Upper Pennyslvanian	15.87	588.22	12.74	591.35	12.8	591.29
01-09	11/16/1982	609.6	612.23	32	17.4	26.78	592.20	582.82	Upper Pennyslvanian	20.54	591.69	12.92	599.31	12.6	599.63
01-10	11/30/1982	636.25	638.92	120	25.25	34.65	611.00	601.60	Upper Pennyslvanian	26.15	612.77	22.96	615.96	22.19	616.73
01-11	1/8/1983	655.49	658.36	19.6	6.72	15.35	648.77	640.14	Upper Pennyslvanian	11.17	647.19	7.03	651.33	6.64	651.72
01-12	1/19/1983	633.31	636.12	38	23.26	32.67	610.05	600.64	Upper Pennyslvanian	26.39	609.73	23.59	612.53	23.9	612.22
01-13	1/19/1983	634.17	637.06	35	19.97	29.42	614.20	604.75	Upper Pennyslvanian	24.67	612.39	21.58	615.48	20.65	616.41
01-14	1/25/1983	655.45	658.09	36	21.12	30.65	634.33	624.80	Upper Pennyslvanian	16.41	641.68	13.36	644.73	14.01	644.08
01-15[2]	2/10/1983	662.27	665.64	37.8	22.1	31.6	640.17	630.67	Upper Pennyslvanian	28.56	637.08	22.22	643.42	28.20	637.44
01-16	2/11/1983	641.09	644.05	38.5	23.75	33	617.34	608.09	Upper Pennyslvanian	DRY	DRY	35.14	608.91	35.71	608.34
01-17	2/12/1983	662.12	664.61	39	23.25	32.55	638.87	629.57	Upper Pennyslvanian	22.26	642.35	19.44	645.17	20.70	643.91
01-18	6/17/1983	658.24	660.55	30.5	14.3	23.59	643.94	634.65	Upper Pennyslvanian	15.54	645.01	12.78	647.77	14.62	645.93
01-19	6/17/1983	656.44	658.92	30.2	15.7	24.7	640.74	631.74	Upper Pennyslvanian	22.04	636.88	20.85	638.07	21.65	637.27
01-20	6/20/1983	630.55	633.45	36.1	21.35	30.69	609.20	599.86	Upper Pennyslvanian	29.13	604.32	23.30	610.15	27.24	606.21
01-21	6/20/83	603.47	606.01	40.50	23.74	32.75	579.73	570.72	Upper Pennyslvanian	17.81	588.20	14.96	591.05	15.43	590.58
01-22	7/8/83	653.09	655.85	35.00	20.50	29.65	632.59	623.44	Upper Pennyslvanian	19.39	636.46	18.23	637.62	18.54	637.31

TABLE 1-1

MONITORING WELL CONSTRUCTION INFORMATION AND WATER LEVEL MEASUREMENTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Ground Elevation (ft amsl)	Top of Riser Elevation (ft amsl)	Total Depth (ft bgs)[1]	Screened Interval				Aquifer	August 17, 2001		June 17, 2002		January 28, 2004	
					Top (ft bgs)	Bottom (ft bgs)	Top (ft amsl)	Bottom (ft amsl)		Depth to Water (ft btor)	Ground Water Elevation (ft amsl)	Depth to Water (ft btor)	Ground Water Elevation (ft amsl)	Depth to Water (ft btor)	Ground Water Elevation (ft amsl)
01-23	7/9/83	625.41	627.88	45.00	30.51	39.58	594.90	585.83	Upper Pennyslvanian	40.89	586.99	38.67	589.21	38.73	589.15
01-24	7/9/83	599.82	602.66	30.40	15.62	25.03	584.20	574.79	Upper Pennyslvanian	14.89	587.77	11.43	591.23	11.70	590.96
01-25	8/6/83	653.89	656.33	32.00	17.42	25.79	636.47	628.10	Upper Pennyslvanian	21.71	634.62	20.92	635.41	21.79	634.54
01-26	8/6/83	669.76	672.33	55.00	40.45	49.57	629.31	620.19	Upper Pennyslvanian	36.54	635.79	35.68	636.65	36.45	635.88
01-27	8/6/83	659.15	661.86	40.30	25.55	34.55	633.60	624.60	Upper Pennyslvanian	25.22	636.64	24.10	637.76	24.98	636.88
01C01	NA	663.96	666.23	NA	NA	NA	NA	NA	Upper Mississippian	139.53	526.70	138.42	527.81	138.54	527.69
01T01	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
01T02	9/8/01	696.83	698.89	115.00	60.00	70.00	636.83	626.83	Upper Pennyslvanian	65.37	633.52	65.25	633.64	65.60	633.29
01T03	6/3/02	664.79	667.12	155.00	144.00	154.00	520.79	510.79	Upper Mississippian	NI	NI	139.16	527.96	139.25	527.87
01T04	6/4/02	663.02	665.81	153.00	141.00	151.00	522.02	512.02	Upper Mississippian	NI	NI	137.97	527.84	138.09	527.72
01T05	6/5/02	639.59	641.85	32.00	21.00	31.00	618.59	608.59	Upper Pennyslvanian	NI	NI	16.84	625.01	17.92	623.93
01T06	1/15/04	674.89	677.06	30.00	19.00	29.00	655.89	645.89	Upper Pennyslvanian	NI	NI	NI	NI	20.28	656.78
01T07	1/17/04	671.73	673.47	30.00	19.00	29.00	652.73	642.73	Upper Pennyslvanian	NI	NI	NI	NI	18.56	654.91

Notes:
1 = Total depth of boring, total depth of well may be less.
2 = Well was repaired and resurveyed. Previous top of riser elevations were: well 01-06 = 597.98; well 01-07 = 605.43; well 01-15 = 665.30 amsl.
bgs = Below ground surface.
btor = Below top of riser.
amsl = Above mean sea level (NAVD88).
NA = Well construction data not available.
NI = Not installed at time of water level measurements.
* Well 01T01 was not installed because the hole did not produce enough water to yield representative ground water samples.

TABLE 1-2

SUMMARY OF
HYDRAULIC CONDUCTIVITY VALUES (cm/sec)
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Well Number	Round 1		Round 2 or Test 2		Average	
	Ogden	Straight-line	Ogden	Straight-line	Ogden	Straight-line
Shallow Wells in Upper Sandstone Unit (620-663 feet amsl)						
01-01	6.24E-05	2.92E-05	na	na	6.24E-05	2.92E-05
01-02	2.10E-06	1.02E-05	2.48E-05	2.26E-05	1.34E-05	1.64E-05
01-03	na	9.51E-07	na	na	na	9.51E-07
01-04	2.61E-06	2.11E-06	2.99E-06	3.02E-06	2.80E-06	2.56E-06
01-05	na	1.43E-06	na	na	na	1.43E-06
01-11	2.07E-06	3.13E-06	na	na	2.07E-06	3.13E-06
01-14	na	1.67E-06	na	1.54E-06	na	1.61E-06
01-15	1.18E-05	8.87E-06	1.55E-05	1.95E-05	1.37E-05	1.42E-05
01-17	2.99E-05	6.37E-05	na	na	2.99E-05	6.37E-05
01-18	2.64E-06	6.58E-06	na	na	2.64E-06	6.58E-06
01-19	3.13E-06	4.73E-06	na	na	3.13E-06	4.73E-06
01-22	1.46E-05	7.77E-06	na	na	1.46E-05	7.77E-06
01-25	1.68E-05	2.07E-05	na	na	1.68E-05	2.07E-05
01-26	3.80E-06	1.89E-05	na	na	3.80E-06	1.89E-05
01-27	na	5.04E-06	na	5.17E-06	na	5.11E-06
01T02	na	9.99E-06	na	9.71E-06	na	9.85E-06
01T05	na	na	6.19E-06	8.55E-06	6.19E-06	8.55E-06
				Geometric mean =	8.21E-06	7.12E-06
				Site geometric mean =	**7.67E-06**	
Shallow Wells in Middle Siltstone and Shale Unit (570-620 feet amsl screen interval)						
01-07	2.26E-06	7.96E-06	na	na	2.26E-06	7.96E-06
01-09	5.55E-06	5.30E-06	na	na	5.55E-06	5.30E-06
01-10	1.18E-06	2.52E-06	na	na	1.18E-06	2.52E-06
01-12	1.18E-05	9.09E-06	na	na	1.18E-05	9.09E-06
01-13	2.05E-04	2.16E-04	na	na	2.05E-04	2.16E-04
01-20	na	2.36E-06	na	na	na	2.36E-06
01-21	8.02E-06	2.52E-05	na	na	8.02E-06	2.52E-05
01-23	na	4.94E-06	na	na	na	4.94E-06
01-24	na	5.17E-06	na	na	na	5.17E-06
				Geometric mean =	8.11E-06	8.80E-06
				Site geometric mean =	**8.46E-06**	
Deep Wells						
01-06	7.46E-05	na	na	2.23E-04	7.46E-05	2.23E-04
01T03	na	na	2.24E-05	9.83E-05	2.24E-05	9.83E-05
				Geometric mean =	4.09E-05	1.48E-04
				Site geometric mean =	**9.45E-05**	

na = not analyzed.

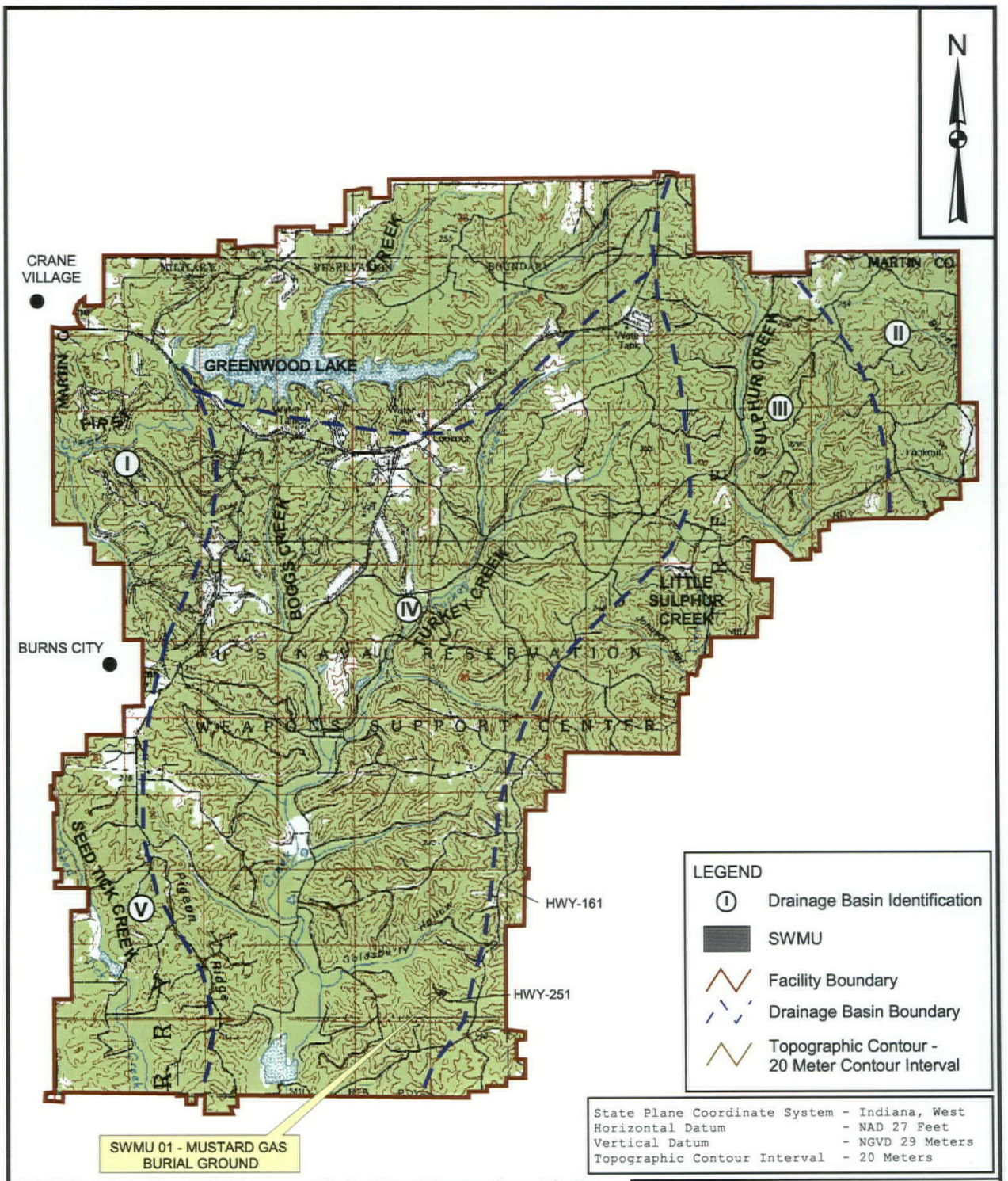
Note: Low-flow purge data and analytical methods presented in Draft RFI, Appendix B.5 (TtNUS, 2003).

DRAWN BY	DATE
J. LAMEY	3/9/00
CHECKED BY	DATE
V. PLACHY	8/12/04
COST/SCHEDULE-AREA	
SCALE	
AS NOTED	

GENERAL LOCATION MAP
NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA

CONTRACT NUMBER	
N0845	
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
DRAWING NO.	REV
FIGURE 1-1	0

P:\GIS\NSWC_CRANE\0087.APR GENERAL LOCATION MAP 8/12/04 AJ



SOURCE: Adapted from "Initial Assessment Study of Naval Weapons Support Center Crane, Indiana." Naval Energy and Environmental Support Activity, May 1983.

DRAWN BY J. LAMEY	DATE 4/19/99	LOCATION OF MGBG AND SURFACE DRAINAGE AT THE NAVAL SURFACE WARFARE CENTER CRANE CRANE ,INDIANA	CONTRACT NUMBER N0845
CHECKED BY V. PLACHY	DATE 8/12/04		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1 - 2 REV 0

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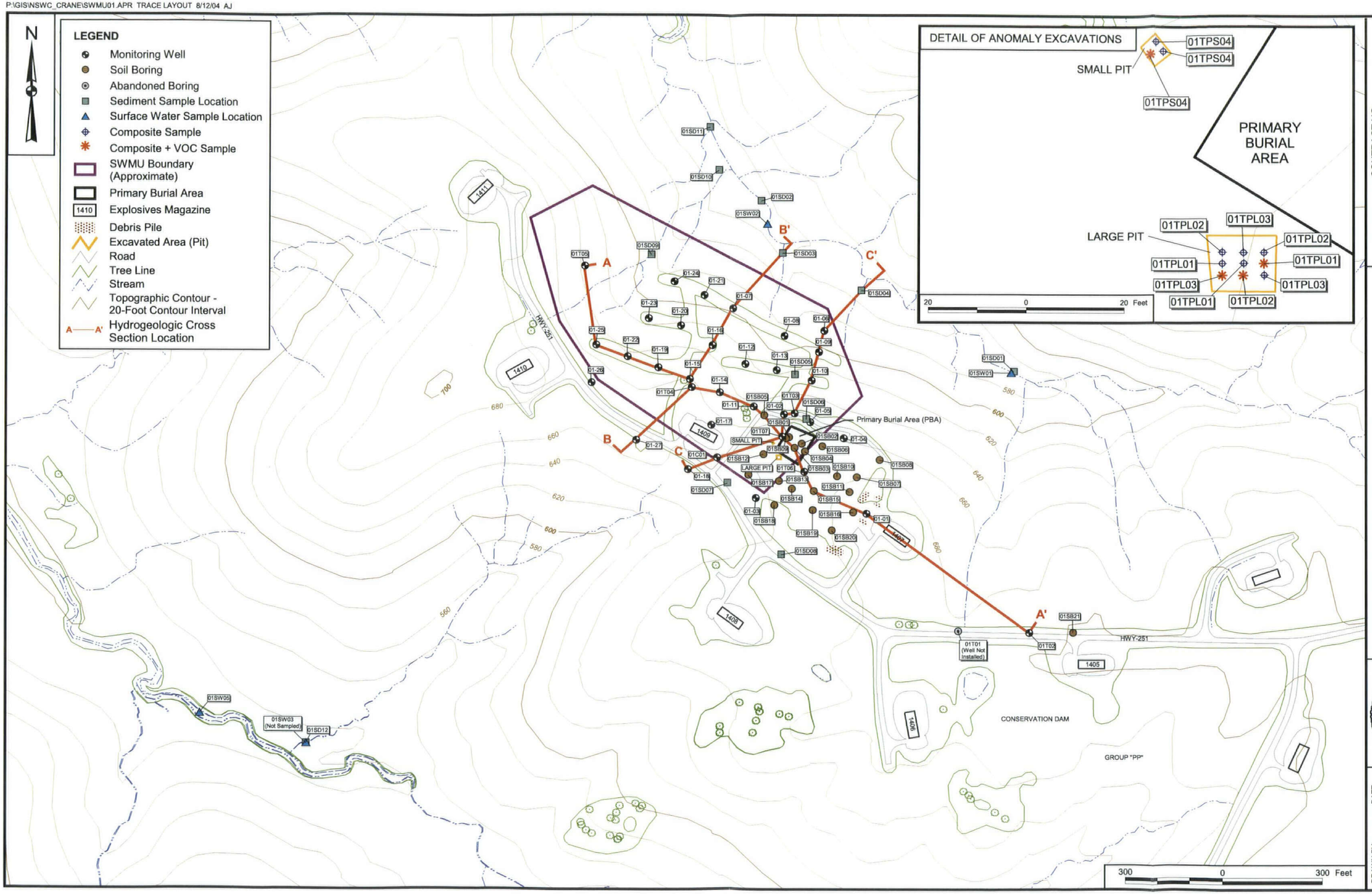
P:\GIS\NSWC_CRANE\SWMU01.APR TRACE LAYOUT 8/12/04 AJ



CONTRACT NO. N0845

APPROVED BY ____ DATE ____

APPROVED BY ____ DATE ____

DRAWING NO. FIGURE 1 - 3

REV 0

GEOLOGIC CROSS SECTIONS AND SAMPLING LOCATIONS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

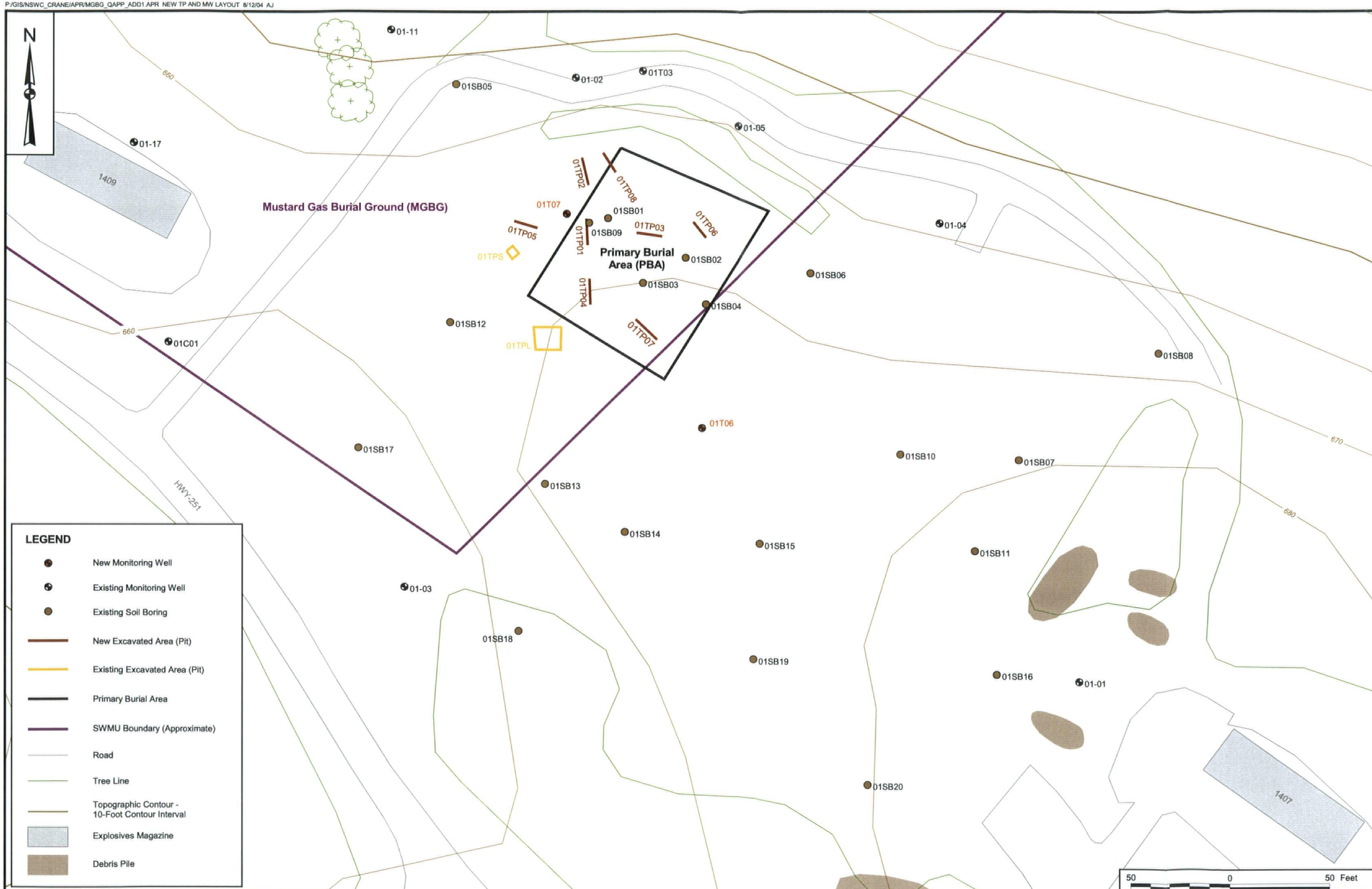
DRAWN BY A. JANOCHA DATE 4/08/04

CHECKED BY V. PLAGHY DATE 8/12/04

COST/SCHED-AREA

SCALE AS NOTED

P:/GIS/NSWC_CRANE/APR/MGBG_QAPP_ADD1.APR NEW TP AND MW LAYOUT 8/12/04 AJ



CONTRACT NO. N0845

APPROVED BY T. JOHNSTON — DATE 4/22/04

APPROVED BY ___ — DATE ___

DRAWING NO. FIGURE 1 - 4

REV 0

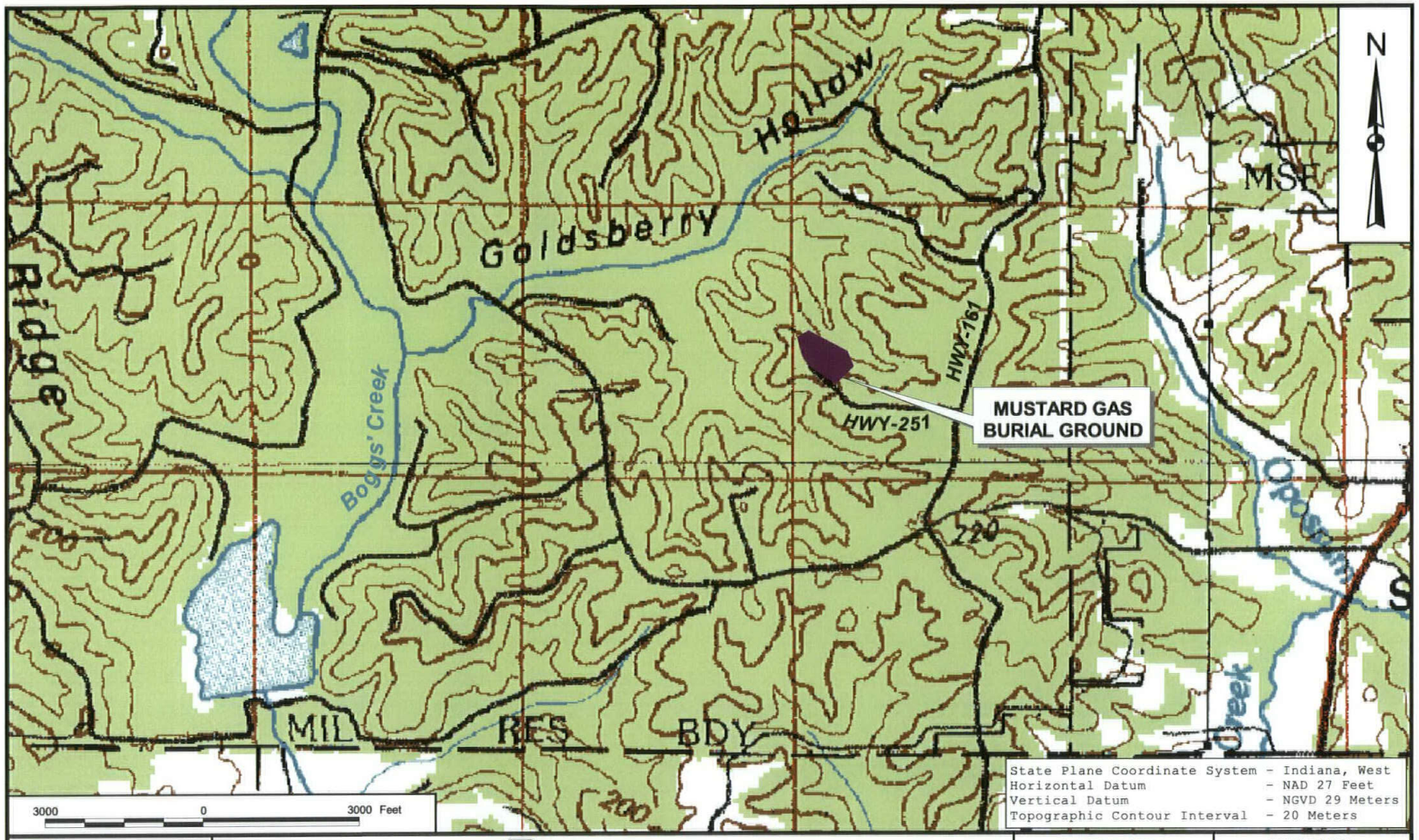
TEST PITS AND NEW MONITORING WELLS INSTALLED IN JANUARY, 2004
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

DRAWN BY A. JANOCHA — DATE 10/12/03

CHECKED BY V. PLACHY — DATE 8/12/04

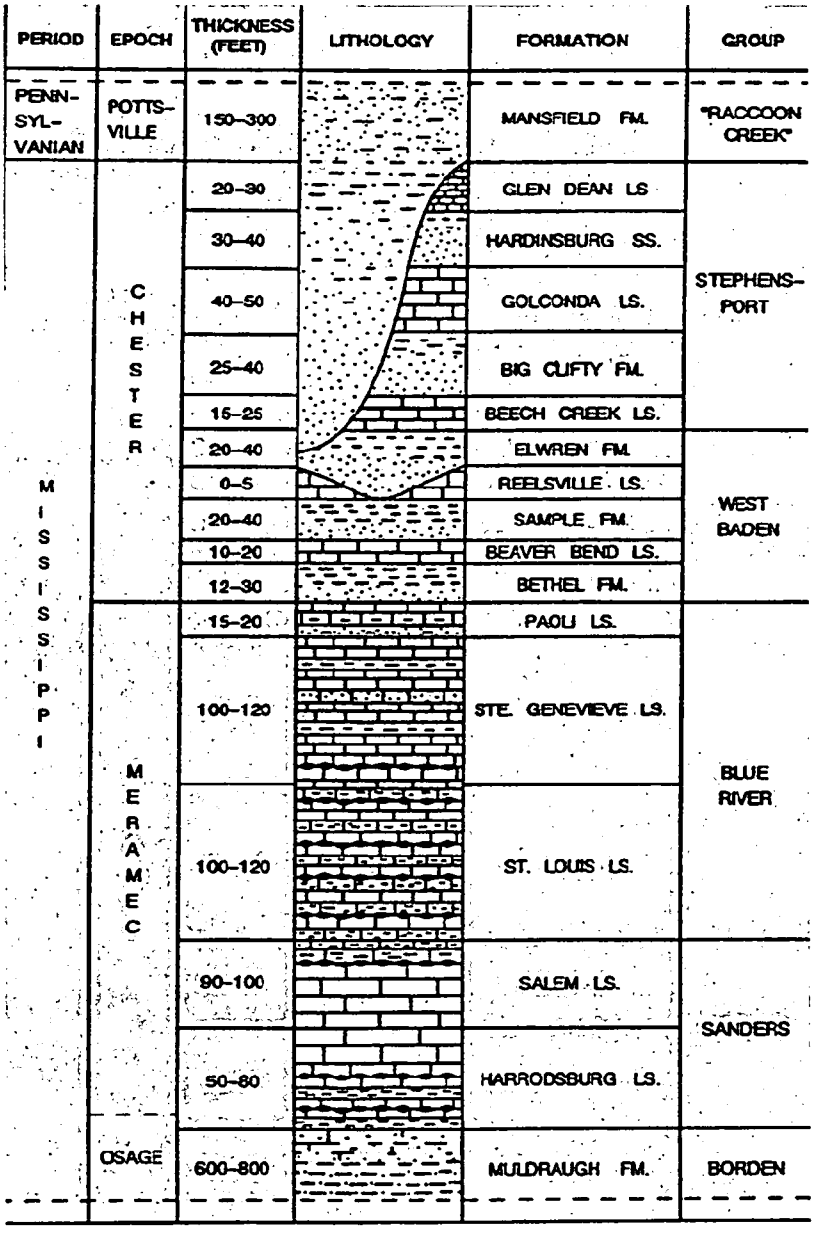
COST/SCHED-AREA ___

SCALE AS NOTED



DRAWN BY J. LAMEY — DATE 2/9/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER N0845	OWNER NUMBER CTO 315
CHECKED BY V. PLACHY — DATE 8/12/04	SURFACE DRAINAGE FEATURES SWMU 01 - MUSTARD GAS BURIAL GROUND NSWC CRANE CRANE, INDIANA	APPROVED BY T. JOHNSTON — DATE 8/12/04	
COST/SCHEDULE-AREA		APPROVED BY — — DATE —	
SCALE AS NOTED		DRAWING NO. FIGURE 1 - 5	REV 0

P:\GIS\NSWC_CRANE\SWMU01.APR SITE MAP-QUAD 8/12/04 AJ

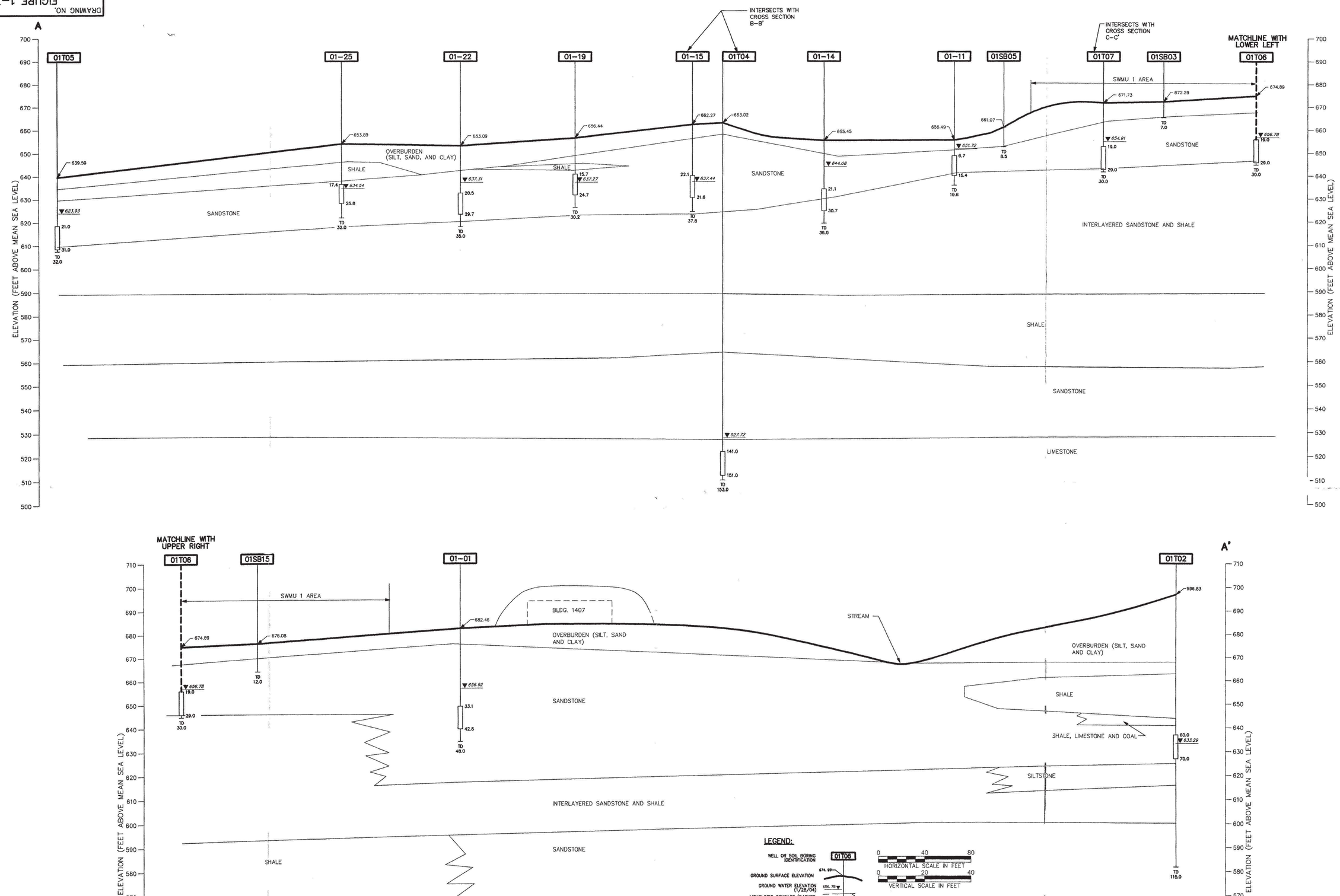


Source: Draft Report, RCRA Facility Investigation
Phase II Groundwater Release Assessment, SWMU 06/09
Demolition Area and Phase III Release
Characterization SWMU 07/09 Old Rifle Range
November 1995-Figure 11 by William L. Murphy and Roy Wade

Source: Palmer, 1969; Cited in Murphy and Wade, 1995

DRAWN BY J. LAMEY	DATE 4/26/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER N0845	OWNER NO. CTO 315
CHECKED BY V. PLACHY	DATE 8/12/04	GENERAL STRATIGRAPHIC COLUMN SWMU 01 - MUSTARD GAS BURIAL GROUND NSWC CRANE CRANE, INDIANA	APPROVED BY T. JOHNSTON	DATE 8/12/04
COST/SCHEDULE-AREA			APPROVED BY —	DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1 - 6	REV 0

P:\GIS\NSWC_CRANE\SWMU01.APR STRATIGRAPHIC COLUMN 8/12/04 AJ



DRAWN BY	DATE
DM	8/13/04
CHECKED BY	DATE
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REVISED BY	DATE
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SCALE AS NOTED	

GEOLOGIC CROSS SECTION A–A'
SWMU 01 – MUSTARD GAS BURIAL GROUND
NAVAL STATION WARFARE CENTER CRANE
CRANE, INDIANA

CONTRACT NO.	
0845	
OWNER NO.	

APPROVED BY	DATE
DRAWING NO. FIGURE 1–7	REV. 0

ACAD:0845GX13.dwg 108/13/04 DM PIT

DRAWING NO. FIGURE 1–7 REV. 0

00026ac27x

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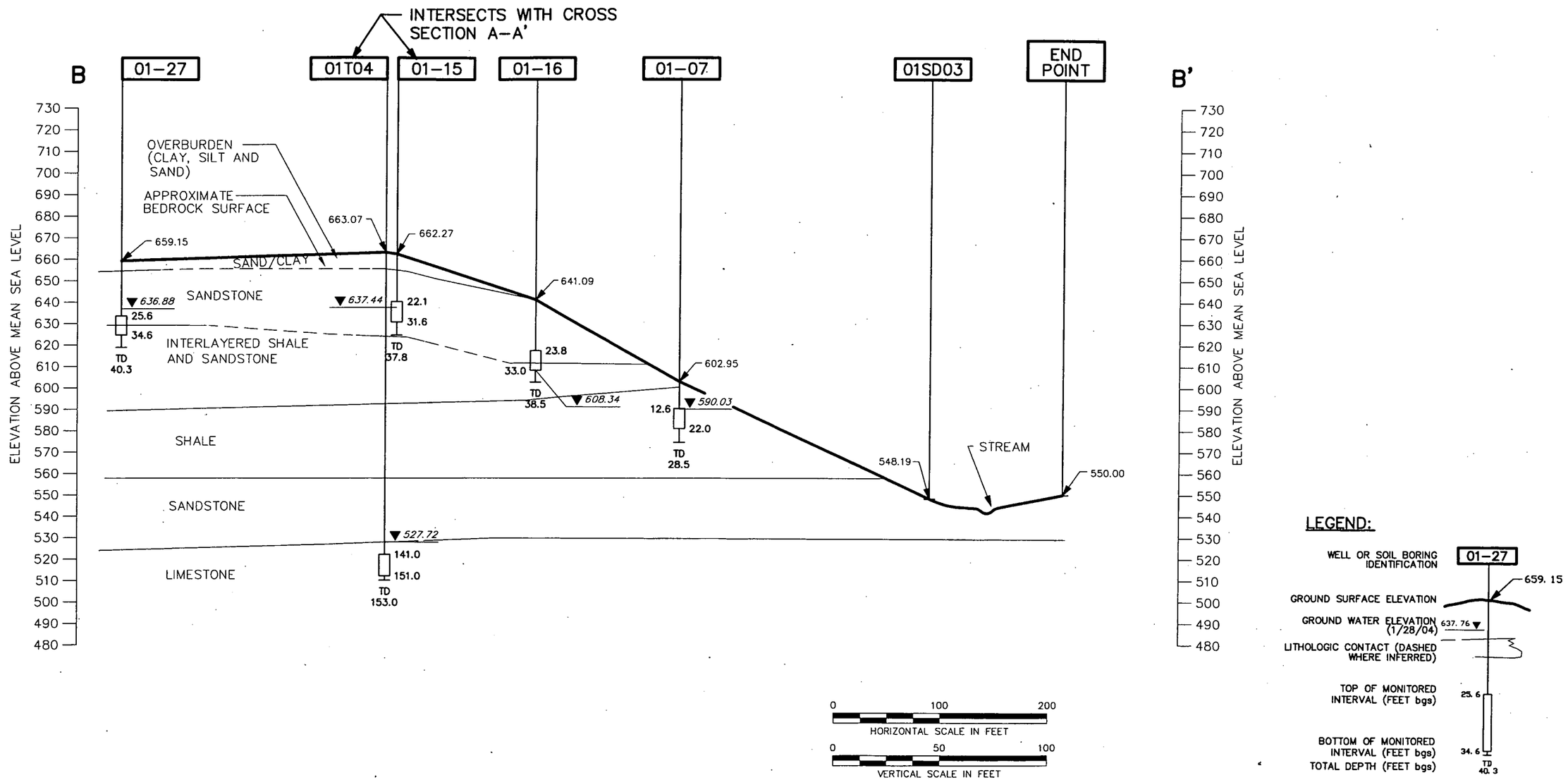


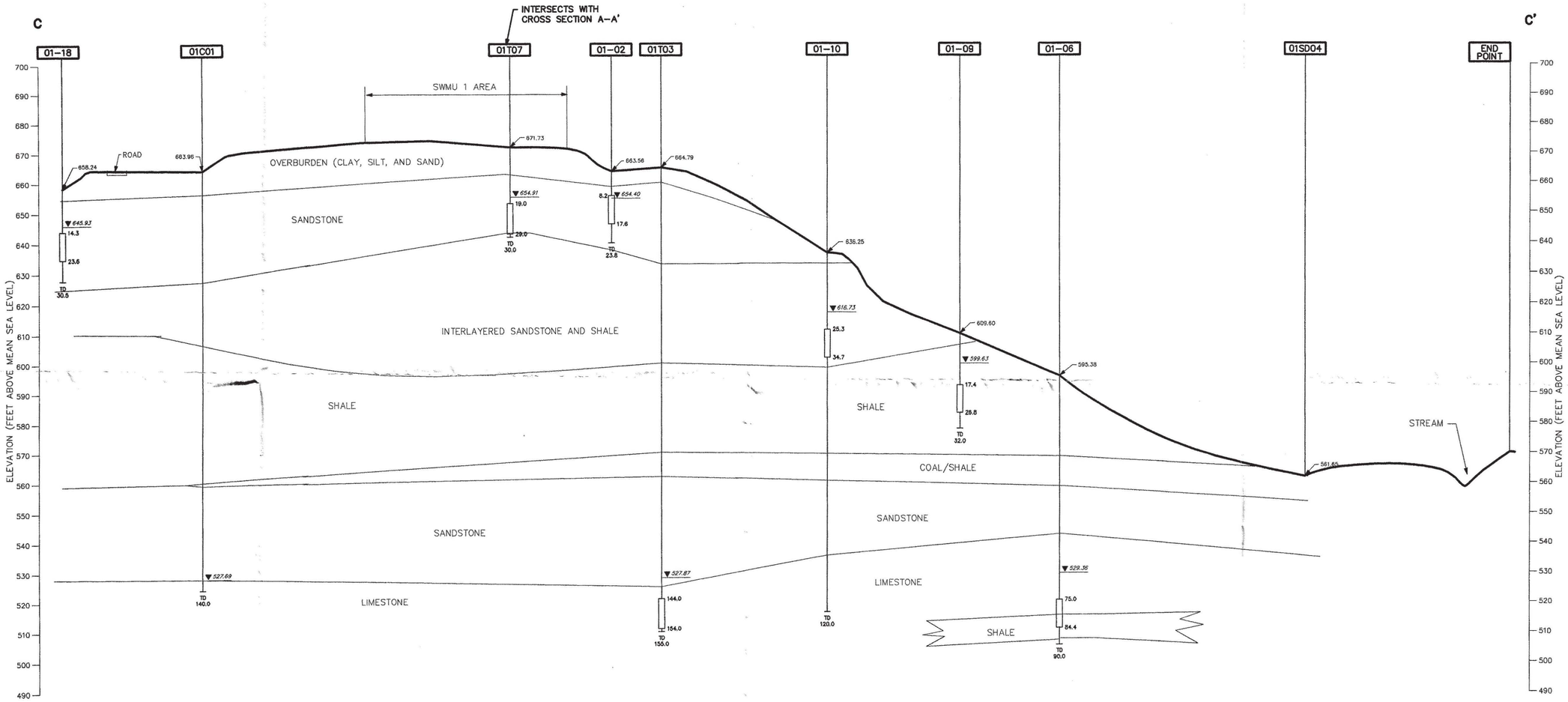
NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DM DATE 8/12/04
CHECKED BY DATE
COST/SCHED–AREA
SCALE AS NOTED

GEOLOGIC CROSS SECTION B–B'
SWMU 01 – MUSTARD GAS BURIAL GROUND
NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA

CONTRACT NO. 0845
APPROVED BY TJ DATE 9/30/02
APPROVED BY DATE
DRAWING NO. FIGURE 1–8
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98



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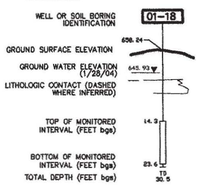


0 40 80
HORIZONTAL SCALE IN FEET
0 20 40
VERTICAL SCALE IN FEET

DRAWN BY DM	DATE 8/13/04
CHECKED BY ----	DATE ----
REVISED BY ----	DATE ----
SCALE AS NOTED	

DEPARTMENT OF THE NAVY · SOUTHERN DIV. FACILITIES ENGINEERING COMMAND

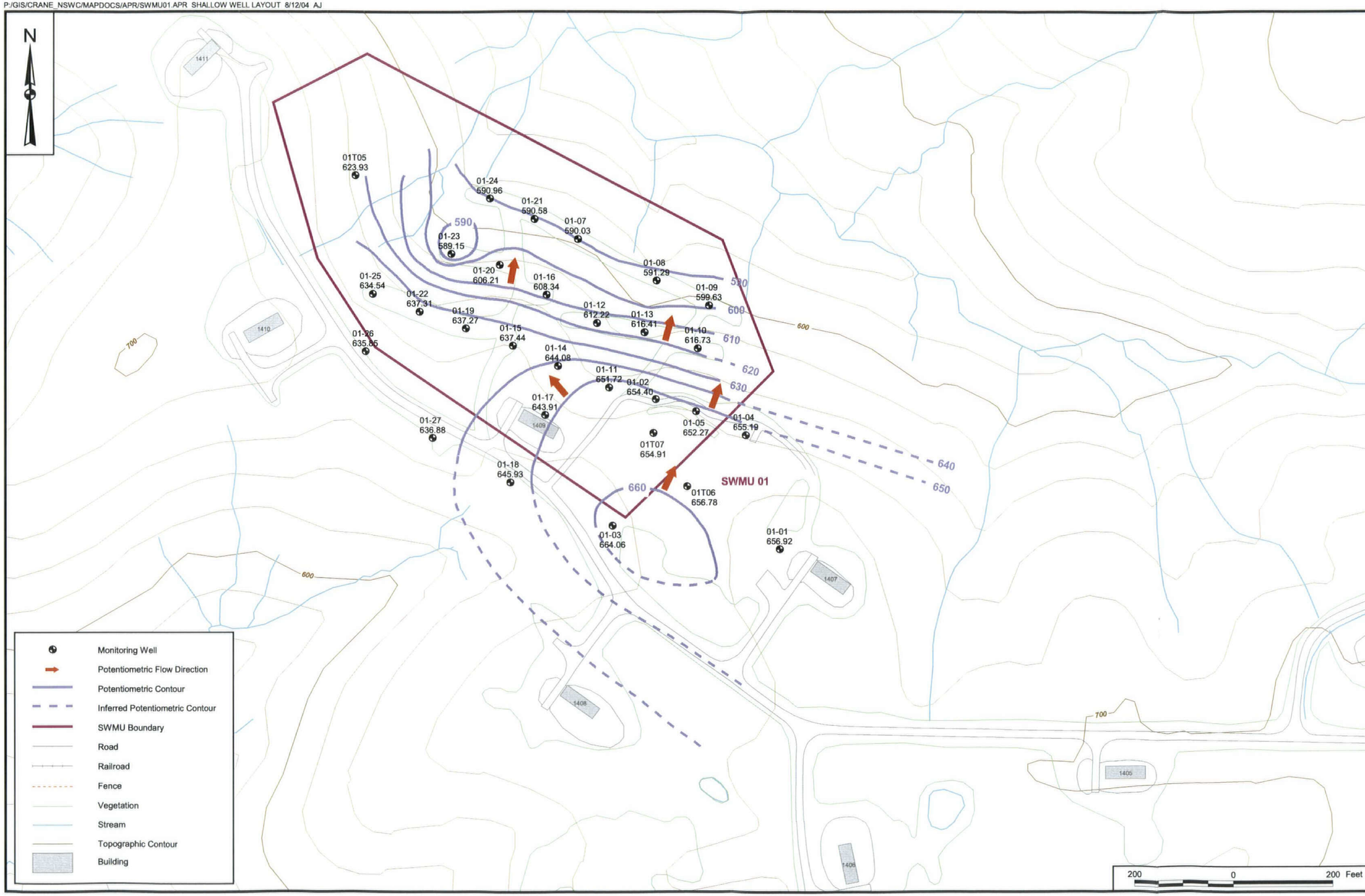
GEOLOGIC CROSS SECTION C–C'
SWMU 01 – MUSTARD GAS BURIAL GROUND
NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA

CONTRACT NO. 0854	
OWNER NO. ----	
APPROVED BY	DATE
DRAWING NO. FIGURE 1–9	REV. 0

ACAD: 0845GX12.dwg 08/13/04 DM PIT

DRAWING NO. FIGURE 1–9 REV. 0

P:/GIS/CRANE_NSWC/MAPDOCS/APR/SWMU01.APR SHALLOW WELL LAYOUT 8/12/04 AJ



CONTRACT NO.
N0845

APPROVED BY ___ DATE ___

APPROVED BY ___ DATE ___

DRAWING NO. FIGURE 1 - 10

REV 0

SHALLOW MONITORING ZONE POTENTIOMETRIC SURFACE MAP
JANUARY 28, 2004
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

DEPARTMENT OF THE NAVY * SOUTHERN DIVISION, NAVAL FACILITIES ENGINEERING COMMAND

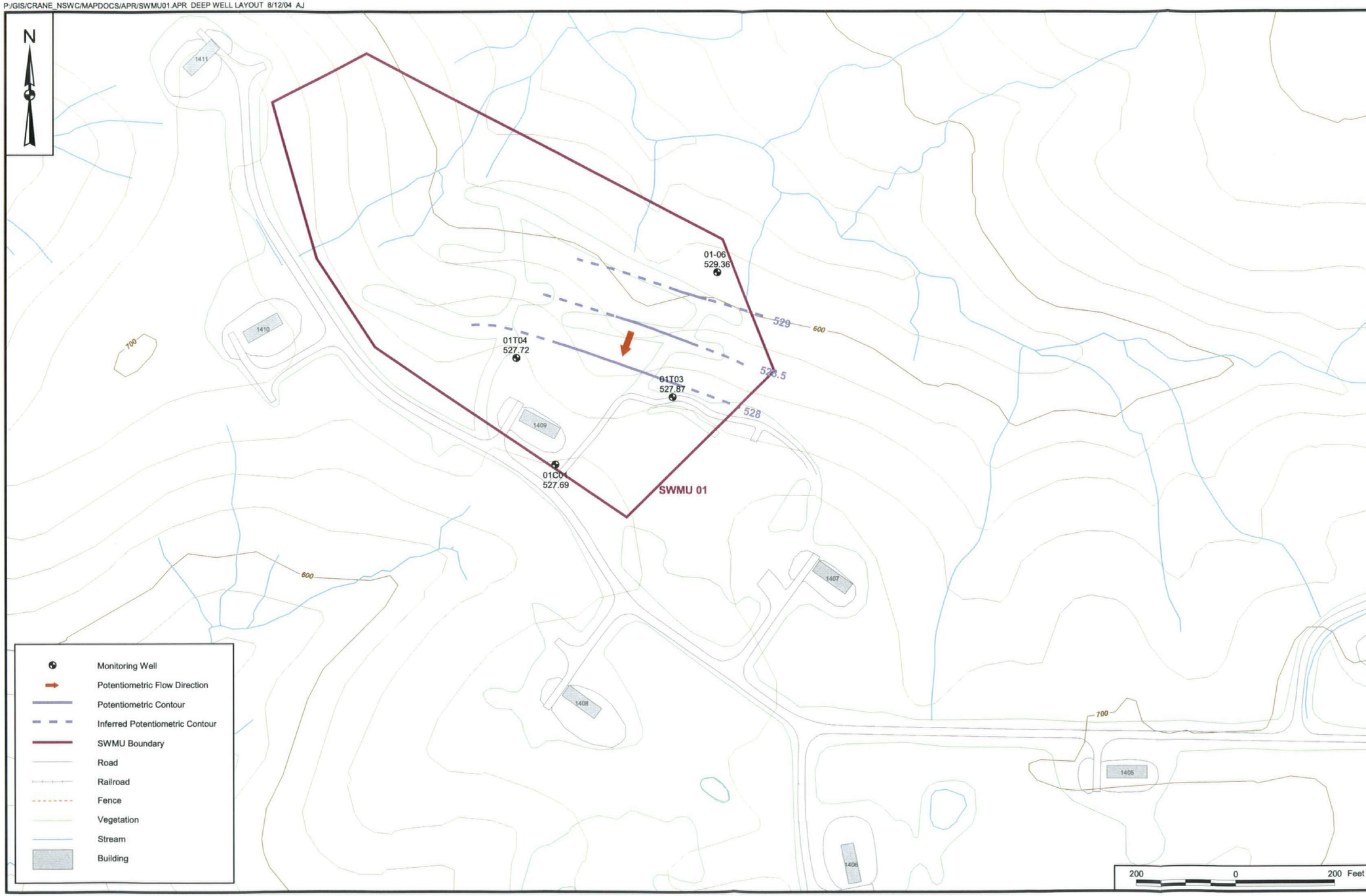
DRAWN BY A. JANOCHA DATE 3/04/04

CHECKED BY V. PLACHY DATE 8/12/04

COST/SCHED-AREA

SCALE AS NOTED

P:/GIS/CRANE_NSWC/MAPDOCS/APR/SWMU01.APR DEEP WELL LAYOUT 8/12/04 AJ



CONTRACT NO.
N0845

APPROVED BY ___ DATE ___

APPROVED BY ___ DATE ___

DRAWING NO. FIGURE 1 - 11

REV 0

DEEP MONITORING ZONE POTENTIOMETRIC SURFACE MAP
JANUARY 28, 2004
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

DEPARTMENT OF THE NAVY * SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMD *

DRAWN BY A. JANOCHA DATE 3/04/04

CHECKED BY V. PLACHY DATE 8/12/04

COST/SCHED-AREA

SCALE AS NOTED

2.0 CONTAMINATED MEDIA OF CONCERN AND RISK ASSESSMENT

This section includes a presentation of recently collected data and a discussion of the data quality. In addition, the recently collected data and data compiled in the RFI report are interpreted to present a comprehensive understanding of the nature and extent of contamination at the MGBG, and factors affecting the fate and transport of the contaminants.

2.1 CHEMICAL DATA AND DATA QUALITY

2.1.1 Data Presentation

Table 2-1 summarizes the analytical program for this CMS by indicating the types of chemicals for which each sample was analyzed. Soil samples were analyzed only for VOCs; whereas, ground water samples were analyzed for VOCs and a wide array of natural attenuation parameters. The data resulting from these analyses are presented in Appendix C.

The frequency of detection (FOD) statistics are grouped according to sample matrix in Appendix C, Tables C-1 and C-3. These tables display the ranges of concentrations detected for each parameter, the sample(s) in which the maximum concentration was observed, the frequency at which each parameter was detected, and the ranges of non-detect values for each parameter. These tables may be used to obtain a preliminary assessment of the breadth and magnitude of contamination. Tables C-2 and C-4 in Appendix C present all data for any chemical that was detected at least once in soil or ground water, respectively. These tables facilitate a more focused review of only the chemicals that were present at detectable concentrations.

Field test kit results that were less than the detection limit for sulfide, hydrogen sulfide, manganous ion, and nitrite were reported as zero ("0") instead of a detection limit with a "U" qualifier flag. The ">" qualifier flag was used to indicate field results that exceeded the calibration range of the measuring system and could not be remeasured (e.g., after dilution). The only results affected in this manner were alkalinity (sample 01GW1103), ferrous iron (sample 01GW1003), manganous ion (sample 01GW1403), and sulfate (sample 01GWT0203).

Appendix C.3 Tables C-5 and C-6 is a complete tabulation of all results for soil and ground water samples, including the duplicate field samples.

2.1.2 Quality of CMS Collected Data

A detailed quality review of the January 2004 data collected for this CMS is presented in Appendix D. A few problems of significance were encountered during analysis and thereafter. Those problems are described in this section. Ultimately, the data quality was concluded to be sufficient to support the CMS goals.

The first significant analysis problem to be encountered was an apparent confusion of calibration files during VOC analysis at Pace Analytical (Tulsa facility). The laboratory found that the results for the continuing calibration standard for a few soil samples had been obtained from the wrong electronic file. Upon investigation, the correct calibration file was determined to be of unsatisfactory quality, hence the required continuing calibration analysis had effectively not been conducted. This led to several investigations, including a review of sample-specific quality control (QC) indicators (i.e., surrogate and internal standard compounds), a review of prior and subsequent laboratory control sample analyses, and a review of the initial calibrations performed prior and subsequent to the affected sample analyses. Although the holding times for analysis had expired, the laboratory also analyzed the remaining quantity of sample that had been collected but not analyzed. Those re-analysis results were consistent with the original results. At the conclusion of the reviews and re-analyses, the laboratory and the Tetra Tech NUS, Inc. (TtNUS) data validators concluded that enough valid QC results were associated with the affected sample analyses, and the re-analyses were consistent enough with the original analyses, to conclude that the soil sample results had not been compromised. No root cause for the poor continuing calibration standard analyses was identified. Additional details are provided in Appendix D, Section D.1.3.1.3.

The second significant problem was associated with ground water sample analyses at Pace Analytical (Tulsa facility). The original sample for well 01-02 was analyzed without dilution, whereas the associated field duplicate sample was too concentrated to be analyzed without first being diluted four-fold. Because the field duplicates are "blind" to the laboratory, this error was not detected until the data were being validated independently by TtNUS. Upon notification of the discrepancy in dilution factors, the laboratory investigated the cause. No root cause for this error was determined; however, the laboratory was able to re-analyze the remaining quantity of original sample that had not been analyzed and was able to do the same for the field duplicate. The re-analysis results for both of these samples agreed with the result originally obtained for the field duplicate. It was concluded that the field duplicate result was correct, and the original results were rejected. The re-analysis results were qualified as estimated ("J" qualifier flag) because the re-analyses occurred outside of the prescribed holding time. As a final check of the data quality, an additional review was conducted of all ground water VOC results from well 01-02 for this round

of analyses (January 2004) and the previous round of analyses (May through June 2002). The results compared well and serve as an independent validation of the recently generated results. Additional details are provided in Appendix D, Section D.1.3.1.3.

On April 5, 2004, the Pace Analytical Tulsa facility notified the Navy and U.S. EPA that the facility involved in the analysis of the samples for this CMS was ceasing operation because of unacceptable practices in the VOC laboratory. The unacceptable practices in question were identified to TtNUS as a persistent failure to use an independent source for calibration verification standards. The laboratory maintains that the VOC results for this CMS are not adversely affected and that the two other problems described above were unrelated to this unacceptable practice. A copy of the notification letter is included in Appendix D.2. Ultimately, the laboratory reassessed all VOC data packages that were affected by these problems. The re-issued data packages contain corrected supporting data for the analyses, but the final results did not change.

In addition to laboratory analysis problems, some of the dissolved oxygen results measured by chemical test kit in the field differed significantly from those measured using the dissolved oxygen meter. The chemical test kit results were considered to be of higher quality than those produced with the meter because dissolved oxygen meters are known to give highly variable readings.

Despite the discrepancies described above, the TtNUS validators concluded that the laboratory's assertion of no adverse effect to the CMS data was corroborated by the available QC data. The precision and accuracy data generally indicated no unusual uncertainties or biases except in those data to which the appropriate data qualifier flags have been assigned (See Appendix C.3). Some data were rejected, but these were typically results for non-COCs, which are of much lesser importance than the COCs. Consequently, the rejected data (see Appendix D Table D-3) did not compromise the attainment of project objectives. A comparison of VOC results from the two most recent rounds of ground water sampling and analyses reveals a consistency that would not be expected if significant quality deficiencies existed. The soil concentrations between the RFI data and these CMS data are also consistent in magnitude and location.

In summary, except in the case of rejected data values, the data quality for all analytes is sufficient to support decision making for the CMS.

2.2 RISK SUMMARIES AND CHEMICALS OF CONCERN

2.2.1 Human Health Risk Assessment

The baseline human health risk assessment (HHRA) for the MGBG evaluated potential risks for construction workers, maintenance workers, occupational workers, adolescent trespassers, recreational users, and hypothetical residents (children and adults) for exposure to soil and/or ground water (TtNUS, 2003). The carcinogenic and noncarcinogenic risks estimated for maintenance workers, occupational workers, adolescent trespassers, and recreational users were acceptable [i.e., less than U.S. EPA benchmarks of a Hazard Index (HI) of 1 for noncarcinogens and an Incremental Lifetime Cancer Risk (ILCR) of 1.0×10^{-4} for carcinogens]. The risks for construction workers and future residents exceeded the benchmark values because of assumed exposure to VOCs in ground water (VOCs accounted for more than 99 percent of the total risks). Minor contributors to the total risks in ground water were manganese (a noncarcinogen) and four carcinogens [bis(2-ethylhexyl) phthalate (BEHP), hexachloroethane, heptachlor, and arsenic]. Groundwater was concluded to be the only medium to pose unacceptable risks to human receptors.

2.2.2 Ecological Risk Assessment

Risks to terrestrial plants, invertebrates, birds, and mammals from organic and inorganic contaminants in surface soil were estimated to be low to negligible. Risks to aquatic receptors from exposure to organic and inorganic contaminants in surface water and sediments were estimated to be low to negligible. No significant aquatic habitat exists in drainage channels associated with the MGBG. Therefore, ecological risks are not a concern at the MGBG.

2.2.3 Revision of the COC List

During the RFI, a total of 37 different chemicals were conservatively identified as chemicals of potential concern (COPCs) in the five different environmental media: surface soil, subsurface soil, ground water, surface water, and sediment (TtNUS, 2003, Table 4-17). Many of these chemicals were only detected in a few samples in one medium at concentrations exceeding the COPC screening level. For example, only one sediment sample had a concentration of acenaphthene greater than the screening level and acenaphthene was not detected at concentrations greater than screening levels in any other environmental medium. Based on further evaluations of the RFI data, the list of 37 COPCs was shortened in the RFI to a list of 13 COCs, which were presented in Table ES-1 of the RFI report (TtNUS, 2003). The majority of COCs were VOCs and ground water was identified as the only medium significantly impacted by site-related contaminants.

Assuming that the remediation of volatile COCs in ground water has occurred at the MGBG, the Phase III RFI risk assessment indicates that most of the total residual risk at the site will be due to manganese, BEHP, hexachloroethane, heptachlor, and arsenic in ground water. However, when added together, the estimated ILCRs for the last four chemicals (i.e., the carcinogens) in this group would not exceed $1x10^{-5}$. This more than an order of magnitude less than the facility industrial risk goal of 10^{-4} and is less than the midpoint of the U.S. EPA target risk range of 10^{-6} to 10^{-4} that is commonly used to evaluate human health risks. The non-carcinogenic risk from manganese contamination was estimated to yield a Hazard Index (HI) of 1.9 for one receptor, which is less than two times the limit of 1.0 used to determine whether a CMS was necessary. The overall carcinogenic risk estimate exceeded 10^{-3}, and is due almost entirely to VOCs in ground water. Based on these results, efforts made to eliminate risks at the MGBG from exposure to ground water would be best spent addressing risk from other MGBG contaminants that exceed the target risk range by orders of magnitude. Thus, the list of COCs was further refined as described in more detail below.

2.2.3.1 Manganese

Manganese was identified in the RFI report as a COC for ground water because the noncarcinogenic risk (HI) for the future child resident (HI = 1.9) exceeded the regulatory goal of 1. The HI for the future adult resident was less than unity. There is no known operationally related source of manganese at the MGBG or upgradient of the site. It is known that manganese concentrations in ground water can be elevated when VOCs are present because the organic matter tends to decrease the oxidation potential to the point at which insoluble manganese compounds in geologic formations become soluble. This may have occurred at MGBG. In this case, remediation of VOCs would be expected to reduce the manganese concentrations in ground water.

Notwithstanding the potential link between the presence of organic chemicals in ground water and bedrock and the elevated manganese concentrations in ground water, some additional observations are reviewed here. The manganese concentrations in well 01T02 (8,040 and 9,170 micrograms per liter (µg/L) in 2001, and 9,600 µg/L in 2002) were the highest of all manganese concentrations across the MGBG wells for the 2001 and 2002 sampling rounds. This well was originally identified as a potential upgradient well. After measuring water levels, it became clear that this well was slightly downgradient of the MGBG ground water contaminant source area. The few organic chemical contaminants detected in well 01T02 in Rounds 1 or 2 (4-amino-2,6-dinitrotoluene, ethene, methane, methylene chloride, TCE, and toluene), were measured at detection limit levels and thus could have been false detections because the detection limits used were lower than the limits the laboratory normally used. No VOCs were detected in

January 2004 in well 01T02 samples at similar detection limits (manganese concentration was not measured in this well in 2004). Well 01T02 is located about 700 feet away from the MGBG and has exhibited only detection limit levels of organic chemical contamination. Thus, it could be considered to have been affected little by site operations, even though it is technically downgradient of the MGBG.

As stated above, the next highest manganese concentration measured at the MGBG was 6,050 µg/L (in well 01-14 in 2001). Well 01-14 is in the middle of the ground water contaminant plume. If well 01T02 had been used as an upgradient well, the manganese would have been eliminated as a COPC based on the relative concentrations of that well and the other MGBG ground water manganese concentrations.

Because manganese concentrations in all other MGBG wells were less than the concentrations in well 01T02 (originally designated as an upgradient well), and because of the relatively small risk due to manganese in ground water, manganese does not warrant a focus for this CMS. Thus, manganese was eliminated as a COC.

2.2.3.2 bis(2-Ethylhexyl) phthalate

BEHP was identified in the RFI report as a COC for ground water because the total residential risk estimated in the HHRA (ILCR = 1.2×10^{-6}) slightly exceeded the lower limit of the U.S. EPA's risk management range (1×10^{-6} to 1×10^{-4}). BEHP is a common laboratory contaminant that was detected in 3 of 13 ground water samples at concentrations close to the analytical detection limit. It is very likely that the reported presence of BEHP is due to laboratory contamination and that any risk associated with exposure to this chemical is estimated to be at the extreme low end of the target risk range. Therefore, BEHP was eliminated as a COC in this CMS.

2.2.3.3 Hexachloroethane

Hexachloroethane was identified in the RFI report as a COC for ground water because the total residential risk estimated in the HHRA (ILCR = 1.9×10^{-6}) slightly exceeded the lower limit of the U.S. EPA's risk management range (1×10^{-6} to 1×10^{-4}). Hexachloroethane was eliminated as a COC in this CMS for the following reasons:

- Hexachloroethane was detected in only one ground water sample and the concentration in this sample was equal to the quantitation limit (qualified "J," estimated). Therefore, there is considerable uncertainty as to whether hexachloroethane is actually present in ground water at the site.

- The maximum detected concentration of hexachloroethane at MGBG (5 µg/L) is significantly less than the Indiana Default Residential Closure Level for Ground Water (37 µg/L).

- Overlooking any risks associated with this chemical would have negligible consequences because the estimated risk is at the extreme low end of the target risk range.

2.2.3.4 Heptachlor

Heptachlor was identified in the RFI report as a COC for ground water because the total residential risk estimated in the HHRA (ILCR = 2.2×10^{-6}) slightly exceeded the lower limit of the U.S. EPA's risk management range (1×10^{-6} to 1×10^{-4}). Heptachlor was eliminated from consideration as a COC in this CMS for the following reasons:

- Heptachlor was positively detected in only two ground water samples at concentrations less than the quantitation limit (qualified "J," estimated). Six other results for heptachlor were qualified with a "B" in data validation because of laboratory blank contamination. These qualified results had concentrations higher that the two reported positive results. Therefore, it is very likely that the reported presence of heptachlor is due to laboratory contamination and that it is not really present in ground water at the site.

- The detected concentrations of heptachlor at MGBG (0.017 and 0.023 µg/L) are about an order of magnitude less than the Indiana Default Residential Closure Level for Ground Water (0.4 µg/L).

- Overlooking any risks associated with this chemical would have negligible consequences because the estimated risk is at the extreme low end of the target risk range.

2.2.3.5 Arsenic

Arsenic was identified in the RFI report as a COC for ground water because the total residential risk estimated in the HHRA (ILCR = 3.0×10^{-6}) slightly exceeded the lower limit of the U.S. EPA's risk management range (1×10^{-6} to 1×10^{-4}). Arsenic was eliminated from consideration as a COC in this CMS for the following reasons:

- Arsenic was detected in only 4 of 37 ground water samples, and the concentrations in all samples (ranging from 2.2 to 7.9 µg/L) were less than the U.S. EPA Maximum Contaminant Level (MCL) (10 µg/L) and Indiana Closure Level (50 µg/L).

- No site-specific or facility background concentrations are available for ground water at NSWC Crane. Therefore, background considerations could not be used for evaluating arsenic in ground water. However, a study of arsenic background levels in the United States conducted by the United States Geological Survey (USGS) (http://webserver.cr.usgs.gov/trace/arsenic) indicates that naturally occurring levels of arsenic in ground water in the region around NSWC Crane range from 1 to 10 µg/L. This range corresponds to the range found at MGBG. The study also found that the background levels across the United States range from 1 to 50 µg/L. It is therefore likely that that the concentrations of arsenic at MGBG are naturally occurring.

- Overlooking any risks associated with this chemical would have negligible consequences because the estimated risk is at the extreme low end of the target risk range.

2.2.3.6 Revised List of COCs

Having eliminated the five chemicals discussed above from the RFI COC list, the remaining eight COCs are the VOCs that have contaminated ground water and which pose, by far, the greatest proportion of risks to humans (approximately 10^{-3} ILCR or greater). These eight COCs are:

- 1,1,1,2-Tetrachloroethane
- 1,1,2,2-Tetrachloroethane
- 1,1-Dichloroethene (1,1-DCE)
- 1,2-Dichloroethane
- Chloroform
- cis-1,2-Dichloroethene
- Tetrachloroethene
- Trichloroethene

To facilitate discussions throughout this report, three indicator COCs were selected from this list to represent the larger group of eight COCs. The indicator COCs, which exhibit chemical and physical properties similar to the larger list of eight COCs are:

- 1,1,2,2-tetrachloroethane (1,1,2,2,-PCA)
- Chloroform
- Trichloroethene (TCE)

Being the most pervasive of ground water COCs, the 1,1,2,2- PCA and TCE are discussed in the most detail. While this renders the discussions more succinct than if all COCs were discussed individually, the use of these chemicals in the remaining discussions should be understood to represent all eight COCs, as appropriate. What is appropriate should be evident from the context of each discussion.

2.3 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination in all media (i.e., soil, sediment, surface water, and ground water) at the MGBG was described most recently in Section 5 of TtNUS, 2003. Only ground water was identified as being currently impacted by site-related contaminants. The conditions described in that document have changed very little, yet, the two new wells and test pits installed in January, 2004 provide additional insight into the nature and extent of MGBG ground water contamination.

Soil, which is commonly a source of ground water contaminants, was generally found not to be contaminated with VOCs or other chemicals (TtNUS, 2003). Methylene chloride was the most widely reported detectable VOC in soil during the RFI. It was detected in 7 of 21 surface soil samples and in 27 of 35 subsurface soil samples in 2001. This compound is significant because it is a breakdown product of chloroform, which is a site ground water contaminant. However, methylene chloride is also a commonly used laboratory chemical and, as a result, is detected frequently in samples as a result of laboratory contamination. Its presence could not be definitively attributed to site activities at the conclusion of the RFI. The inability to associate methylene chloride with site activities is due in part to the absence of spatial relationships to suggest that methylene chloride concentrations are spatially correlated with either site activities or with ground water contamination levels. Methylene chloride was not detected in the test pit samples collected and analyzed in 2004. For comparison, the two most prevalent ground water contaminants, trichloroethene and 1,1,2,2-tetrachloroethane, were detected in 1 of 6 and 2 of 6 test pits soil samples, respectively. This is further evidence that methylene chloride, the previously most widely detected soil VOC but also a common laboratory contaminant, is not a significant site-related contaminant. Other minor soil contaminants were believed to be related to debris piles near the MGBG that may have been generated in conjunction with road construction, past exhumations, or similar activities that are not directly related to historical burials at the MGBG. Details are provided in TtNUS 2003.

1,1,2,2-PCA was detected at a single sediment location (01SD03) in two sampling rounds at concentrations of 7 and 9 µg/kg. This chemical is the most prevalent ground water contaminant. Its presence in sediment was considered to be evidence of potential contamination from ground water being expressed in the drainage channel where the chemical was detected. Otherwise, sediment and surface

waters were generally uncontaminated with site-related chemicals. These media were not sampled in 2004.

Upon completion of the risk assessments, which are documented in the RFI report (TtNUS, 2003), the only chemicals retained as COCs were VOCs in ground water. This is consistent with the data collected in the 1980s, which also had established VOCs as contaminants in ground water. Together, these data from the early 1980s to the present consistently establish VOCs in ground water as the only significant concern.

The data in Appendix C, Table C-3, reveal that the new well 01T07 exhibited the greatest number of detectable VOCs in 2004. This is also the only well in which all chlorinated organic solvents detected to date have been detected in the same sampling round. This well is immediately downgradient of the PBA, which is the presumed contaminant source area, based on site history and all data collected to date. Finally, the chlorinated VOC concentrations in this well were consistently the highest of all the VOCs in the most recent sampling round. Based on these observations, well 01T07 is concluded to be the well closest to the source of ground water VOC contamination.

The dramatic reduction of chlorinated organic solvent contamination in well 01-02 that was observed between 2001 and 2002 and documented in the RFI report was verified between 2002 and 2004 (See Table 2-2). The plume boundary is also relatively unchanged (See Figures 2-1 and 2-2), although the data, if taken at face value, indicate that the concentrations at the western edge of the plume are increasing very slowly. In particular, the measured TCE concentrations in well 01-25 increased from 65 to 96 µg/L between 2001 and 2004. The last concentration measured prior to 2001 was 59 µg/L, in 1986 (TtNUS, 2001). This is a very slight increase considering that the time period spanned by these apparently increasing concentrations is 18 years. There is no explanation for how a small, 6 µg/L, increase occurred over the15-year span from 1986 to 2001 whereas a much larger, 31 µg/L increase occurred in just 3 years from 2001 to 2004. The other chlorinated VOC concentrations appear to have decreased or remained essentially unchanged in well 01-25. For example, the concentrations of 1,1,2,2-PCA were 39 µg/L in 1986, 32 µg/L in 2001, 24 µg/L in 2002, and 29 µg/L in 2004. The chloroform concentrations were 5, 7, 6, and 7 µg/L for the same years, respectively. These three chemicals are the only chemicals detected in well 01-25 in 1986, whereas Table 2-2 indicates that other chemicals have been detected more recently. There are several possible explanations for this. One explanation is that the chemicals are detected more recently because the plume has migrated further west than it was in 1986. Another possibility is that improvements in measurement technology facilitate the detection of lower concentrations today than in 1986. Yet another possibility is that data reporting conventions in 1986 precluded the reporting of chemical concentrations at today's levels. The low flow

purging methods that are currently used for collecting samples are also more efficient at retaining volatile contaminants. Finally, the different laboratories that were used could have had different biases that caused these chemicals to go undetected in 1986 or to be artificially elevated today. Some of these hypotheses would be impossible to test. Others, while they could be tested, would not be worth investigating because the answers would not add appreciably to an understanding of the nature or the extent of contamination.

In the RFI report, a reference was made to the potential for dense non-aqueous phase liquid (DNAPL) to exist at the MGBG. The recently measured VOC concentrations indicate otherwise. DNAPL is commonly concluded to be present if the measured concentration exceeds 1 percent of the solubility of the contaminant. This limit is not exceeded, as is shown in the following section. Thus, the ground water VOCs are apparently completely dissolved, or adsorbed to solid substrate, but probably do not exist as free product. Reasons for the previously observed high concentrations in the tens and hundreds of thousands of µg/L of TCE are unexplained to date and probably could not be explained without undertaking a prohibitive, costly research effort to explain this one anomaly. Furthermore, it is not believed to be necessary to do so to complete the CMS.

Five soil borings were drilled across the PBA during the RFI. The eight test pits dug at the beginning of this CMS complemented the previous soil borings by adding to the spatial coverage of soils in and near to the PBA. No elevated VOC readings were obtained during field screening of test pit soils. Field gamma radiation measurements also yielded no readings greater than two times the mean background level. Three of the six test pit soil samples submitted for laboratory analysis exhibited detectable levels of VOCs: 20 µg/kg and 24 µg/kg of 1,1,2,2-PCA in samples 01TP080506 and 01TP020506, respectively; and 1 µg/kg of TCE in sample 01TP050607. These concentrations are an order of magnitude less than the U.S. EPA Region 9 residential Preliminary Remediation Goals (PRGs) of 411 µg/kg for 1,1,2,2-PCA and 53 µg/kg for TCE. Because these two contaminants are also the primary ground water contaminants, a slight connection between the soil and ground water contaminants evidently exists.

The soil sample collection process (i.e., removing from the backhoe bucket a portion of soil that was collected at the bottom of test pits) caused a disturbance of the soil. Consequently, the test pit soil samples were expected to yield concentrations that were less than those actually present in the soil. Nevertheless, the observed VOC concentrations at the bottoms of the test pits were lower than expected (expectations were hundreds of µg/kg or greater) if the soils are a major source of VOC contamination in ground water. Thus, the bulk of the chlorinated VOC contamination in ground water apparently is originating in the bedrock with only a minor contribution from the soil. This would be consistent with the known disposal of small amounts of chemicals by digging holes or pits and disposing the chemicals in the

holes. The bedrock is within approximately 7 feet of ground surface at the PBA, and any liquid solvents disposed in holes there would not travel far before encountering bedrock. Shallower VOCs would volatilize into the atmosphere.

In summary, VOC contamination observed in shallow ground water is derived from to VOCs leaching from the bedrock, with a minor contribution possibly coming from soil. The area with the most contaminated soils and the apparent source of ground water contamination is the PBA. The bulk of ground water contamination is attributed to leaching from bedrock.

Deep wells have exhibited little to no contamination and the minor contamination detected has been at or very near laboratory analytical method limits. The presence of aquitards has presumably limited the vertical migration of contamination to deeper strata. Thus, the ground water contamination is limited to the shallow water-bearing zone to a maximum depth of about 70 feet bgs and a corresponding elevation of about 590 feet amsl (Figures 1-7 through 1-9). A significant portion (approximately 30 percent) of this depth to the shale aquitard may be unsaturated, depending on the location. Thus, the maximum saturated thickness of contaminated ground water is about 50 feet or less. Figures 2-1 and 2-2 show the current plume boundaries for TCE and 1,1,2-2-PCA, respectively, which are the most predominant ground water contaminants. Chloroform is also present at a relatively high concentrations, in just one location – well 01T07 – in the interior of the contaminant plume, so the chloroform datum has not been plotted. However, chloroform is discussed in the following section because it is part of a different chemical degradation chain than TCE and 1,1,2,2-PCA. It also has been detected in several wells but all concentrations were less than 16 µg/L in the recent sampling round.

The shallow ground water contaminant plumes may be expanding downgradient in the northwestward direction but if it is, the expansion rate is very slow. The majority of ground water data indicate that plume boundaries are stable and the last two rounds of ground water VOC data show little change in the overall plume concentrations or areal coverage. Given the remote location of the MGBG, the current plume and any continued plume migration is not expected to affect offsite receptors. Any continued expansion of the plume should be accompanied by concentration decreases that result from dilution, dispersion, adsorption, and possibly degradation effects. The data show that VOC concentrations in ground water, overall, continue to decrease. Time frames for VOC concentration changes and other aspects of chemical fate and transport are discussed in detail in the following section.

2.4 CONTAMINANT FATE AND TRANSPORT

Knowledge of a contaminant's potential to migrate and persist in an environmental medium is important when evaluating the potential for a chemical to elicit an adverse human health or ecological effect. This section contains information on chemical properties and degradation potential of the COCs, the environmental conditions of the site, and hydrological considerations likely affecting contaminant fate and transport in the MGBG and surrounding area.

The emphasis of this section is to describe the fate and transport properties of the three most important site COCs (TCE, 1,1,2,2-PCA, and chloroform). These compounds are chlorinated aliphatic compounds and represent the fate and transport that is expected for the remaining COCs (also chlorinated aliphatic compounds).

2.4.1 Chemical and Physical Properties Affecting COC Mobility

Table 2-3 presents several important physical and chemical properties of TCE, 1,1,2,2-PCA, and chloroform. These properties can be used to estimate the environmental mobility and fate of site contaminants. The properties discussed include the following:

- Specific gravity
- Vapor pressure
- Water solubility -Henry's Law Constant
- Octanol/water partition coefficient (K_{ow})
- Organic carbon partition coefficient (K_{oc})
- Soil-water distribution coefficient (K_d)
- Bioconcentration factor (BCF)
- Mobility index (MI)

Available literature values of the water solubility, K_{ow}, K_{oc}, vapor pressure, Henry's Law constant, BCF, MI, and specific gravity are presented in Table 2-3 for the three organic COCs. Calculated values, which were obtained using approximation methods, are presented when literature values are not available and the values could be computed. A discussion of the environmental significance of each of these parameters follows.

2.4.1.1 Specific Gravity

The primary use of specific gravity is to determine whether a chemical has a tendency to float or sink in water and in saturated geologic zones if it is present as a pure chemical or at concentrations sufficient to cause a phase separation. Chemicals with a specific gravity greater than 1, including halogenated aliphatic compounds, will tend to sink if present as a pure liquid. Chemicals with a specific gravity less than 1 (e.g., ketones) will tend to float. This physical characteristic becomes important only when the chemicals are at very high concentrations and are liquid when they are in pure phase. Only two compounds (1,1,2,2-PCA and TCE) were detected in sufficiently high concentrations to speculate that they may have been present in soils or ground water in the past as DNAPLs. The greatest concentration of 1,1,2,2-PCA detected in ground water at the MGBG between 2001 and 2004 was 38,000 µg/L (38 mg/L), which is approximately 1.3 percent of its solubility limit in water (2,900 mg/L, Table 2-3). The greatest concentration of TCE detected in ground water between 2001 and 2004 was 16,000 µg/L (16 mg/L), which is approximately 1.5 percent of its solubility limit in water (1,100 mg/L, Table 2-3). Data from the 1980s indicate that concentrations of these chemicals in the 1980s were even greater, suggesting that DNAPLs may have been present in soils or ground water at the site in the past.

2.4.1.2 Vapor Pressure

Vapor pressure provides an indication of the rate at which a chemical volatilizes from both soil and water. Volatilization is a significant loss process for VOCs in surface water, surface soil, and sediment. Surface soils, subsurface soils, sediment, and surface waters in the MGBG area do not contain significant concentrations of VOCs; therefore, volatilization from soil and surface water is not currently an important loss mechanism at this site. However, volatilization in the past may account for the few detections of COCs in the soil samples collected during the RFI. Past detections of VOCs in sediments could reflect a minor migration of VOCs, to drainage channel sediments with subsequent volatilization.

2.4.1.3 Water Solubility

The rate at which a chemical is leached from soil or rock surfaces by infiltrating precipitation is proportional to the chemical's water solubility. More soluble chemicals are more readily leached than less soluble chemicals. The water solubilities presented in Table 2-3 indicate that the VOCs are usually several orders of magnitude more water soluble than pesticides, herbicides, and some of the PAHs. Of the three VOCs being evaluated, chloroform is the most soluble in water (solubility limit = 9,300 mg/L). All of the solubilities listed in Table 2-3 are much greater than the observed maximum concentrations in 2002 and 2004; therefore, DNAPL is concluded not to be present.

2.4.1.4 Henry's Law Constant

Both vapor pressure and water solubility are of use in determining volatilization rates from surface water bodies and ground water. The ratio of these two parameters (the Henry's Law constant) is used to calculate the equilibrium chemical concentrations in the vapor (air) phase versus the liquid (water) phase for the dilute solutions commonly encountered in environmental settings. For chemicals with a Henry's Law constant greater than 5×10^{-3} atm-m^3/mole, such as many of the halogenated aliphatic compounds, volatilization and diffusion in soil gas could be significant.

2.4.1.5 Octanol/Water Partition Coefficient

K_{ow} is a measure of the equilibrium partitioning of chemicals between octanol and water. A linear relationship between the K_{ow} and the uptake of chemicals by fatty tissues of animal and human receptors, or the BCF, has been established (Lyman, et al., 1990). The K_{ow} is also useful in characterizing the sorption of compounds by organic soils where experimental values are not available. Pesticides and aromatic compounds, lacking functional groups that enhance water solubility, are several orders of magnitude more likely to partition to fatty tissues than the more soluble VOCs. K_{ow} values are also used to estimate BCFs in aquatic organisms.

2.4.1.6 Organic Carbon-Water Partition Coefficient

K_{oc} indicates the tendency of a chemical to adhere to organic matter contained in soils. Many VOCs have relatively low K_{oc} values and tend to be fairly mobile in the environment. Chemicals with high K_{oc} values generally have low water solubilities and vice versa. This parameter may be used to infer the relative rates at which the more mobile chemicals (e.g., ketones and halogenated aliphatics) are transported in ground water. Immobile chemicals can be transported by erosional processes when they occur in surface soils. Several factors affect the measured value of K_{oc}. Values of K_{oc} usually decrease with increasing temperature. The fine silt and clay fraction of soil and sediments may have a greater tendency to adsorb chemicals because they often have a higher concentration of organic matter (hence, a higher number of sorption sites per unit volume). All other factors being equal, stream and drainage channel sediments, which often comprise relatively fine geologic materials, should accumulate contaminants more readily than coarser materials. The balance between adsorption to sediments and volatilization from the sediments may account for the few detections of VOCs to data in MGBG drainage channels.

2.4.1.7 Soil-Water Distribution Coefficient

K_d is a measure of the equilibrium distribution of a chemical in soil/water systems. The K_d of organic chemicals is a function of both the K_{oc} and the fraction of organic carbon (f_{oc}) in the soil, as follows:

$$K_d = K_{oc} * f_{oc}$$

The degree to which organic chemicals sorb to soils is very important when assessing migration potential. If a chemical tends to sorb strongly to soil, there is much less probability that the chemical will reach ground water and affect ground water quality.

A total of seven sediment samples collected from the gullies and channels adjacent to the MGBG were analyzed for total organic carbon (TOC). Values of TOC ranged from 5,580 to 49,600 mg/kg. TOC may also be expressed as f_{oc} in sediment. For the MGBG sediments, f_{oc} values ranged from 0.5 to 5.0 percent (average = 2.4 percent). This amount of organic carbon in the sediments is providing a relatively large capacity for sorption of organic compounds. This capacity favors retention of the solvents on sediment particles rather than dissolution into the surface water. In addition, the drainage channels in the vicinity of the MGBG have no water in them for the majority of the year. The f_{oc} values for the Pennsylvanian rock units are likely to be one or two orders of magnitude lower than the values for sediment samples. Hence, sorption capacity of the rock will be much lower.

2.4.1.8 Bioconcentration Factor

BCF represents the ratio of the concentration in aquatic animal tissue to the concentration in water. The ratio is both contaminant- and species-specific. When site-specific values are not measured, literature values are used or the BCF is derived from the K_{ow}. Many pesticides and PAHs will bioconcentrate at levels three to five orders of magnitude greater than those concentrations found in the water, but VOCs and energetic compounds are not as readily bioconcentrated.

2.4.1.9 Mobility Index

The MI is a quantitative assessment of mobility that uses water solubility (S), vapor pressure (VP), and the K_{oc} (Laskowski et al., 1983). It is defined as follows:

$$MI = \log ((S*VP)/K_{oc})$$

A scale to evaluate MI, as presented by Ford and Gurba (1984), is as follows:

Relative MI	Mobility Description
> 5	extremely mobile
0 to 5	very mobile
-5 to 0	slightly mobile
-10 to -5	immobile
< -10	very immobile

Of the organic chemicals detected at the MGBG, chlorinated VOCs generally have MIs greater than 5 and are considered to be extremely mobile (Table 2-3). The MIs for the three primary COPCs detected at the MGBG are presented in Table 2-3.

2.4.2 Chemical Persistence and Degradation Processes

Photolysis and oxidation reactions are not considered to be significant degradation mechanisms for chlorinated aliphatics (Mabey, et al., 1982). Limited hydrolysis of saturated aliphatics (i.e., alkanes) may occur, but it does not appear to be a significant degradation mechanism for unsaturated species (e.g., alkenes) (Mabey, et al., 1982).

The original chlorinated VOCs released at the MGBG apparently included 1,1,2,2-PCA, TCE, PCE, and carbon tetrachloride because these chemicals are the most prevalent of the COCs or they are the parent compounds to other detected VOCs that are formed through the degradation of the parent compounds. Being a relatively common laboratory and industrial chemical, chloroform may also have been released but it is also a COC degradation product, as is methylene chloride.

Degradation of the parent compounds has apparently resulted in the reduction in overall chlorinated VOC mass at the site and the formation of six or more chlorinated daughter products that are characteristic of a biodegradation mechanism. Biodegradation rates for TCE, 1,1,2,2-PCA, and chloroform in soil and ground water are summarized in Table 2-4. Of these three compounds, 1,1,2,2-PCA is considered to be the most susceptible to biodegradation, and TCE is considered to be the least susceptible (Table 2-4). These processes are discussed in more detail below.

2.4.2.1 TCE Biodegradation

Four of the chlorinated VOCs detected in soil and ground water samples are chlorinated ethene compounds: PCE, TCE, and two dichloroethene (DCE) isomers (1,1-DCE and cis-1,2-DCE). Generally,

PCE and TCE are used as cleaning solvents, and the DCE compounds and vinyl chloride are generally considered to be biodegradation products of PCE and TCE. TCE can also be a biodegradation product of PCE. In general, soil microbes strip off chlorine atoms from the ethene chain via reductive dechlorination, one chlorine atom at a time, as follows:

PCE → TCE → DCE → vinyl chloride

The dechlorination of TCE typically produces much more cis-1,2-DCE than either 1,1-DCE or trans-1,2-DCE (Aziz, et al., 2000).

At the MGBG, none of the chlorinated ethene compounds were detected in surface or subsurface soil samples, except for TCE at 1 µg/kg in a single test pit soil sample (01TP05060). In ground water, TCE was the most frequently detected contaminant (44 out of 83 ground water samples from 2001 to 2004) with concentrations as high as 16,000 µg/L. It was detected at the greatest concentration (133,000 µg/L, well 01-02, November 1982) of all the chlorinated ethenes. These data suggest that TCE was the primary ethene compound disposed at the MGBG. cis-1,2-DCE was detected in 10 of 82 samples, with concentrations ranging from 0.6 to 14.0 µg/L during the same time period. 1,1-DCE was detected in 16 of 82 ground water samples, with concentrations ranging from only 0.2 to 4.0 µg/L in the same time period. The presence of cis-1,2-DCE and 1,1-DCE in ground water suggests that biodegradation of TCE is occurring around well 01T07 and farther downgradient toward well 01-15.

2.4.2.2 1,1,2,2-PCA Biodegradation

Only one chlorinated ethane compound (1,1,2,2-PCA) was detected in MGBG soil, and it was detected in only one soil boring sample at 2 µg/kg (soil boring 01SB09). This chemical was detected in two test pit soil samples (20 µg/kg and 24 µg/kg of 1,1,2,2-PCA in samples 01TP020506 and 01TP080506, respectively). 1,1,2,2-PCA was detected in 23 out of 83 ground water samples from 2001 to 2004 with concentrations ranging from 0.3 to 38,000 µg/L. The maximum concentration ever detected (589,000 µg/L) was found in well 01-02 in 1982. Also detected in ground water were large concentrations (up to 341 µg/L) of 1,1,2-TCA (detected in 27 of 83 samples) and up to 4,070 µg/L of 1,2-dichloroethane (DCA), detected in 12 of 82 samples. It appears that the 1,1,2,2-PCA is being sequentially biodegraded to 1,1,2-TCA and 1,2-DCA. This pathway for biodegradation is described by Lorah, et al. (1997).

2.4.2.3 Chloroform Biodegradation

Aside from methylene chloride, only one chlorinated methane compound (chloroform) was detected in MGBG soil, and it was detected in only one soil boring sample at 4 µg/kg (soil boring 01SB09). Chloroform was detected in 24 out of 83 ground water samples collected between 2001 and 2004. This compound is a degradation product of carbon tetrachloride. Carbon tetrachloride, however, was only detected at 10 µg/L in the one sample taken from well 01T07 in 2004. Like the other two primary COCs being discussed, the maximum concentration of chloroform detected in ground water (2,000 µg/L) was found in well 01-02 in 1982; the most recently measured concentration was 790 µg/L in well 01T07. Chloroform can biodegrade sequentially into methylene chloride and chloromethane. At the MGBG, methylene chloride has been detected in ground water at a low frequency (8 of 82 samples from 2001 through 2004) and at low concentrations (15 µg/L or less). Numerous (37) soil detections of methylene chloride in 2001 were documented in the RFI report, but this chemical is a common laboratory contaminant and the observed concentrations were similar to commonly observed laboratory contamination concentrations. Therefore, it is difficult to distinguish what relative proportion of the observed concentrations, if any, could be associated with a release of chloroform. Chloromethane has not been detected at all. Thus, there is some evidence of biodegradation products of chloroform being present at the MGBG, but it is difficult to know how significant this degradation mechanism is.

2.4.3 Natural Attenuation Indicator Parameters

During the three rounds of ground water sampling from 2001 to 2004, field measurements of numerous geochemical and natural attenuation parameters were performed using electronic instruments and field test kits (Tables 2-5 and 2-6). In addition, laboratory analyses for dissolved gases and other natural attenuation-related parameters were performed on select samples. These measurements were made to help evaluate the natural attenuation potential for this site and to facilitate natural attenuation scoring according to U.S. EPA Guidance (U.S. EPA, 1998). Based on the discussion in Section 2.4.2, reducing conditions are conducive for the biodegradation of chlorinated aliphatic compounds such as TCE, 1,1,2,2-PCA, and chloroform (U.S. EPA, 1998; Aziz, et al., 2000 and 2001).

2.4.3.1 Oxidation-Reduction Conditions

Field readings of dissolved oxygen (DO) and oxidation-reduction potential (ORP) were measured for every ground water sample collected. DO was measured with a more sensitive, portable chemical test kit in select wells. Shallow ground water near the source area of the plume (01-02, 01T05) has moderately oxidizing to oxidizing conditions.

Moving westward and northwestward from wells 01T02 and 01T05, the monitoring wells in the central part of the plume (01-12, 01-13, 01-14, 01-15) had slightly oxidizing to slightly reducing conditions. The dissolved oxygen concentrations were generally less than 1.0 mg/L, and the ORP values were generally less than 0 millivolts (mV) (Table 2-5). Potentials of approximately -100 mV or less are commonly associated with reducing conditions conductive to natural attenuation of chlorinated organic solvents via reductive dechlorination. In particular, wells 01-14 and 01-15 displayed the lowest DO concentrations and ORP of any monitoring wells.

Toward the leading edge of the plume (wells 01-19, 01-20, 01-22, 01-25), shallow ground water again becomes moderately oxidizing to oxidizing. Around the outer edges of the plume (wells 01-08, 01-11, 01-17, 01T05), the shallow ground water is slightly reducing in 01-08 but is moderately oxidizing to oxidizing in the remainder of the wells (Table 2-5).

Ground water outside of the plume area and deep ground water samples ranged from mildly reducing to oxidizing (Table 2-5). Overall, the strongest reducing conditions occurred in monitoring wells 01-14 and 01-15 (but the oxidation reduction potentials alone do not reflect conditions that are conducive to reductive dechlorination). These wells are located in the plume interior near regions of relatively high contamination.

Manganese and iron are present in large quantities as native components of bedrock. The concentrations of these metals increase in ground water as the ground water conditions become more reducing because the reducing conditions cause them to convert to more soluble chemical species. Low concentrations of ferrous iron and manganese(+2) were detected in and around the contaminant source area (wells 01-02, 01-05, and 01T07). However, ferrous iron and manganese(+2) concentrations were elevated in monitoring wells 01-14 and 01-15, coinciding with the low dissolved oxygen and ORP measurements. Ferrous iron was as high as 8.8 mg/L in well 01-15 and manganese(+2) was as high as 22 mg/L in well 01-14 (Table 2-5).

Toward the leading edge of the plume (wells 01-19, 01-20, 01-22, 01-25) and around the outer perimeter of the plume (wells 01-08, 01-11, 01-17), ferrous iron and manganese(+2) concentrations were generally less than 0.3 mg/L, except in well 01T05 at the leading edge of the plume, in which the ferrous iron and manganese(+2) concentrations were as high as 0.35 and 9.5 mg/L, respectively.

Ferrous iron and manganese(+2) concentrations are less than 3.4 mg/L in shallow wells located outside of the plume area and were much lower in the deep monitoring wells. An exception was well 01T02, where 8.5 and 22 mg/L of ferrous iron and manganese(+2), respectively, were detected. No geochemical

reason has been discovered to explain the high concentrations of reduced iron and manganese in this well. Past laboratory analyses for total manganese revealed concentrations approaching 10 mg/L in this well (TtNUS, 2003).

Dissolved hydrogen was elevated [(2.1 and 9.7 nanoMolar (nM)] in two wells close to the VOC contaminant area source (01-02 and 01-05, respectively). In addition, methane concentrations were higher in one well close to the source (well 01-05, 0.49 µg/L) and in several wells downgradient of the source (e.g., wells 01-15 and 01-19).

Elevated concentrations of nitrite and sulfide ions are additional indicators of reducing conditions. Nitrite concentrations greater than 0.01 mg/L were detected in only two wells, 01-02, which is located very close to the source area, and 01-10, which is outside of the plume area to the north of the PBA. Sulfide concentrations greater than 0.05 mg/L were detected in two wells, 01-14 and 01-25, which are located in the central and leading edge of the plume, respectively.

Overall, geochemical data suggest that the shallow ground water around the perimeter of the plume is mildly to moderately oxidizing. In the interior of the plume around wells 01-14 and 01-15, geochemical conditions are reducing. Elevated concentrations of ferrous iron, manganese(+2), methane, and sulfide were all detected in these two wells and their presence is indicative of reducing conditions.

2.4.3.2 COC Degradation Products

If geochemical conditions are adequately reducing, TCE usually degrades sequentially to DCE isomers (primarily cis-1,2-DCE) and then to vinyl chloride, as discussed in Section 2.4.2.1. Some studies have revealed that the trans-1,2,-dichloroethene is also occasionally produced, but this isomer is not the most prevalent degradation product under typical degradation conditions. However, TCE could degrade to DCE isomers under reducing conditions and the DCE isomers could be degraded aerobically to carbon dioxide, thereby eliminating the production of vinyl chloride and ethene. In the 1980s, high concentrations of trans-1,2-DCE (24.3 to 2,650 µg/L) were detected in monitoring well 01-02. Moderate concentrations (3 to 24 µg/L) were detected in wells 01-11, 01-12, 01-14, 01-15, and 01-19. The samples collected in the 1980s apparently were not analyzed for cis-1,2-DCE (or the results were not reported).

During the Phase III RFI, concentrations of trans-1,2-DCE between 1 and 11 µg/L were detected in six different wells (01-11, 01-12, 01-15, 01-19, 01-22, and 01T07). Concentration of cis-1,2-DCE ranged from 1 to 14 µg/L in 11 different wells. During the RFI, the highest cis-1,2-DCE concentration (14 µg/L) occurred in well 01T07 nearest to the source area. Although TCE daughter products were not found in

great abundance during the RFI, concentrations of trans-1,2-DCE as high as 2,600 µg/L were detected in well 01-02 in 1982 (the concentration was 24 µg/L in this well in 1985). This implies that degradation of TCE has occurred in the past and is likely active to some degree in the present. Vinyl chloride has only been detected in one well sample (01T0701) and was barely detectable (1 µg/L in 2004). Hence, the anaerobic degradation pathway for the DCE isomers is currently not very likely. However, because of the mildly oxidizing to oxidizing conditions in much of the plume domain, the formation of vinyl chloride should not be expected and the general failure to detect this compound is consistent with these expectations.

As discussed in Section 2.4.2.2, 1,1,2,2-PCA can degrade anaerobically into 1,1,2-TCA and 1,2-DCA. Such anerobic degradation is facilitated when the overall organic content of the ground water supports microbial metabolism. TOC concentrations in all 11 wells sampled in 2004 were less than 2 mg/L. Some of the TOC is contributed by the ground water contaminants. These relatively low concentrations indicate that an increased organic carbon concentration would likely be needed to support large populations of microbes and rapid degradation of chlorinated aliphatic compounds. In the 1980s, 1,1,2-TCA concentrations of 101 and 341 µg/L were detected in wells 01-11 and 01-12, respectively. Concentrations of 1,1,2-TCA between 2.2 and 17 µg/L were detected in five other wells. Between 2001 and 2004, 1,1,2-TCA concentrations between 4 and 16 µg/L were detected in five different wells. The first daughter product of 1,1,2-TCA biodegradation is typically 1,2-DCA. In 1982, 2,100 and 4,070 µg/L of this daughter compound were detected in well 01-02, near the source area. Up to 17 µg/L of this compound was detected during the RFI and CMS (2001 through 2004), and the highest concentration was found in well 01T07, nearest to the contaminant source area. Thus, large concentrations of daughter products were present in the plumes in the 1980s when the parent compounds were at much higher concentrations, but the concentrations of daughter products have declined significantly as the parent compound concentrations have decreased.

Low concentrations of methylene chloride were detected in well 01-02 (47 µg/L), 01-07 (40 µg/L), and several other wells in the plume area in 1982 and 1983. During the RFI (2001 through 2004), the maximum detection of methylene chloride (15 µg/L) occurred in monitoring well 01T07 located immediately downgradient of the PBA. Although not found in great concentrations, the presence of methylene chloride, especially around the source area, suggests that chloroform is being biodegraded slowly by reductive dechlorination. However, this observation is tempered by the understanding that the observed methylene chloride concentrations could represent laboratory contamination rather than degradation of the chloroform.

Microbes degrade the COCs most efficiently via reductive dechlorination processes (U.S. EPA, 1998). Breakdown products of these dechlorination reactions include chloride ions, carbon dioxide, ethene, and

ethane. The MGBG chloride data are highly variable, so it is also difficult to determine whether any positive chloride anomaly exists in the plume area. Some of the variability in chloride and alkalinity concentrations may be a result of the use of hypochlorite to decontaminate mustard gas (an oily liquid) that was spilled onto soil in 1974 (TtNUS, 2001). The concentrations of ethane and ethene ranged approximately from non-detectable at 0.005 µg/L to 0.090 µg/L (ethane) or 0.058 µg/L (ethane) in 2004; most concentrations were less than 0.04 µg/L). These concentrations are not significant; however, there appear to be slightly elevated concentrations of ethane in wells 01-05, 01-14, 01-15, and 01-19. Ethane concentrations ranged from 0.04 µg/L to 0.09 µg/L in these wells. Because daughter products of the three primary COCs are not accumulating in the ground water, it is assumed that the degradation rates for the daughter compounds are much greater than the rates for the parent compounds.

Reductive dechlorination is typically accompanied by increased alkalinity, as well as a generation of degradation products. Alkalinity is elevated in the plume area but no significant pH changes within or adjacent to the plume (Table 2-6) have been observed and it is unclear that the elevated alkalinity is a result of dechlorination.

2.4.4 Persistence of COCs over Time

Graphs of natural logarithm COC concentrations over time are included in Appendix E for eight wells located within the main body of the plume. Four to seven ground water samples have been collected from each of these wells over the past 22 years (1982 through 2004) with a 15-year gap in the middle of this time period during which no samples were collected. The concentrations of TCE (Appendix E.2) appear to be declining relatively rapidly in the source area and immediately downgradient of the source area (wells 01-02, 01-05, 01-11, and 01-12). Near the center of the plume (well 01-15), TCE concentrations have remained relatively steady over time. Farther downgradient to the west-northwest (wells 01-19, 01-22, 01-25), TCE appears to be gradually rising. In general, the maximum and mean concentrations of TCE have decreased 2.5 orders of magnitude since 1982 (Figure 2-3). The median concentration has decreased also, but not as greatly.

The concentrations of 1,1,2,2-PCA have decreased significantly over time in all monitoring wells along the main axis of the plume, except in wells 01-19 and 01-22, where gradual increases in concentration have occurred over time. In general, the maximum, mean, and median concentrations of 1,1,2,2-PCA have decreased 1.5 to 2.5 orders of magnitude since 1982 (Figure 2-4). Based on the rate of decline and the levels of degradation (i.e., daughter) products found in monitoring wells in the past, the degradation rate of 1,1,2,2-PCA appears to be fastest of the three primary COCs being evaluated.

The chloroform concentrations in most of the monitoring wells were generally highly variable, often dropping or rising sharply over short time intervals. Like TCE and 1,1,2,2-PCA, the chloroform concentrations have dropped significantly over time in the wells closest to the source area and immediately downgradient. Near the leading edge of the plume however, concentrations have risen slightly in wells 01-22 and 01-25. Overall, there have been significant decreases in the maximum and median chloroform concentrations in the plume over time (Figure 2-5). The median concentration has also decreased, but to a lesser extent. In the most recent set of samples (January 2004), the sample from well 01T07 in the source area had a chloroform concentration of 790 µg/L. The next highest concentration of chloroform detected was only 15 µg/L in well 01-22.

2.4.5 Natural Attenuation Feasibility Scoring

The U.S. EPA has developed a "Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water" (U.S. EPA, 1998). In this document, a large range of information is presented on reductive dechlorination processes, geochemical conditions that favor reductive dechlorination, and the expected byproducts of these reactions. A qualitative screening process is presented in the document that allows a preliminary evaluation to be made for a site regarding its potential for natural attenuation processes to be effective in reducing contaminant concentrations. Data from the MGBG have been used to perform this evaluation (Table 2-7). A score of 14 was calculated, which means there is limited evidence that anaerobic reductive dechlorination is proceeding (U.S. EPA, 1998pp. 29-32). DO concentrations ranging from essentially 0 to 8 mg/L and ORP measurements ranging from -71 up to 511 mV in 2004 indicate that reducing conditions are not prevalent across the shallow ground water bearing unit. The oxidizing conditions, which are most prevalent within the plume area, are not conducive to rapid chlorinated biodegradation rates. Hence, degradation is occurring at only a slow to moderate rate.

2.5 PHYSICAL CONCEPTUAL SITE MODEL

A contaminant transport pathway represents the physical path or mechanism by which a contaminant moves or could move under appropriate conditions from one location (e.g., a contaminant source area) to another location. A transport pathway may also involve a phase change for the contaminant (e.g., a contaminant is absorbed to soil, volatilizes to soil gas in the vadose zone, and then migrates into a building basement as a gas). In addition, contaminant transport pathways provide mechanisms and conduits for contaminants to migrate to new locations where they may contribute to a human health or ecological risk. The determination of whether a pathway is currently causing a risk or could potentially

cause a future risk depends on the combination of chemical characteristics, the existence of a potential pathway, the physical site conditions, and the potential for exposure to occur now or in the future.

This section combines information presented in previous sections into a cohesive physical conceptual model for the MGBG site that includes descriptions of the following:

- Location, nature, and magnitude of the contaminant source.
- Geological and hydrogeological conditions affecting directions and rates of contaminant migration.
- Processes of biodegradation and natural attenuation influencing the migration and persistence of the COCs in ground water.
- Potential for COCs in ground water to reach the ground surface and affect surface water bodies.
- Potential scenarios for exposure of humans to COCs and related risks.
- Potential ecological receptors and associated risks.

2.5.1 Contaminant Source

The VOCs were originally released in the MGBG almost certainly within the PBA. Chemicals, presumably including the solvents that are still present, were reportedly disposed in shallow holes in the overburden. Despite all of the soil borings that have been collected and the test pits that have been dug in the MGBG, no soil materials have yet been discovered that yielded significant or even moderate concentrations of VOCs. Thus, a specific location from which the solvents originated at the site is not known. It is likely that the location is very small in area and may have consisted of a single hole in which disposal(s) of a small amount (perhaps as small as a few ounces) of chemical(s) occurred. The chemicals apparently moved downward through the soil and into bedrock, without much lateral dispersion in the vadose zone. This would account for the very limited solvent detections in soil borings and test pits, and it would be consistent with the limited thickness (approximately 7 feet or less in the PBA) of the soil overburden. The highest concentrations of COCs detected in the latest round of ground water sampling were detected in monitoring well 01T07 (see Figures 2-1 and 2-2), which is immediately downgradient of the PBA. This well was also the only well in which all chlorinated VOCs detected to date were found. Ground water flow directions are predominantly in the northern and northwesternly directions away from the PBA, but the PBA is evidently on a ground water divide from which contaminant migration occurs in other directions as well. More details are presented below. Therefore, it is concluded that the solvents were disposed in the PBA a short distance (e.g., 10 to 50 feet) east or southeast of monitoring well 01T07. As discussed previously, there may have been a small amount of DNAPL present in the subsurface 10 to 20 years ago, but there does not appear to be any DNAPL remaining at the site based on current concentrations.

2.5.2 Ground Water Transport

After the released solvents migrated downward into the bedrock, they would have first encountered the shallow sandstone. This is the rock unit in which the majority of shallow wells are screened. The sandstone is weathered and fractured and is sufficient permeable to allow the solvents to migrate laterally under the influence of gravity . Based on slow-purge well tests (Table 1-2), the intergranular permeability of the upper sandstone is not great (about 0.003 to 0.13 foot per day; geometric mean = 0.022 foot/day). It is believed that the sandstone is well-cemented in some areas and that preferential migration pathways exist along small fractures and joints in the sandstone. Thus, the overall permeability of the sandstone might be greater than indicated by the slow-purge tests, and the intergranular porosity might be relatively low because of cementation. Calculations of hydraulic conductivity, assumptions for porosity, and calculations for ground water seepage velocity are presented in the RFI report (TtNUS, 2003, Appendix B). Because of the potential (and even likelihood) for preferential pathways to exist, a computation of average migration rates and seepage velocities seems to be most appropriate for characterizing the plume as a whole. In the RFI, average lateral groundwater seepage velocities were calculated and ranged from 0.225 to 1.35 feet per day (82 to 493 feet per year).

The 1,1,2,2-PCA and TCE plume lengths in 1982 were delineated to about 660 feet in the westward direction. If the solvent disposal at the MGBG occurred around 1960, then the contaminants traveled at least 660 feet in 22 years, or at least 30 feet per year. Because the time of contaminant release is unknown, the actual rate of contaminant migration is also unknown. Nevertheless, the current extent of contamination is similar to the extent of contamination delineated in the 1980s and indicates that the plume site probably stabilized within 30 to 40 years of the time of release.

Vertical migration of ground water and COCs into deeper Pennsylvanian or Mississippian rock units is considered to be minimal for two reasons. First, there is a very large head difference between the upper monitoring wells and the deep monitoring wells. The sandstone at the base of the Pennsylvanian strata appears to be dry, partly because recharge from above is minimal. The large vertical head difference is probably due to the fact that the permeabilities of the intervening shales and siltstone in the middle of the Pennsylvanian strata are very low, and these units therefore impede the downward flow of ground water. The second reason is that all four deep monitoring wells screened in upper Mississippian limestone (01-06, 01C01, 01T03, and 01T04) have shown only a trace of site-related contaminants [1 µg/L of TCE in 01T03 (2003)] and 1 µg/L of TCE in 01C01 (2004)]. These concentrations are near the nominal laboratory detection limit of 0.5 µg/L and could reflect false positive results. With the COCs themselves as markers for contaminant migration pathways and rates, this is convincing evidence that an aquitard exists between the upper sandstone and lower strata to confine the contamination to the shallow zone.

Ground water elevations measured in shallow monitoring wells, when contoured, yield a potentiometric surface as shown in Figure 1-10. The highest ground water elevation occurs in well 01-03 on the southwestern side of the MGBG. A ground water divide runs more or less along the topographic centerline of the ridge along Highway 251 (Figure 1-10). Shallow ground water on the northern side of the divide flows to the north and northwest. Shallow ground water on the southern side of the divide flows south and southwest. There are four shallow monitoring wells (01-03, 01-18, 01-26, and 01-27) located near Highway 251 along the ground water flow divide. As shown in Figures 2-1 and 2-2, there are virtually no VOCs present in these four wells, (although 0.6 µg/L of 1,1,2,2-PCA was detected in 01-27 in 2004). The general absence of VOCs in these four wells confirms the belief that contaminated ground water is not flowing significantly from the MGBG in a southern or southwestern direction; the vast majority ground water flow is toward to the north and northwest.

The time of travel is not known with a high degree of certainty but is estimated to be between 10 and 50 years with little to no expansion after the mid 1980s. If the time of VOC release were known with more certainty, the estimated time of travel would be less uncertain. As shown in Figures 2-1 and 2-2, the plume has migrated from the PBA about 800 feet to the northwest (near well 01T05) over a period of at least 25 years. The concentrations of 1,1,2,2-PCA and TCE decrease approximately two to three orders of magnitude between the PBA and well and 01T05. Degradation products (e.g., 1,1,2-TCA, 1,2-DCA, 1,1-DCE, 1,2-DCE) are found in wells along the plume centerline to the northwest of well 01T07. The maximum concentrations of 1,1,2-TCA and cis-1,2-DCE were detected near the midpoint of the plume's long axis (in well 01-15), about 300 feet northwest of well 01T07. As the contaminants migrate, dissolved oxygen and other electron acceptors are consumed, and the ground water becomes progressively reducing. 1,1,2,2-PCA and TCE are degrading until the maximum concentrations of the degradation products occur near well 01-15. As the ground water migrates farther to the northwest, the degradation products are presumably degrading as fast as, or faster than, they are being formed because their concentrations, in addition to the concentrations of 1,1,2,2-PCA and TCE, decline between wells 01-15 and 01-25. Besides biodegradation, dilution from surface recharge and dispersion are also factors that cause the concentrations to decline in a northwesterly direction. The lateral size of the plume has remained relatively stable since the 1980s, based on the 5 µg/L isoconcentration contours shown in Figure 2-1 of this report and Figures 5-6 and 5-8 of the RFI report (TtNUS, 2003). However, the maximum concentrations and total mass within the plume boundary have declined significantly over the past 25 years. This is evident from the decrease in concentrations over time for the plume which has remained essentially the same size for 20 years or more.

2.5.3 Biodegradation Rates and Products

As discussed in Section 2.4, the concentration-time plots (Appendix E) indicate that the concentrations of the three primary COCs are decreasing over time. Large concentrations of biodegradation products were detected in the monitoring wells in the 1980s and were still being detected, but at lower concentrations, in 2001 through 2004. Additional discussion of rates of VOC degradation is presented in the next section.

2.5.4 Concentration-Time Graphs and Natural Attenuation Rates

Natural logarithm concentrations versus time were plotted for eight major wells within the plume that have three or more samples analyzed over time (Appendix E). As discussed in Section 2.4.4, concentrations of the three primary VOCs are decreasing over time. The media cleanup standards (MCSs) determined for TCE, 1,1,2,2-PCA, and chloroform in ground water are 5, 0.9, and 80 µg/L, respectively (calculations are shown in Appendix E, Figures E.1-9, E.2-9, and E.3-9, respectively). A slope was calculated for each concentration-time graph in Appendix E. This slope represents an attenuation rate constant for the particular COC within a small area adjacent to the specific well where monitoring is taking place. In Appendix E, the median slope for the wells near the source and the center of the plume was calculated for each COC being evaluated. These median slopes are used to represent the overall attenuation rates of the COCs over time. Assuming that the representative concentration is the maximum concentration observed in 2004, the predicted length of time (rounded to one significant figure) for the plume concentrations to reach the MCSs will be about 80 years for TCE and 1,1,2,2-PCA and 60 years for chloroform.

The graphs showing the overall plume concentration trends over time (Figures 2-3 through 2-5) were also used to calculate an approximate cleanup time for the plume via natural attenuation using the median concentrations. Based on the graphs of median concentrations over time, the predicted lengths of time for the plume concentrations to reach the MCSs will be about 30 and 42 years for TCE, and 1,1,2,2-PCA, respectively. The median chloroform concentration (2 µg/L) is already less than the MCS (80 µg/L). Because of the significant uncertainty in estimating decay rates and representative concentrations for a plume that varies significantly in concentrations as this plume does, these decay times should be used only as rough estimates. It would not be surprising to find that decay under natural attenuation conditions with no treatment takes longer than 100 years.

The data for mean and maximum plume concentrations over time were prepared for TCE and 1,1,2,2-PCA; these are included as Figures 2-6 and 2-7, respectively. Supporting calculations are provided in Appendix E. The vertical axes of these two plots show the logarithms (base 10) of the

concentration data. The time scale, however, is the more important scale. The lease squares lines of best fit for the data have also been plotted and extended into the future. Using the best-fit lines shown on Figure 2-6, the maximum and mean concentrations of TCE in the plume reach the MCS of 5 µg/L between 2035 and 2040.

These are approximate estimates of time necessary to achieve MCSs because of the "noisy" concentration-time relationships (i.e., the r^2 values of the trend lines are moderate). Because these plots show the logarithms of the concentrations, the scatter is not as evident as if the plots of concentration versus time are viewed. Such plots for individual wells are provided in Appendix E, Figures E.2-1 through E.2-8. The data scatter is evident from the large prediction intervals that are represented by curved lines drawn above and below the trend lines of best fit. These 95% intervals represent the span of possible concentration values (with 95% statistical confidence) that could be obtained at any particular time, based on the lines of best fit and associated uncertainty. They are similar to confidence intervals except that they represent concentration point estimates rather than average concentration estimates. Prediction intervals are typically wider than confidence intervals, which are used to place boundaries on the best estimate of the location of the actual trend line rather than individual temporal concentration estimates. In the plots of Figure 2-6, the upper prediction limit does not intersect the MCS at any time in the future. The lower prediction limit is already less than the MCS at all times.

The large uncertainty observed in these predictions is a result for several factors. First, there are only a few data points available for plotting. The denominator of the prediction interval includes the statistical degrees of freedom as a factor. With only four data points, there are just two degrees of freedom. This indicates that one of the best ways to obtain better estimates of the trend lines (and to yield narrower prediction intervals) would be to increase the number of data points in the trend. The spacing of the data points also creates some uncertainty. There is a 15 year gap between the 1980s and 2000s data sets. This effectively causes the early 1980s and early 2000s each to be represented by a single point, which is the average of two data values. On a linear concentration scale, the plot of the concentrations over time is curved. It is difficult to define the shape of the curve when the data points are spaced in this manner. The concentration data are also subject to significant scatter. The large changes in contaminant concentrations over time are reflected in the plots. Finally, as the prediction intervals are extrapolated further into the future, predictions have less and less relationship with the data on which they are based. Hence, the intervals diverge rapidly from the best fit line at future times.

Figure 2-7 shows the same type of predictions mean and maximum 1,1,2,2-PCA plume concentrations. Similar to the TCE predictions, the best-fit line through the 1,1,2,2-PCA data shows a time to reach MCS (0.9 µg/L) that is between 2035 and 2040. Also similar to the TCE predictions, there is a lot of error

associated with the trend lines. Plots for individual wells can be viewed with a normal concentration axis in Appendix E. Figures E.1-1 through E.1-8. The actual year in which maximum and mean 1,1,2,2-PCA plume concentrations reach the MCS is uncertain.

Despite the uncertainties revealed in these plots, the consistency of time estimates for the best fit trend lines to achieve MCSs for TCE and 1,1,2,2-PCA is encouraging. They are essentially identical, regardless of whether mean or maximum concentrations are used as the bases for the estimates. Minimum concentration data were not plotted because they would not add any more useful information to the plots.

An additional analysis of the TCE and 1,1,2,2-PCA data is presented in Appendix E in terms of contaminant mass. The area contained within the smallest contours for Figures 2-1 and 2-2 were calculated. The plume area for TCE within the 5 µg/L contour was calculated to be 234,000 ft^2. Using an average of 30 feet for the saturated sandstone thickness and a porosity value of 0.005 for cemented, fractured sandstone, a volume of contaminated groundwater was calculated to be 1.00×10^6L for TCE and 1.22×10^6L for 1,1,2,2-PCA. Using the average plume concentrations for the two compounds over time, a graph of mass versus time was prepared for the two compounds. These graphs are included in Appendix E (Figures E.4-1 and E.4-2. These graphs of mass versus time show that mass decreases relatively fast over time. The mass of each compound is below 1 kg between 2035 and 2050. However, the error bounds for these predictions are even larger because of the additional uncertainties associated with estimating the exact plume size, plume thickness, porosity, and average concentrations over time.

Based on best fit lines through the concentration data, the estimate of the time necessary to achieve MCLs for COCs without any treatment of the contaminant plume is about 35 years. The prediction intervals indicate that the actual time to remediation could be much longer. Collecting additional temporal data would significantly improve the precision of these estimates.

2.5.5 Contaminant Plume Dynamics

The plume has maintained the same overall shape for at least 22 years (1982 through 2004). Concentrations are decreasing through all of the source area and the center of the plume. Slight increases in COC concentrations near the leading edge of the plume (i.e., monitoring wells 01-22, 01-25 and 01T05) have been observed. If any size increase is occurring, it appears to be occurring in the northwesterly direction at a very slow rate that will not result in increased risks to any receptors.

2.5.6 Discharge of Shallow Ground Water

The shallow sandstone has a base elevation of about 620 ft amsl (see Section 1.4.3). The sandstone crops out along the hillside about 150 to 200 feet north of the PBA. It is believed that contaminated ground water is flowing along the base of this sandstone toward the northern hillside and discharging into the thin soil and shallow weathered bedrock in the vicinity of wells 01-12, 01-13, and 01-20. The ground water does not necessarily discharge to the ground surface; it could be moving along the rock-soil interface. Where this shallow ground water intersects fractures in the weathered bedrock along the edge of the ridge, the ground water is seeping downward into deeper rock strata (interlayered shales, siltstone, and sandstone) and affecting the water quality in monitoring wells 01-12, 01-13, and 01-20.

The main bulk of contaminants is migrating northwestward toward wells 01-25 and 01T05. By the time the plume reaches well 01-25 and 01T05 however, the ground water flow direction is expected to shift northward and eventually approach the land surface at an elevation of about 615 to 620 feet amsl. Shallow ground water is expected to flow to the north-northeast near wells 01-25 and 01T05, because the potentiometric surface (Figure 1-10) suggests that the hydraulic gradient is to the north-northeast in the immediate vicinity of these two wells.

2.5.7 Transfer of Contaminants to Shallow Soils, Vegetation, and Gully Sediments

Because contaminated ground water may approach the ground surface along the side of the northern slope, there is potential for contaminants to be transferred to shallow soil along the hillside or to surface water and sediment in the gullies on the sides and at the base of the northern slope. As discussed in Section 2.4.1, the volatility of these three COCs usually prevents them from accumulating or residing for any length of time in surface or near-surface soil, sediment, or surface water.

Two sediment samples (01SD0301 in 2001 and 01SD0302 in 2002) had very low detections of 1,1,2,2-PCA (7 µg/kg and 9 µg/kg, respectively). The single location where these two samples were collected is shown on Figure 1-3). These detections may indicate that ground water has transported contaminants to a seep on the hillside, thereby contaminating a surface sediment location on the northern side of the ridge. No seeps were identified during the 2001, 2002, or 2004 sampling events, even though a thorough search for seeps was made. Anecdotal observation indicates the visual detection of one seep immediately south of well 01-02 in 2003 during a casual site visit (undocumented conversation between TtNUS Program Geologist, Keith Henn, and TtNUS Task Order Manger, Tom Johnston).

It is common for seeps of low-flow rates to go undetected on a hillside in spring, summer, and fall because the water can either be taken up by trees and other vegetation (i.e., evapotranspiration) or the wet soil is hidden by grass, other ground vegetation, and/or dead leaves. Because of this, the existence of seeps is expected and the seeps would provide a mechanism for COCs to volatilize when exposed to the atmosphere at or near the land surface. VOCs were not detected in any surface water sample collected on the sides of the ridges. Note that the 1,1,2,2-PCA detected at the one sediment location did not cause an exceedance of human health or ecological screening values and therefore does not pose a risk.

TABLE 2-1

SUMMARY OF SAMPLES COLLECTED VERSUS SAMPLES PROPOSED (BY ANALYTICAL FRACTION)
SWMU 01 - MUSTARD GAS BURIAL GROUND [1]
NSWC CRANE
CRANE INDIANA

		Laboratory Natural Attenuation Parameters									
Sample ID	Volatiles SW-846/8260B	Nitrate + Nitrite (as N)	Chloride	Sulfate	Total Hardness (as CaCO3)	Dissolved Organic Gases[2]	Dissolved Hydrogen	Total Organic Carbon	Total Inorganic Carbon	Volatile Fatty Acids	Field MNA Parameters[3]
Ground Water											
01GW0103	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
01GW0203	1/1[4]	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
01GW0303	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW0403	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW0503	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
01GW0603	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW0702	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW0803	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW0903	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW1003	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
01GW1103	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
01GW1202	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW1302	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW1403	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
01GW1503	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
01GW1601	0/1[5]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW1702	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW1802	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW1902	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
01GW2002	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW2102	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW2202	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW2303	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 2-1

SUMMARY OF SAMPLES COLLECTED VERSUS SAMPLES PROPOSED (BY ANALYTICAL FRACTION)
SWMU 01 - MUSTARD GAS BURIAL GROUND [1]
NSWC CRANE
CRANE INDIANA

		Laboratory Natural Attenuation Parameters									
Sample ID	Volatiles SW-846/8260B	Nitrate + Nitrite (as N)	Chloride	Sulfate	Total Hardness (as CaCO3)	Dissolved Organic Gases[2]	Dissolved Hydrogen	Total Organic Carbon	Total Inorganic Carbon	Volatile Fatty Acids	Field MNA Parameters[3]
01GW2402	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
01GW2503	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
Ground Water (Continued											
01GW2603	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW2702	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GWC0103	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GWT0204	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GWT0302	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GWT0402	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GWT0502	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
01GWT0601	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GWT0701	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ground Water Totals	**33/34**	**11/11**	**11/11**	**11/11**	**11/11**	**11/11**	**11/11**	**11/11**	**11/11**	**11/11**	**11/11**
Subsurface Soil (Test Pit Bottoms)											
01TP020506	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01TP010607	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01TP040607	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01TP050607	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01TP060506	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01TP080506	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil Totals	**6/6**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

TABLE 2-1

SUMMARY OF SAMPLES COLLECTED VERSUS SAMPLES PROPOSED (BY ANALYTICAL FRACTION)
SWMU 01 - MUSTARD GAS BURIAL GROUND [1]
NSWC CRANE
CRANE INDIANA

		Laboratory Natural Attenuation Parameters									
Sample ID	Volatiles SW-846/8260B	Nitrate + Nitrite (as N)	Chloride	Sulfate	Total Hardness (as CaCO3)	Dissolved Organic Gases[2]	Dissolved Hydrogen	Total Organic Carbon	Total Inorganic Carbon	Volatile Fatty Acids	Field MNA Parameters[3]
Ground Water Field Duplicates											
01GW2002-D	1/0[6]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01GW0103-D	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
01GW1103-D	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
01GW0203-D	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
01GW0503-D	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
GW Field Duplicate Totals	**5/4**	**4/4**	**4/4**	**4/4**	**4/4**	**4/4**	**4/4**	**4/4**	**4/4**	**4/4**	**4/4**
Soil Field Duplicates											
01TP01-D	1/1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Soil Duplicate Totals	**1/1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

NA = Not Applicable.

1 Number of samples analyzed/Number of samples proposed.

2 Dissolved organic gases comprise acetylene, *n*-butane, *i*-butane, ethane, ethene, methane, propane, and propene.

3 Monitored natural attenuation (MNA) field parameters include field measurements of alkalinity, carbon dioxide, dissolved oxygen, hydrogen sulfide, iron (+2), manganese (+2), nitrite (as N), and sulfide (SOP CTO315-16).

4 Several original VOC results were rejected; however, the duplicate data for this sample were verified to be of acceptable quality to replace the original data set.

5 Well 01-16, for which no sample was collected, has historically been dry and did not yield enough water to be sampled in this field event.

6 This sample was not scheduled and is an extra sample.

TABLE 2-2

CHLORINATED VOLATILE ORGANIC COMPOUND DATA FOR THE PERIOD 2001 TO 2004 (DETECTIONS ONLY)
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE INDIANA

Well	Parameter	Year	Sample Number	Concentration, µg/L
01-02	1,1,2,2-TETRACHLOROETHANE	2001	01GW0201	38000
		2002	01GW0202	30
		2004	01GW0203	52
			01GW0203-D	59
	1,1,2-TRICHLOROETHANE	2002	01GW0202	0.6
		2004	01GW0203	0.7
			01GW0203-D	1
	CHLOROFORM	2001	01GW0201	840
		2002	01GW0202	1
		2004	01GW0203	1
			01GW0203-D	2
	TETRACHLOROETHENE	2001	01GW0201	370
		2002	01GW0202	1
		2004	01GW0203	1
			01GW0203-D	2
	TRICHLOROETHENE	2001	01GW0201	16000
		2002	01GW0202	20
		2004	01GW0203	30
			01GW0203-D	31
01-03	CHLOROFORM	2004	01GW0303	0.7
01-05	1,1,2,2-TETRACHLOROETHANE	2001	01GW0501	9
		2002	01GW0502	8
		2004	01GW0503	6
			01GW0503-D	6
	1,1,2-TRICHLOROETHANE	2001	01GW0501	9
		2002	01GW0502	11
		2004	01GW0503	5
			01GW0503-D	5
	1,1-DICHLOROETHENE	2001	01GW0501	0.2
	CIS-1,2-DICHLOROETHENE	2001	01GW0501	2
		2002	01GW0502	2
		2004	01GW0503	2
			01GW0503-D	2
	TETRACHLOROETHENE	2001	01GW0501	2
		2002	01GW0502	2
		2004	01GW0503	1
			01GW0503-D	1
	TRANS-1,2-DICHLOROETHENE	2001	01GW0501	0.3
	TRICHLOROETHENE	2001	01GW0501	550
		2002	01GW0502	840
		2004	01GW0503	320
			01GW0503-D	320

TABLE 2-2

CHLORINATED VOLATILE ORGANIC COMPOUND DATA FOR THE PERIOD 2001 TO 2004 (DETECTIONS ONLY)
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE INDIANA

Well	Parameter	Year	Sample Number	Concentration, µg/L
01-08	1,1,2,2-TETRACHLOROETHANE	2002	01GW0802	3
			01GW0802-D	3
		2004	01GW0803	4
	1,1,2-TRICHLOROETHANE	2001	01GW0801	0.6
		2002	01GW0802	3
			01GW0802-D	3
		2004	01GW0803	5
	CIS-1,2-DICHLOROETHENE	2002	01GW0802-D	0.5
		2004	01GW0803	1
	TRICHLOROETHENE	2001	01GW0801	4
		2002	01GW0802	7
			01GW0802-D	7
		2004	01GW0803	10
01-10	TRICHLOROETHENE	2001	01GW1001	0.4
01-11	1,1,1,2-TETRACHLOROETHANE	2001	01GW1101	3
	1,1,2,2-TETRACHLOROETHANE	2001	01GW1101	170
		2002	01GW1102	1
	1,1,2-TRICHLOROETHANE	2001	01GW1101	5
	1,1-DICHLOROETHENE	2001	01GW1101	0.7
	1,2-DICHLOROETHANE	2001	01GW1101	4
	CHLOROFORM	2001	01GW1101	15
		2002	01GW1102	0.7
	CIS-1,2-DICHLOROETHENE	2001	01GW1101	5
	METHYLENE CHLORIDE	2002	01GW1102	1
	TETRACHLOROETHENE	2001	01GW1101	6
		2002	01GW1102	2
		2004	01GW1103	1
			01GW1103-D	1
	TRANS-1,2-DICHLOROETHENE	2001	01GW1101	2
	TRICHLOROETHENE	2001	01GW1101	180
		2002	01GW1102	15
		2004	01GW1103	3
			01GW1103-D	4
01-12[2]	1,1,1,2-TETRACHLOROETHANE	2004	01GW1202	1
	1,1,2,2-TETRACHLOROETHANE	2001	01GW1201	230
		2004	01GW1202	320
	1,1,2-TRICHLOROETHANE	2004	01GW1202	9
	1,1-DICHLOROETHENE	2004	01GW1202	0.5
	1,2-DICHLOROETHANE	2004	01GW1202	2
	CHLOROFORM	2001	01GW1201	9
		2004	01GW1202	9
	CIS-1,2-DICHLOROETHENE	2004	01GW1202	5

TABLE 2-2

CHLORINATED VOLATILE ORGANIC COMPOUND DATA FOR THE PERIOD 2001 TO 2004 (DETECTIONS ONLY)
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE INDIANA

Well	Parameter	Year	Sample Number	Concentration, µg/L
	TETRACHLOROETHENE	2004	01GW1202	4
	TRANS-1,2-DICHLOROETHENE	2004	01GW1202	2
	TRICHLOROETHENE	2001	01GW1201	190
		2004	01GW1202	220
01-13[2]	1,1,2,2-TETRACHLOROETHANE	2001	01GW1301	9
			01GW1301-D	12
		2004	01GW1302	32
	1,1,2-TRICHLOROETHANE	2001	01GW1301-D	0.4
		2004	01GW1302	1
	CHLOROFORM	2004	01GW1302	0.8
	CIS-1,2-DICHLOROETHENE	2001	01GW1301-D	0.7
		2004	01GW1302	0.6
	TRICHLOROETHENE	2001	01GW1301	8
			01GW1301-D	13
		2004	01GW1302	18
01-14	1,1,2,2-TETRACHLOROETHANE	2001	01GW1401	8
		2004	01GW1403	6
	1,1,2-TRICHLOROETHANE	2001	01GW1401	0.4
	1,2-DICHLOROETHANE	2001	01GW1401	0.3
	CHLOROFORM	2001	01GW1401	0.1
	CIS-1,2-DICHLOROETHENE	2001	01GW1401	0.9
		2002	01GW1402	1
		2004	01GW1403	1
	TRANS-1,2-DICHLOROETHENE	2001	01GW1401	0.3
		2002	01GW1402	0.4
	TRICHLOROETHENE	2001	01GW1401	20
		2002	01GW1402	26
		2004	01GW1403	21
01-15	1,1,1,2-TETRACHLOROETHANE	2002	01GW1502	1
	1,1,2,2-TETRACHLOROETHANE	2001	01GW1501	250
		2002	01GW1502	230
		2004	01GW1503	49
	1,1,2-TRICHLOROETHANE	2001	01GW1501	14
		2002	01GW1502	16
		2004	01GW1503	3
	1,1-DICHLOROETHENE	2002	01GW1502	1
	1,2-DICHLOROETHANE	2002	01GW1502	9
		2004	01GW1503	1
	CHLOROFORM	2002	01GW1502	6
		2004	01GW1503	1

TABLE 2-2

CHLORINATED VOLATILE ORGANIC COMPOUND DATA FOR THE PERIOD 2001 TO 2004 (DETECTIONS ONLY)
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE INDIANA

Well	Parameter	Year	Sample Number	Concentration, µg/L
	CIS-1,2-DICHLOROETHENE	2002	01GW1502	9
		2004	01GW1503	2
	TETRACHLOROETHENE	2002	01GW1502	5
		2004	01GW1503	1
	TRANS-1,2-DICHLOROETHENE	2002	01GW1502	3
		2004	01GW1503	0.6
	TRICHLOROETHENE	2001	01GW1501	310
		2002	01GW1502	360
		2004	01GW1503	51
01-17[2]	1,1,1,2-TETRACHLOROETHANE	2001	01GW1701	0.3
			01GW1701-D	0.3
		2004	01GW1702	0.6
	1,1,2,2-TETRACHLOROETHANE	2001	01GW1701	10
			01GW1701-D	10
		2004	01GW1702	8
	1,1,2-TRICHLOROETHANE	2001	01GW1701	0.8
			01GW1701-D	0.8
		2004	01GW1702	0.9
	1,1-DICHLOROETHENE	2001	01GW1701	0.4
			01GW1701-D	0.4
		2004	01GW1702	0.5
	1,2-DICHLOROETHANE	2001	01GW1701	1
		2004	01GW1702	1
	CHLOROFORM	2001	01GW1701	4
			01GW1701-D	4
		2004	01GW1702	5
	CIS-1,2-DICHLOROETHENE	2001	01GW1701	1
			01GW1701-D	1
		2004	01GW1702	1
	TETRACHLOROETHENE	2001	01GW1701	1
			01GW1701-D	1
		2004	01GW1702	1
	TRANS-1,2-DICHLOROETHENE	2001	01GW1701	0.7
			01GW1701-D	0.7
		2004	01GW1702	0.9
	TRICHLOROETHENE	2001	01GW1701	45
			01GW1701-D	44
		2004	01GW1702	56
01-18[2]	1,1,2,2-TETRACHLOROETHANE	2001	01GW1801	0.3
	METHYLENE CHLORIDE	2001	01GW1801	0.2
	TRICHLOROETHENE	2001	01GW1801	5

TABLE 2-2

CHLORINATED VOLATILE ORGANIC COMPOUND DATA FOR THE PERIOD 2001 TO 2004 (DETECTIONS ONLY)
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE INDIANA

Well	Parameter	Year	Sample Number	Concentration, µg/L
01-19[2]	1,1,1,2-TETRACHLOROETHANE	2001	01GW1901	5
	1,1,2,2-TETRACHLOROETHANE	2001	01GW1901	270
		2004	01GW1902	280
	1,1,2-TRICHLOROETHANE	2001	01GW1901	9
		2004	01GW1902	0.8
	1,1-DICHLOROETHENE	2001	01GW1901	2
	1,2-DICHLOROETHANE	2001	01GW1901	10
	CHLOROFORM	2001	01GW1901	27
		2004	01GW1902	2
	CIS-1,2-DICHLOROETHENE	2001	01GW1901	8
	METHYLENE CHLORIDE	2001	01GW1901	0.4
	TETRACHLOROETHENE	2001	01GW1901	6
		2004	01GW1902	2
	TRANS-1,2-DICHLOROETHENE	2001	01GW1901	3
	TRICHLOROETHENE	2001	01GW1901	300
		2004	01GW1902	380
01-20[2]	1,1,2,2-TETRACHLOROETHANE	2001	01GW2001	30
		2004	01GW2002	37
			01GW2002-D	31
	1,1,2-TRICHLOROETHANE	2001	01GW2001	0.6
		2004	01GW2002	0.8
			01GW2002-D	0.6
	CHLOROFORM	2004	01GW2002	0.5
	METHYLENE CHLORIDE	2001	01GW2001	0.3
	TRICHLOROETHENE	2001	01GW2001	30
		2004	01GW2002	25
			01GW2002-D	20
01-22[2]	1,1,1,2-TETRACHLOROETHANE	2001	01GW2201	2
		2004	01GW2202	2
	1,1,2,2-TETRACHLOROETHANE	2001	01GW2201	150
		2004	01GW2202	71
	1,1,2-TRICHLOROETHANE	2001	01GW2201	4
		2004	01GW2202	4
	1,1-DICHLOROETHENE	2001	01GW2201	0.8
		2004	01GW2202	0.9
	1,2-DICHLOROETHANE	2004	01GW2202	4
	CHLOROFORM	2001	01GW2201	15
		2004	01GW2202	15
	CIS-1,2-DICHLOROETHENE	2001	01GW2201	4
		2004	01GW2202	4
	METHYLENE CHLORIDE	2001	01GW2201	0.3

TABLE 2-2

CHLORINATED VOLATILE ORGANIC COMPOUND DATA FOR THE PERIOD 2001 TO 2004 (DETECTIONS ONLY)
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE INDIANA

Well	Parameter	Year	Sample Number	Concentration, µg/L
	TETRACHLOROETHENE	2001	01GW2201	3
		2004	01GW2202	3
	TRANS-1,2-DICHLOROETHENE	2001	01GW2201	2
		2004	01GW2202	2
	TRICHLOROETHENE	2001	01GW2201	120
		2004	01GW2202	150
01-23	TETRACHLOROETHENE	2004	01GW2303	1
01-24[2]	TRICHLOROETHENE	2001	01GW2401	0.4
01-25	1,1,1,2-TETRACHLOROETHANE	2001	01GW2501	2
		2002	01GW2502	1
		2004	01GW2503	1
	1,1,2,2-TETRACHLOROETHANE	2001	01GW2501	32
		2002	01GW2502	24
		2004	01GW2503	29
	1,1,2-TRICHLOROETHANE	2002	01GW2502	2
		2004	01GW2503	2
	1,1-DICHLOROETHENE	2004	01GW2503	0.5
	1,2-DICHLOROETHANE	2002	01GW2502	2
		2004	01GW2503	2
	CHLOROFORM	2001	01GW2501	7
		2002	01GW2502	6
		2004	01GW2503	7
	CIS-1,2-DICHLOROETHENE	2002	01GW2502	2
		2004	01GW2503	2
	METHYLENE CHLORIDE	2002	01GW2502	1
	TETRACHLOROETHENE	2002	01GW2502	1
		2004	01GW2503	1
	TRANS-1,2-DICHLOROETHENE	2002	01GW2502	0.8
		2004	01GW2503	0.9
	TRICHLOROETHENE	2001	01GW2501	65
		2002	01GW2502	74
		2004	01GW2503	96
01-27[2]	1,1,2,2-TETRACHLOROETHANE	2004	01GW2702	0.6
01C01	TRICHLOROETHENE	2004	01GWC0103	1
01T02	METHYLENE CHLORIDE	2001	01GWT0201	0.2
	TRICHLOROETHENE	2001	01GWT0201	0.2
			01GWT0202	0.2
01T03	TRICHLOROETHENE	2002	01GWT0301	1
01T05	1,1,2,2-TETRACHLOROETHANE	2002	01GWT0501	2
		2004	01GWT0502	3
	CHLOROFORM	2002	01GWT0501	1

TABLE 2-2

CHLORINATED VOLATILE ORGANIC COMPOUND DATA FOR THE PERIOD 2001 TO 2004 (DETECTIONS ONLY)
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE INDIANA

Well	Parameter	Year	Sample Number	Concentration, µg/L
	TRICHLOROETHENE	2002	01GWT0501	2
		2004	01GWT0502	3
01T07[2]	1,1,1,2-TETRACHLOROETHANE	2004	01GWT0701	45
	1,1,2,2-TETRACHLOROETHANE	2004	01GWT0701	660
	1,1,2-TRICHLOROETHANE	2004	01GWT0701	16
	1,1-DICHLOROETHANE	2004	01GWT0701	0.5
	1,1-DICHLOROETHENE	2004	01GWT0701	4
	1,2-DICHLOROETHANE	2004	01GWT0701	17
	CARBON TETRACHLORIDE	2004	01GWT0701	10
	CHLOROFORM	2004	01GWT0701	790
	CIS-1,2-DICHLOROETHENE	2004	01GWT0701	14
	METHYLENE CHLORIDE	2004	01GWT0701	15
	TETRACHLOROETHENE	2004	01GWT0701	130
	TRANS-1,2-DICHLOROETHENE	2004	01GWT0701	11
	TRICHLOROETHENE	2004	01GWT0701	620
	VINYL CHLORIDE	2004	01GWT0701	1

µg/L = micrograms per liter

1 Only detectable concentrations are listed. If a round number appears to be missing, it could be that the chemical was not detected or the well was not sampled.
All wells were sampled in Round 3 (January/February, 2004) except for the dry well, 01-16.
2 This well was not sampled in Round 2 (May/June 2002).

TABLE 2-3

PHYSICAL AND CHEMICAL PROPERTIES OF ORGANIC COCs
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Chemical	Specific Gravity[1] (@ 20/4°C)[1]	Vapor Pressure (mm Hg @ 20°C)[2]	Water Solubility (mg/L @ 20°C)[1]	Octanol/Water Partition Coefficient[3]	Organic Carbon Partition Coefficient[4]	Henry's Law Constant (atm-m3/mole)[3]	Bioconcentration Factor (mg/kg/mg/L)[3]	Mobility Index log((solubility*VP)/K_{oc})
HALOGENATED ALIPHATICS								
1,1,2,2-Tetrachloroethane	1.60 (15/4°C)	4.00E+00	2.90E+03	2.45E+02	9.33E+01	3.80E-04	3.90E+01	2.09E+00
Chloroform	1.4832	1.60E+02	9.3E+03 (25°C)	9.33E+01	3.98E+01	3.39E-03 (25°C)	2.60E+01	4.57E+00
Trichloroethene	1.4642	7.70E+01 (25°C)	1.10E+03 (25°C)	3.39E+02	1.66E+02	1.17E-02 (25°C)	9.70E+01	2.67E+00

NA = Not available.

1 (20/4°C) indicates that density of the chemical was measured at 20°C; whereas, density of water was measured at 4°C. Numbers in parentheses below indicate densities were measured at
2 U.S. EPA, 1992c.
3 Mabey, et al., 1982.
4 U.S. EPA, 1996. Soil Screening Guidance.

TABLE 2-4

RANGES OF BIODEGRADATION RATES FOR ORGANIC COCs
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Chemical	SOIL		GROUND WATER	
	Short Half-Life (days)	Long Half-Life (days)	Short Half-Life (days)	Long Half-Life (days)
1,1,2,2-Tetrachloroethane	0.45	44	0.45	44
1,1,2-Trichloroethane	136	365	136	730
1,2-Dichloroethane	100	180	100	360
Tetrachloroethene	180	360	360	720
Trichloroethene	180	360	321	1,653
Cis-1,2-Dichloroethene	28	180	56	2,875
1,1-Dichloroethene	28	180	56	132
Chloroform	28	180	56	1,800

Range of biodegradation half-life values from Howard, et al., 1991.

NA = Not available.

TABLE 2-5

OXIDATION -REDUCTION CONDITIONS IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Monitoring Well ID	Sampling Date	Sampling Round	Oxidation-Reduction Conditions/Parameters										
			Dissolved Oxygen - Test kit mg/L	Dissolved Oxygen - Meter mg/L	ORP mV	Hydrogen nM	Methane µg/L	Ferrous Iron mg/L	Manganese (+2) mg/L	Nitrate mg/L	Nitrite mg/L	Sulfate mg/L	Sulfide mg/L
Monitoring Wells Located Within the PCLE Zone													
01-02	2001	1		1.6	480								
	2002	2	4.5	7.57	488		1 UJ	0.01	0.1	0.08	0.08	25	0.01
	2004	3	5.5		238	2.1	0.04 J	0	0.4	0.1 U	0.004	33.3	0.03
01-05	2001	1		2.37	490.4								
	2002	2		9.06	50								
	2004	3	3	0.01	-14.4	9.7	0.49 J	2.2	1	0.1 U	0.1 U	840	0
01-12	2001	1		1.56	466								
	2002	2											
	2004	3		0.53	-11.9								
01-13	2001	1		0.38	206								
	2002	2		0.64	159.6								
	2004	3											
01-14	2001	1		0.08	-156								
	2002	2		2.41	-57								
	2004	3	0.05	0.47	-47	3.3	0.37 J	2.8	> 22	0.1 U	0	420	0.05
01-15	2001	1		0.71	75.2								
	2002	2	0.3	8.35	-71		24 J	8.8	1.7	0	0	80 >	0
	2004	3	0.2	-0.01	-7.7	12	56 J	3.3	4.2	0.1 U	0.007	534	0
01-19	2001	1		2.07	434								
	2002	2											
	2004	3	3	1.46	346	2.4	11 J	0.01	0	0.15	0	286	0.03
01-20	2001	1		2.67	327								
	2002	2											
	2004	3		2.1	8.4								
01-22	2001	1		1.55	511								
	2002	2											
	2004	3		0.79	76								
01-25	2001	1		0.74	433								
	2002	2	0.4	0.63	232		1 UJ	0	0.3	0.21	0	80 >	0.02
	2004	3	0.25	0.31	52.7	2.5	0.16 J	0.03	0	0.29	0	348	0.23
01T07	2004	3		1.33	185								
Monitoring Wells Located Near the Outer Edge of the Plume													
01-08	2001	1		0.39	39.6								
	2002	2		0.73	-51								
	2004	3		0.48	-62								
01-11	2001	1		1.01	444.8								
	2002	2	2	3.55	562		1 UJ	0.01	0.7	0.29	0	12	0.01
	2004	3	3	5.09	5.4	2 J	0.03 J	0	0.3	0.1 U	0.001	15.6	0.02
01-17	2001	1		2.82	474								
	2002	2		2.5	55.9								
	2004	3											
01T05	2002	2	3	3.92	228		1 UJ	0.07	6.2	0.38	0.006	80 >	0
	2004	3	0.5	1.38	198	2.5	0.19 J	0.35	9.5	0.1 U	0.006	778	0

TABLE 2-5

OXIDATION -REDUCTION CONDITIONS IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Monitoring Well ID	Sampling Date	Sampling Round	Oxidation-Reduction Conditions/Parameters										
			Dissolved Oxygen - Test kit mg/L	Dissolved Oxygen - Meter mg/L	ORP mV	Hydrogen nM	Methane µg/L	Ferrous Iron mg/L	Manganese (+2) mg/L	Nitrate mg/L	Nitrite mg/L	Sulfate mg/L	Sulfide mg/L
Monitoring Wells Located Outside of the Plume													
01-01	2001	1		0.95	393								
	2002	2		1.28	168								
	2004	3	0.6	0.16	-14.6	5.8	0.24 J	0.86	3.4	0.1 U	0	277	0
01-03	2001	1		0.84	-152								
	2002	2		6.77	-6								
	2004	3		3.96	37.2								
01-04	2001	1		0.63	490								
	2002	2		5.61	575								
	2004	3		5.58	6.5								
01-07	2001	1		0.38	221.5								
	2002	2		0.76	-49								
	2004	3											
01-09	2001	1		0.71	618.1								
	2002	2		1.55	433								
	2004	3		2.67	313								
01-10	2001	1		0.72	71								
	2002	2		1.76	-16								
	2004	3	0.6	1.56	49.3	3.2	0.07 J	> 3.3	2.5	0.1 U	0.17	88.2	0.03
01-18	2001	1		0.86	93.8								
	2004	3		1.2	-53.1								
01-21	2001	1		1.19	28.1								
	2002	2		0.58	-62								
	2004	3											
01-23	2001	1		1.58	433.2								
	2002	2		3.01	3								
	2004	3		1.31	-149								
01-24	2001	1		0.54	78.5								
	2004	3	0.2	2.18	-90	2	1.4 J	> 3.3	1.5	0.1 U	0.006	17.8	0.01
01-26	2001	1		0.75	543.9								
	2002	2		2.66	7								
	2004	3		-0.04	34.4								
01-27	2001	1		2.89	396.1								
	2004	3		0.26	-25.7								
01T02	2001	1		7.19	345								
	2002	2	1.5	10.17	98		0.9 J	8.5	> 22	0.04	0	> 80	0.04
	2004	3		0	38.3								
01T06	2004	3		6.75	196								

TABLE 2-5

OXIDATION -REDUCTION CONDITIONS IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Monitoring Well ID	Sampling Date	Sampling Round	Oxidation-Reduction Conditions/Parameters										
			Dissolved Oxygen - Test kit mg/L	Dissolved Oxygen - Meter mg/L	ORP mV	Hydrogen nM	Methane µg/L	Ferrous Iron mg/L	Manganese (+2) mg/L	Nitrate mg/L	Nitrite mg/L	Sulfate mg/L	Sulfide mg/L
Deep Monitoring Wells													
01-06	2001	1		0.69	109								
	2002	2		2.56	142								
	2004	3		1.58	24								
01C01	2001	1		0.12	365.7								
	2002	2		2.28	565								
	2004	3		0.01	-10.8								
01T03	2002	2	0.7	7.72	404		1 UJ	0.01	0.3	0.32	0.008	> 80	0
	2004	3		0.28	40.9								
01T04	2002	2	2	2.63	272		1 UJ	0.01	0	1.28	0	54	0
	2004	3	2	0.49	-6.4			0.01	0			48	0

mg/L - milligrams per liter
mV - millivolts
ng/L - nanograms per liter
nM - nanomoles per liter
S.U. - Standard Units
µg/L - micrograms per liter

Analytical Result Qualifiers:
J - Indicates that the chemical was detected. However, the associated numerical result may not be a precise representation of the amount that is actually present in the sample. The laboratory reported concentration is considered to be an estimate of the true
U - Indicates that the sample was not detected at the numerical detection limit (sample-specific quantitation limit) noted. Nondetected results from the laboratory are reported in this manner.

TABLE 2-6

DEGRADATION PRODUCTS AND OTHER GEOCHEMICAL PARAMETERS IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Monitoring Well ID	Sampling Date	TtNUS Sampling Round	Well Sampling Round(1)	Degradation Products				Other Geochemical Parameters		
				Ethene ng/L(2)	Ethane ug/L(2)	Alkalinity mg/L(3)	Chloride mg/L(2)	pH S.U. (3)	Specific Conductance mS/cm (3)	TOC mg/L (2)
Monitoring Wells Located Within the PCLE Zone										
01-02	2001	1						6.17	1.659	7.8
	2002	2		1 U	1 U	50	4.1	5.89	0.209	3.6
	2004	3		0.009 J	0.003 J	68	3 J	6.33	0.177	1.9
01-05	2001	1						6.00	2.37	4.78
	2002	2						6.86	2.112	
	2004	3		0.02 J	0.09 J	250	77	6.96	1.535	1.7 J
01-12	2001	1						5.89	0.643	
	2004	3	2					6.86	0.412	
01-13	2001	1						6.44	0.608	
	2004	3	2					7.27	0.458	
01-14	2001	1						6.50	1.47	
	2002	2						6.34	1.083	
	2004	3		0.024 J	0.046 J	240	68.7	6.43	1.015	1.5 J
01-15	2001	1						6.59	1.352	
	2002	2		1 U	1 U	250	56.8	6.42	1.396	4.4 J
	2004	3		0.058 J	0.051 J	325	80.2 J	6.79	1.141	1.1 J
01-19	2001	1						6.43	1.162	
	2004	3	2	0.013 J	0.04 J	260	46.6 J	7.01	0.866	1.4 J
01-20	2001	1						7.14	1.567	
	2004	3	2					6.02	1.297	
01-22	2001	1						6.41	1.281	
	2004	2	2					6.96	0.915	
01-25	2001	1						6.4	1.289	
	2002	2		1 U	1 U	250	42.8	7.02	1.363	4.7 J
	2004	3		0.012 J	0.026 J	10 U	41.4	7.05	1.032	1.5 J
01T07		3						6.25	1.238	
Monitoring Wells Located Near the Outer Edge of the Plume										
01-08	2001	1						6.28	0.546	
	2002	2						6.75	0.404	
	2004	3						6.96	0.417	
01-11	2001	1						5.74	0.444	
	2002	2		1 U	1 U	15	0.60	5.32	0.065	2.9 J
	2004	3		0.008 J	0.001 J	>1000	0.77 J	5.61	0.054	5 U
01-17	2001	1						5.54	0.824	
	2004	3	2					6.23	0.661	
01T05	2002	2	1	1 U	1 U	70	127	5.77	2.61	5.1 J
	2004	3	2	0.046 J	0.004 J	40	93.7	5.73	1.044	1 J
Monitoring Wells Located Outside of the Plume (Ambient Conditions)										
01-01	2001	1						6.00	1.007	4.5 J
	2002	2						5.77	0.873	
	2004	3		0.01 J	0.006 J	175	39.5	6.31	0.796	1.4 J
01-03	2001	1						6.26	0.486	35.3 J
	2002	2						6.58	0.207	
	2004	3						6.6	0.105	
01-04	2001	1						6.7	0.922	3.7
	2002	2						6	1.466	
	2004	3						6.83	0.722	
01-07	2001	1						6.9	0.518	
	2004	3	2					6.72	0.823	

TABLE 2-6

DEGRADATION PRODUCTS AND OTHER GEOCHEMICAL PARAMETERS IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA
PAGE 2 OF 2

Monitoring Well ID	Sampling Date	TtNUS Sampling Round	Well Sampling Round(1)	Degradation Products				Other Geochemical Parameters		
				Ethene ng/L(2)	Ethane ug/L(2)	Alkalinity mg/L(3)	Chloride mg/L(2)	pH S.U. (3)	Specific Conductance mS/cm (3)	TOC mg/L (2)
01-09	2001	1						4.41	0.272	
	2002	2						5.26	0.088	
	2004	3						5.39	0.083	
Monitoring Wells Located Outside of the Plume (Ambient Conditions), Continued										
01-10	2001	1						6.33	0.699	
	2002	2						6.87	0.812	
	2004	3		0.016 J	0.002 J	250	4.9	7.02	0.474	1.5 J
01-18	2001	1						6.94	0.768	
	2004	3	2					7.24	0.509	
01-21	2001	1						5.61	1.1	
	2004	3	2					6.78	0.618	
01-23	2001	1						4.99	2.161	
	2002	2						6.28	1.648	
	2004	3						7.6	1.305	
01-24	2001	1						6.69	0.679	
	2004	3	2	0.005 UJ	0.01 J	180	4.4	7.1	0.313	5 U
01-26	2001	1						7	1.428	
	2002	2						6.34	1.129	
	2004	3						6.82	1.111	
01-27	2001	1						6.06	1.297	
	2004	3	2					7.14	0.775	
01T02	2001	1						5.41	2.939	2.06
	2002	2		2 J	1 UJ	120	94.4	5.68	2.686	9.2 J
	2004	3						5.76	2.299	
01T06		3	1					6.18	1.178	
Deep Monitoring Wells										
01-06	2001	1						5.25	1.67	6.21
	2002	2						6.61	1.466	
	2004	3						6.95	1.198	
01C01	2001	1						6.97	0.522	2.9
	2002	2						6.9	0.394	
	2004	3						7.95	0.337	
01T03	2002	2	1	1 U	1 U	275	2.1	7.23	0.739	3.7 J
	2004	3	2					7.29	0.562	
01T04	2002	2	1	1 U	1 U	158	1.6	7.45	0.482	2.6 J
	2004	3	2					7.8	0.287	1.2 J

mg/L - milligrams per liter.
mV - millivolts.
nM - nanomoles per liter.
µg/L - micrograms per liter.
ng/L - nanograms per liter.
S.U. - Standard Units.
SDG - Sample Data Group.
TtNUS - Tetra Tech NUS.

1 "TtNUS Sampling Round" corresponds to the sequential TtNUS field event during which some wells were not sampled. "Well Sampling Round" reflects the number of the sampling event for an individual well.
2 Analytical Laboratory result
3 Field measurement

Analytical Result Qualifiers:
J - Indicates that the chemical was detected. However, the associated numerical result may not be a precise representation of the amount that is actually present in the sample. The laboratory reported concentration is considered to be an estimate of the
U - Indicates that the sample was not detected at the numerical detection limit (sample-specific quantitation limit) noted. Nondetected results from the laboratory are reported in this manner. This qualifier is added to a positive result (reported by the laboratory) that is determined through data validation to be a false detection.

TABLE 2-7

NATURAL ATTENUATION SCORE
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE INDIANA

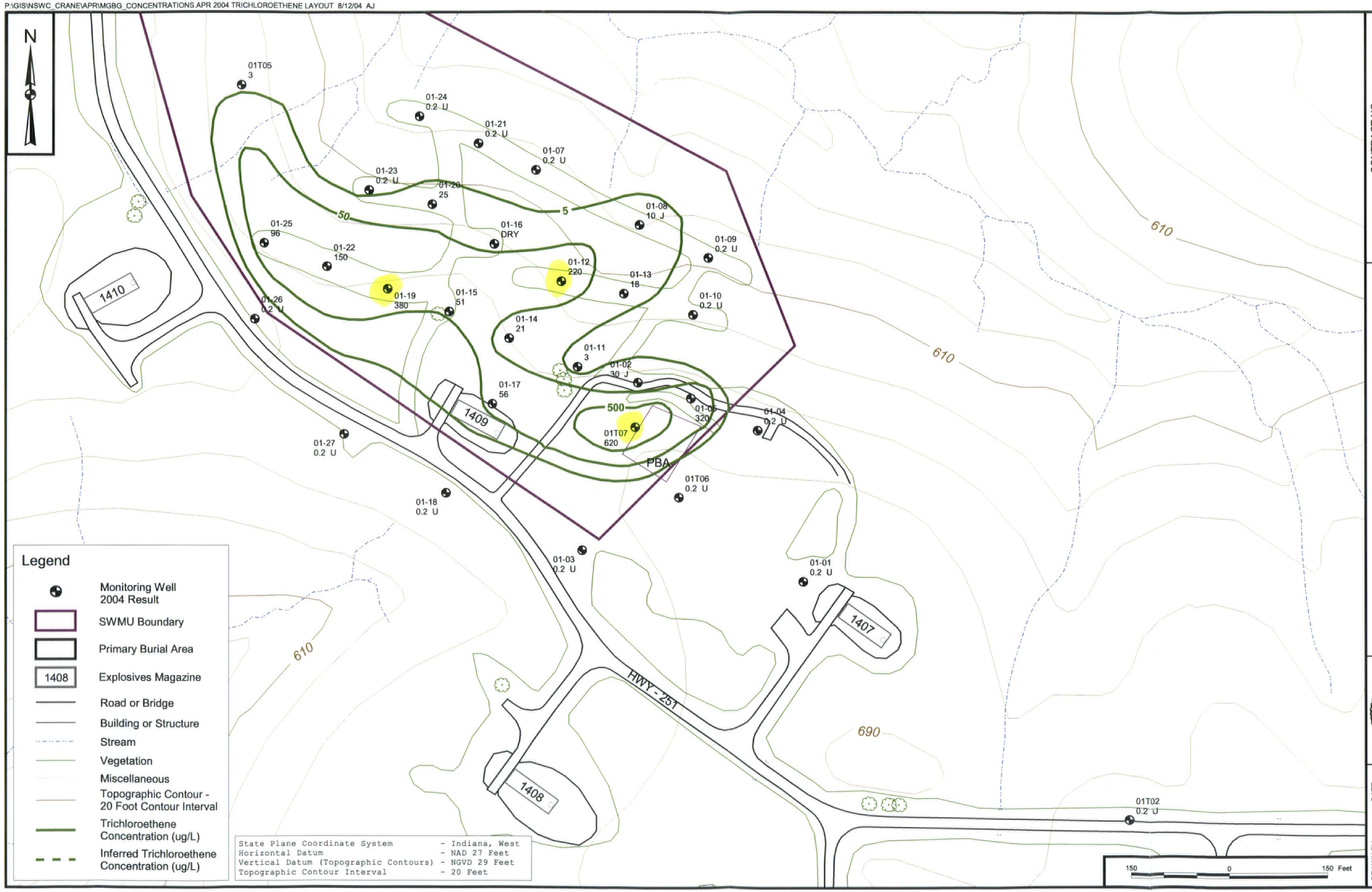
EPA Worksheet for Screening for Anaerobic Biodegradation of Chlorinated Solvents

Location:	NSWC Crane	**By:**	KWHenn
Site:	MGBG	**Date:**	5/7/2004
Well No:	Site Wide	**Chkd:**	T. Johnston
Date Sampled:	1/26/2004	**Date:**	5/8/2004

Analytical Parameter	NA Indicator Level	Point Value	Conc. In Most Contaminated Zone	Well Name	Units	Points Awarded
Dissolved Oxygen	<0.5, >5 mg/L	3, -3	1.33	01T07	mg/L	0
Nitrate	<1 mg/L	2	0.01 U	01-02	mg/L	2
Iron II	>1 mg/L	3	0	01-02	mg/L	0
Sulfate	<20 mg/L	2	33.3	01-02	mg/L	0
Sulfide	>1 mg/L	3	0.03	01-02	mg/L	0
Methane	<0.5, >0.5 mg/L	0, 3	0.04 J	01-02	mg/L	3
ORP	<50, <-100 mV	1, 2	238	01-02	mV	0
pH	<5 , >9	-2	6.33	01-02	SU	0
TOC	>20 mg/L	2	1.9J	01-02	mg/L	0
Temperature	>20 deg. C	1	8.12	01-02	°C	0
Carbon Dioxide	>2x Bkgrnd	1	15	01-02/01-01	mg/L	0
Alkalinity	>2x Bkgrnd	1	68	01-02/01-01	mg/L	0
Chloride	>2x Bkgrnd	2	3J	01-02	mg/L	0
Tetrachloroethene	Parent	0	1J	01-02	ug/L	0
Trichloroethene	If daughter	2	620	01T07	ug/L	0
cis-1,2-Dichloroethene	If daughter	2	14J	01T07	ug/L	2
Vinyl Chloride	If daughter	2	1J	01T07	ug/L	0
Ethene/Ethane	>10, >100	2, 3	0.003J	01-02	ug/L	0
1,1,1-Trichloroethane	Parent	0	0.2U	01-02	ug/L	0
1,2-Dichloroethane	If daughter	2	17 J	01T07	ug/L	2
Chloroethane	If daughter	2	0.3U	01T07	ug/L	0
Carbon Tetrachloride	Parent	0	10 J	01T07	ug/L	0
Chloroform	Parent/daughter	0/2	790	01T07	ug/L	2
Dichloromethane	Parent/daughter	0/2	NA	NA	ug/L	0
BTEX	>100	2	0	NA	ug/L	0
Volatile Fatty Acids	>100	2	0	NA	ug/L	0
Hydrogen	>1 nM	3	2.1	01-02	nM	3
Hydrogen	<1 nM	0	NA	01-02	nM	0
					Score	14

Score	**Interpretation**
0 to 5	Inadequate evidence for anaerobic biodegradation
6 to 14	Limited evidence for anaerobic biodegradation
15 to 20	Adequate evidence for anaerobic biodegradation
>20	Strong evidence for anaerobic biodegradation
NA - Not analyzed or not applicable.	BTEX = Benzene, ethylbnzene, zylene, and toluene
	J = Estimated value.

P:\GIS\NSWC_CRANE\APR\MGBG_CONCENTRATIONS.APR 2004 TRICHLOROETHENE LAYOUT 8/12/04 AJ



CONTRACT NO. N0845

APPROVED BY T. JOHNSTON — DATE 5/20/04

APPROVED BY — DATE

DRAWING NO. — REV 0

FIGURE 2 - 1

TRICHLOROETHENE CONCENTRATIONS (UG/L) IN SHALLOW WELLS, 2004
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

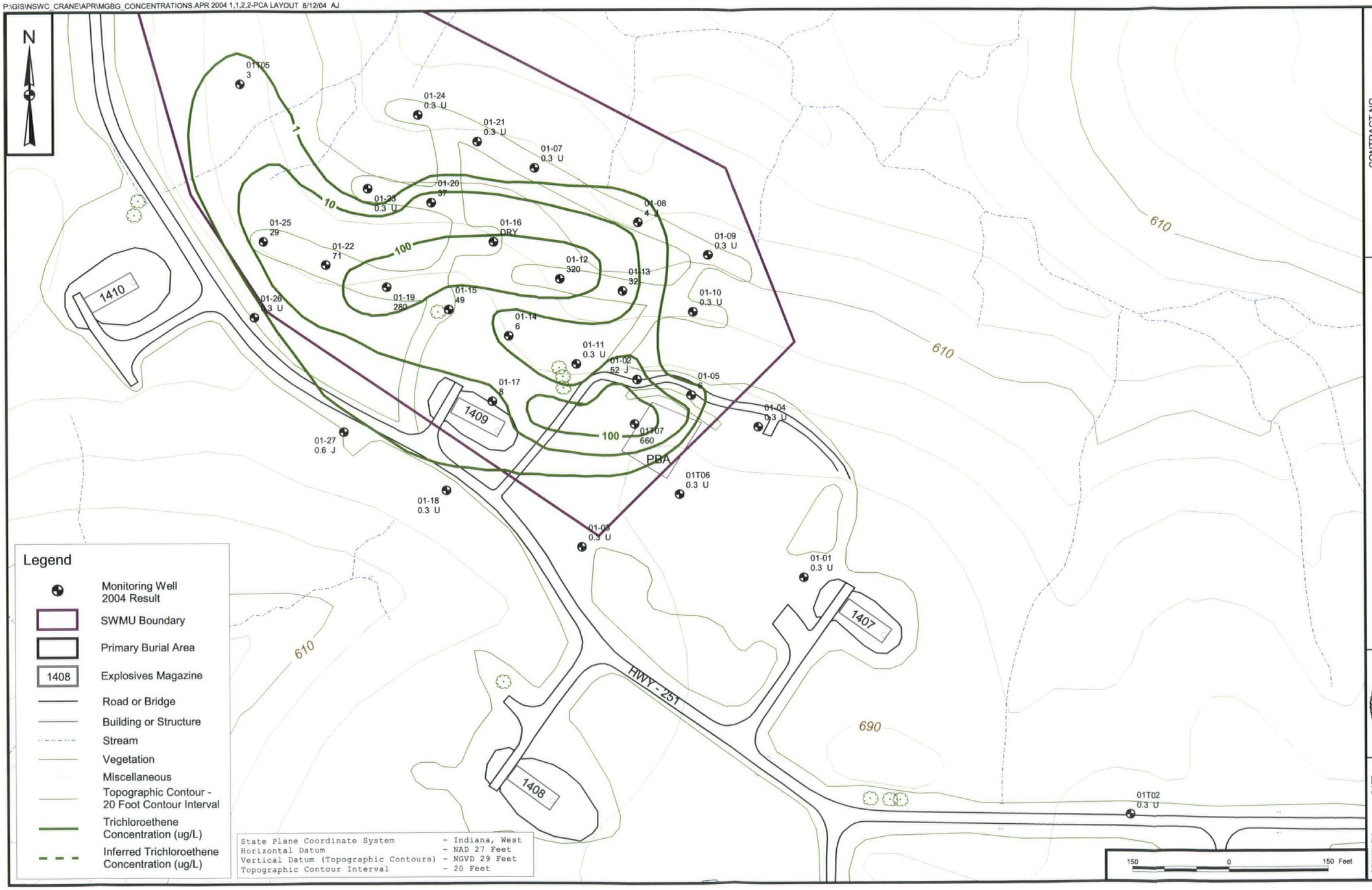
DRAWN BY J. LAMEY — DATE 8/20/02

CHECKED BY V. PLACHY — DATE 8/12/04

COST/SCHED-AREA

SCALE AS NOTED

P:\GIS\NSWC_CRANE\APR\MGBG_CONCENTRATIONS.APR 2004 1,1,2,2-PCA LAYOUT 8/12/04 AJ



CONTRACT NO. N0845

APPROVED BY T. JOHNSTON — DATE 5/20/04

APPROVED BY ___ — DATE ___

DRAWING NO. FIGURE 2 - 2 — REV 0

1,1,2,2-TETRACHLOROETHANE CONCENTRATIONS (UG/L) IN SHALLOW WELLS, 2004
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

DRAWN BY J. LAMEY — DATE 8/20/02

CHECKED BY V. PLACHY — DATE 8/12/04

COST/SCHED-AREA

SCALE AS NOTED

FIGURE 2-3

CUMULATIVE TCE PLUME CONCENTRATIONS OVER TIME
NSWC CRANE
CRANE, INDIANA

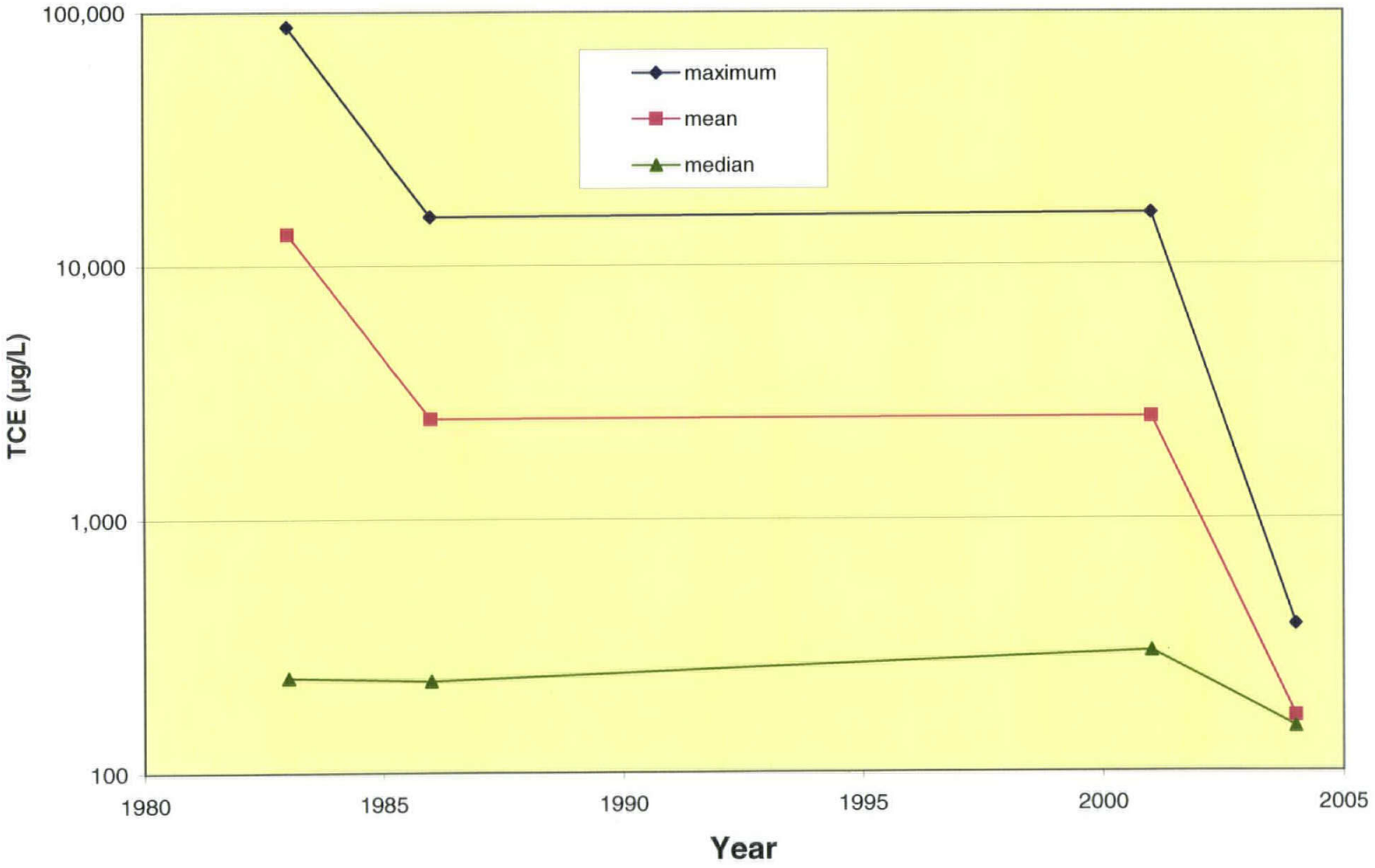


FIGURE 2-4

CUMULATIVE 1,1,2,2-PCA PLUME CONCENTRATIONS OVER TIME
NSWC CRANE
CRANE, INDIANA

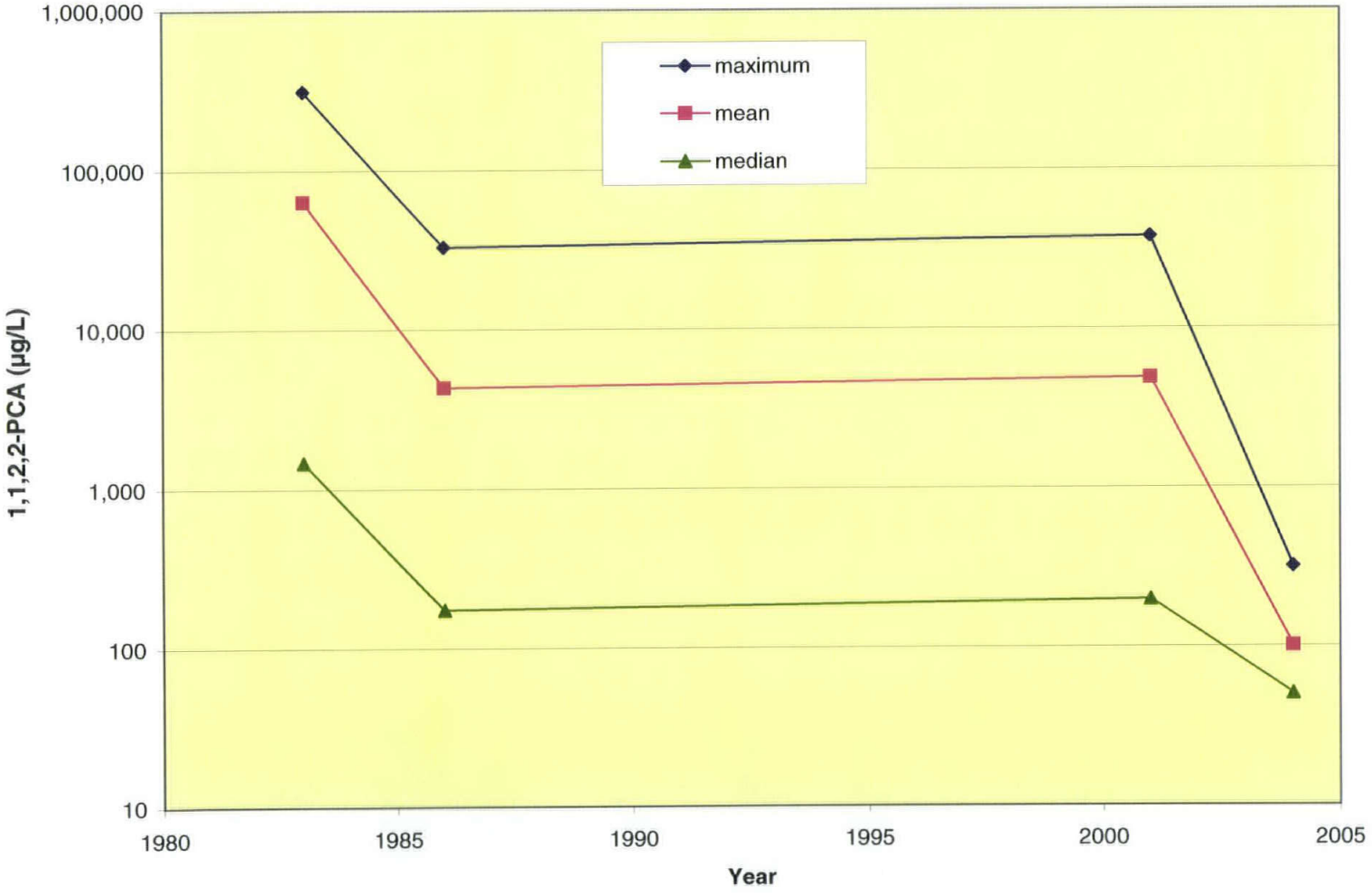


FIGURE 2-5

CUMULATIVE CHLOROFORM PLUME CONCENTRATIONS OVER TIME
NSWC CRANE
CRANE, INDIANA

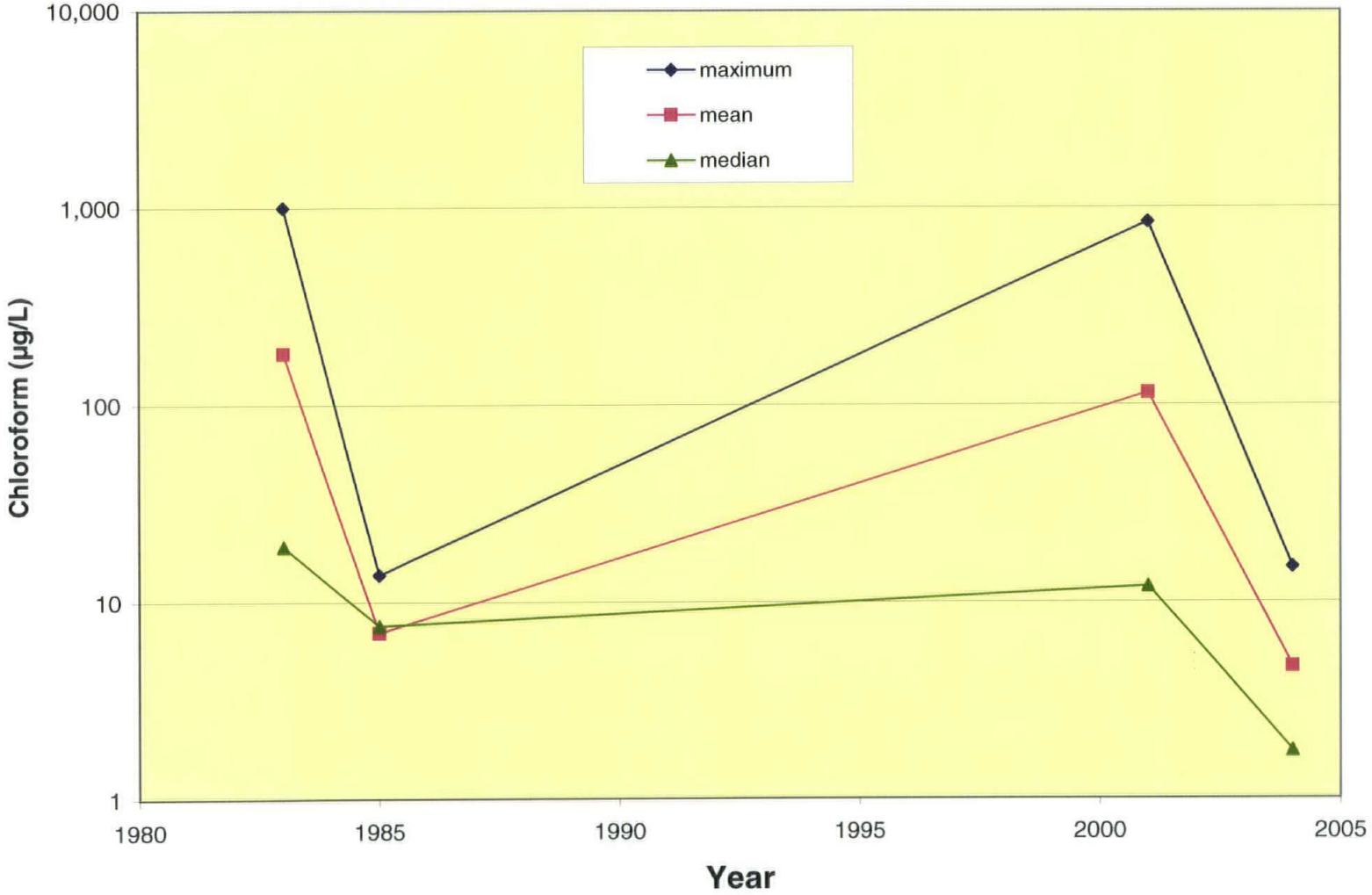
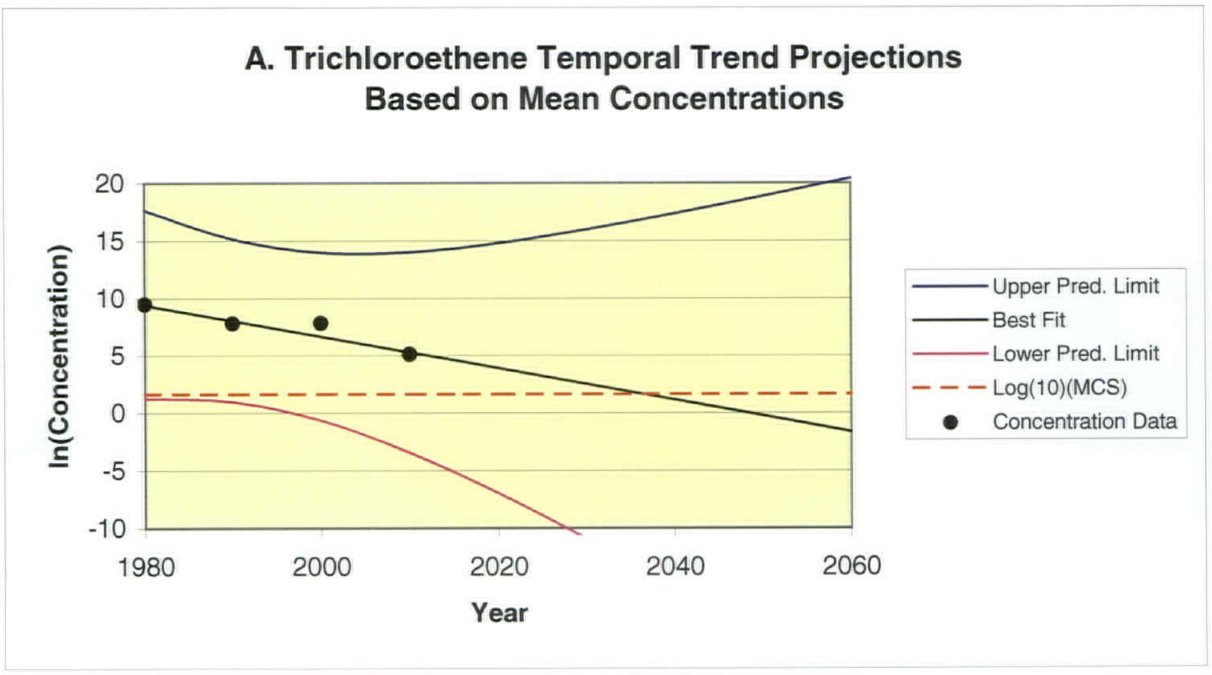


FIGURE 2-6

TRICHLOROETHENE ESTIMATED TIMES TO ACHIEVE MEDIA CLEANUP STANDARDS

NSWC CRANE
CRANE, INDIANA



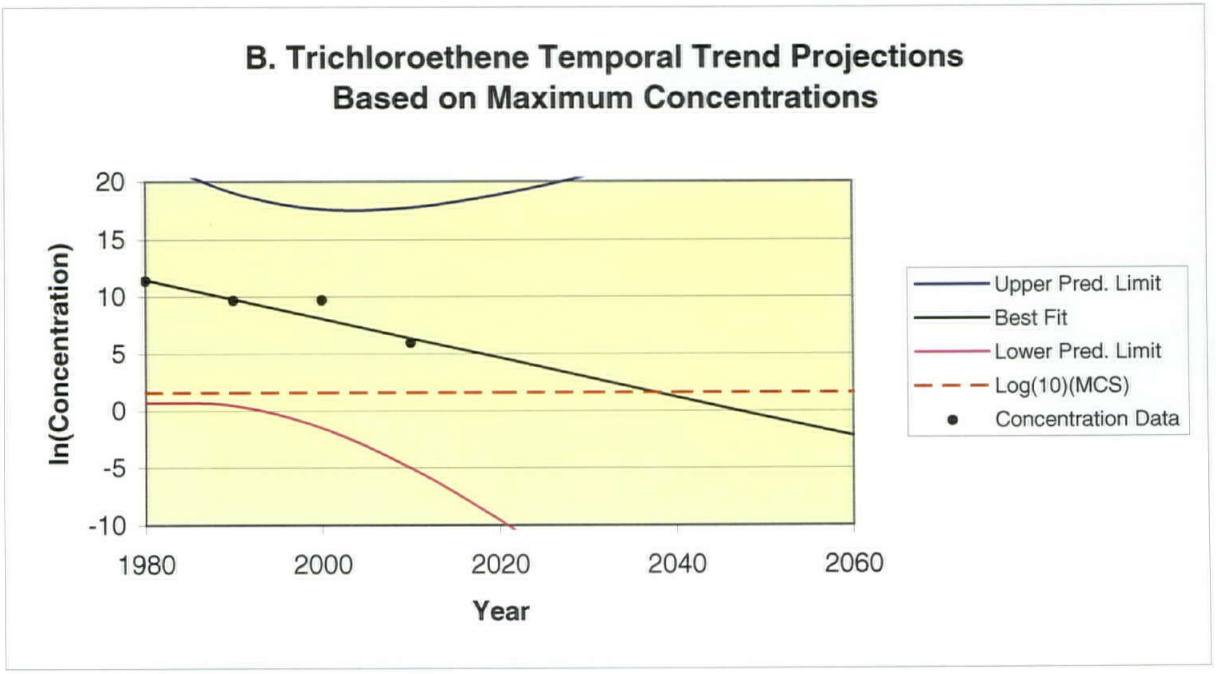
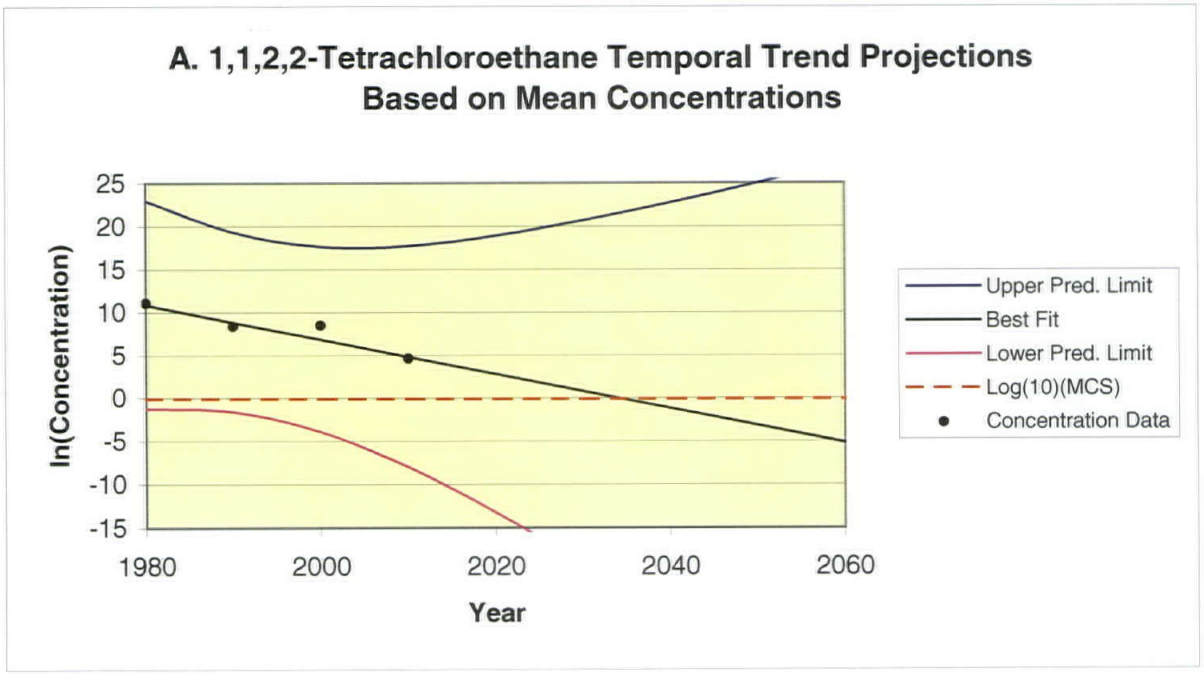
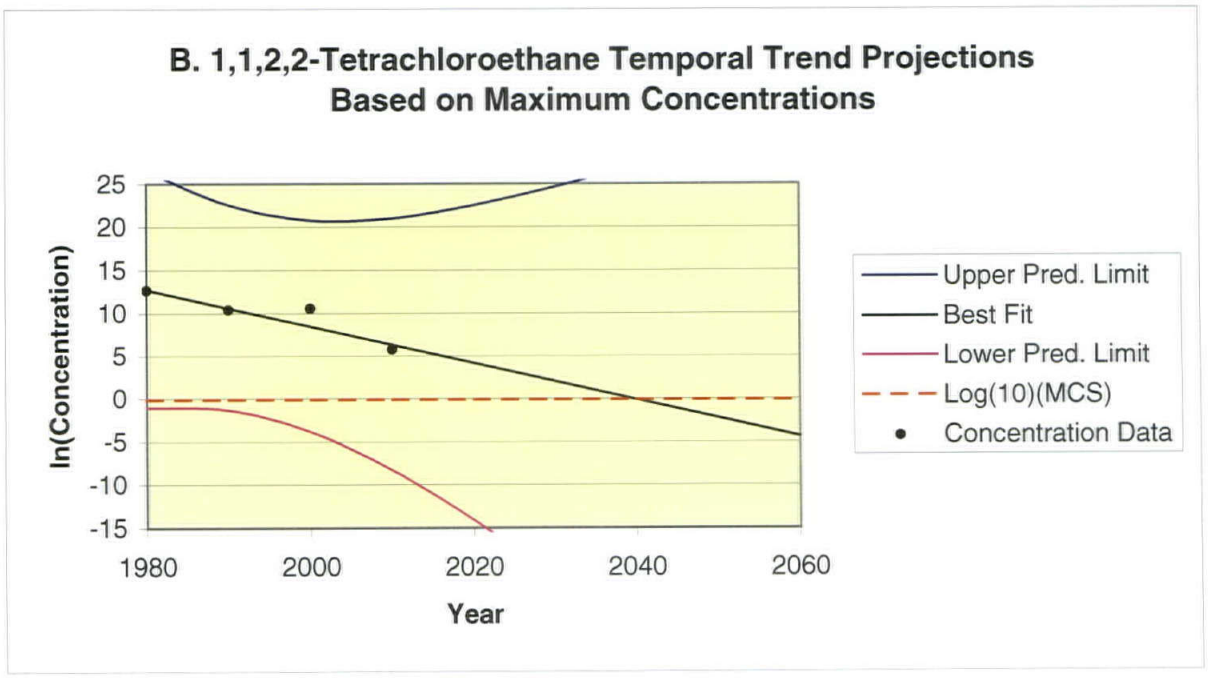


FIGURE 2-7

1,1,2,2-TETRACHLOROETHANE ESTIMATED TIMES TO ACHIEVE MEDIA CLEANUP STANDARDS

NSWC CRANE
CRANE, INDIANA





3.0 DEVELOPMENT OF CORRECTIVE ACTION OBJECTIVES

3.1 INTRODUCTION

The purpose of this section is to identify ARARs and TBC criteria and to develop CAOs for ground water at the MGBG site. The CAOs are based on contaminant characterization, risk assessment, and compliance with risk-based and ARAR-based action levels.

3.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

ARARs include the requirements, criteria, or limitations promulgated under federal and state law that address a chemical, location, or action at a site. The definition of an ARAR is as follows:

- Any standard, requirement, criterion, or limitation under federal environmental law.
- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-citing law that is more stringent that the associated federal standard, requirement criterion, or limitation.

One of the primary concerns during the development of CAOs is the degree of human health and environmental protection afforded by a given remedy. Consideration should be given to remedies that attain or exceed ARARs.

Definitions of the two types of ARARs, as well as TBC criteria, are as follows:

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site.

- Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable" address problems or situations sufficiently similar (relevant) to those encountered at a site such that their use is well suited (appropriate) to the particular site.

- TBC criteria are nonpromulgated, enforceable guidelines or criteria that may be useful for developing remedial actions or necessary for determining what is protective of human health and/or the

environment. Examples of TBC criteria include U.S. EPA Drinking Water Advisories and Risk-Based Concentrations (RBCs).

ARARs fall into three categories as follows based on the manner in which they are applied:

- Contaminant-specific – These include health-risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples of contaminant-specific ARARs include MCLs and Clean Water Act (CWA) Ambient Water Quality Criteria.

- Location-specific – These restrictions are based on the concentrations of specific contaminants or the conduct of activities in specific locations. These may restrict or preclude certain remedial actions or may apply only to certain portions of a site.

- Action-specific – These are technology- or activity-based controls or restrictions on activities related to management of contaminants. Action-specific ARARs pertain to implementing a given remedy.

All contaminant-, location-, and action-specific ARARs and TBCs for SWMU 01 are listed in Tables 3-1, 3-2, and 3-3, respectively. Sections 3.3.1, 3.3.2, and 3.3.3 provide a brief description of each contaminant-, location-, and action-specific ARAR and TBC, respectively, shown in those tables.

3.3.1 Contaminant-Specific ARARs and TBCs

This section provides a summary description of federal and State of Indiana contaminant-specific ARARs and TBC criteria of potential concern at SWMU 01.

The Safe Drinking Water Act (SDWA) (40 CFR 141-143) promulgated National Primary Drinking Water Standard MCLs (40 CFR Part 141). MCLs are enforceable standards for contaminants in public drinking water supply systems. They consider not only health factors but also the economic and technical feasibility of removing a contaminant from a water supply system. Secondary MCLs (SMCLs) (40 CFR Part 143) are not enforceable but are intended as guidelines for contaminants that may adversely affect the aesthetic quality of drinking water, such as taste, odor, color, and appearance, and may deter public acceptance of drinking water provided by public water systems.

The SDWA also established MCL Goals (MCLGs) for several organic and inorganic compounds in drinking water. MCLGs indicate the level of contaminants in drinking water at which no known or anticipated health effects would occur, allowing for an adequate margin of safety. MCLGs are non-enforceable public health

goals. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 CFR 300.430(e)(2)(i)] states that MCLGs set at levels greater than zero shall be attained by remedial actions for ground water or surface waters that are current or potential sources of drinking water where MCLs are relevant and appropriate to the circumstances of the release.

The CWA sets U.S. EPA AWQCs, which are non-enforceable guidelines (TBCs) developed for pollutants in surface waters pursuant to Section 304(a)(1) of the CWA. Although AWQCs are not legally enforceable, they are TBC as potential ARARs. AWQCs are available for the protection of human health from exposure to contaminants in surface water as well as from ingestion of aquatic biota and for the protection of freshwater and saltwater aquatic life. AWQCs may be considered for actions that involve ground water treatment and/or discharge to nearby surface waters.

U.S. EPA Health Advisories are non-enforceable guidelines developed by the U.S. EPA Office of Drinking Water for contaminants that may be intermittently encountered in public water supply systems. Health advisories are available for short-term, longer-term, and lifetime exposures for a 10-kg child and a 70-kg adult. Health advisories may be pertinent for remedial action/corrective measures involving ground water, especially for contaminants not regulated by the SDWA.

Reference Doses (RfDs), as defined in the U.S. EPA Integrated Risk Information System (IRIS), are estimates (with uncertainty spanning perhaps an order of magnitude) of daily exposure to the human population (including sensitive subgroups) that are likely to be without an appreciable risk of deleterious effects during a lifetime. RfDs are developed for chronic and/or subchronic human exposure to hazardous chemicals and are based on the assumption that thresholds exist for certain toxic effects. The RfD is usually expressed as an acceptable dose (mg) per unit body weight (kg) per unit time (day). The RfD is derived by dividing the no-observed-adverse-effect level (NOAEL) or the lowest-observed-adverse-effect level (LOAEL) by an uncertainty factor (UF) multiplied by a modifying factor (MF).

U.S. EPA Carcinogenic Slope Factors, as defined in the Integrated Risk Information System (IRIS), are upper bounds, approximating a 95-percent confidence limit, on the increased cancer risk from a lifetime exposure to contaminants. These estimates, usually expressed in units of proportion (of a population) affected per mg/kg/day, is generally reserved for use in the low-dose region of the dose-response relationship, that is, for exposures corresponding to risks less than 1 in 100.

Region 9 PRGs are risk-based concentrations derived from standardized equations combining exposure information assumptions with U.S. EPA toxicity data for contaminants in soil, air, and tap water. They are considered to be protective for humans (including sensitive groups) over a lifetime. However, PRGs are

not always applicable to a particular site and do not address non-human health endpoints such as ecological impacts. PRGs are not de facto cleanup standards; however, they could be used to establish final cleanup levels for a site after a proper evaluation takes place. Region 9 PRGs are risk-based concentrations that are intended to assist risk assessors and others in initial screening-level evaluations of environmental measurements.

IDEM has established a non-rule policy called the Risk Integrated System of Closure (RISC) that incorporates environmental risk assessment principles to protect human health and the environment and to achieve consistent closure of contaminated soil and ground water. As a non-rule policy document, RISC guidance does not have the effect of law. However, the policy provides a systematic approach for consistently and rationally implementing the laws and rules that govern site investigation and closure. Included in this policy are risk-based closure level constituent concentrations calculated to be protective of human health.

Indiana Water Quality Standards (IWQS) [Indiana Administrative Code (IAC) 327] establish minimum standards for the protection of surface water quality. IDEM has established two sets of water quality criteria; one for bodies of water that are in the Great Lakes Basin and another for all other State bodies of water. Each set of criteria includes values for the protection of human health, aquatic life, and wildlife. There are two categories of human health criteria, drinking water and non-drinking water. The drinking water criteria apply to the point of intake. Separate human health cancer and non-cancer criteria are derived if the contaminant has the potential to cause cancer. The value of the highest level of protection is used for each contaminant. Water from SWMU 01 does not drain to the Great Lakes Basin.

3.3.2 Location-Specific ARARs and TBCs

This section presents a summary of federal and State of Indiana location-specific ARARs and TBC criteria of potential concern for SWMU 01. The potential ARARs and TBCs are as follows:

The Endangered Species Act of 1973 [16 United States Code (USC) 1531] (50 CFR Part 17) conserves the ecosystems upon which endangered and threatened species depend and was enacted to protect and recover listed species. Corrective measure actions, if required, would need to be conducted in a manner such that the continued existence of any endangered or threatened species is not jeopardized or its critical habitat is not adversely affected. Consultation with the United States Fish and Wildlife Service is also required. SWMU 01 is located in Martin County. The State of Indiana has identified a list of endangered, threatened, and rare species for Martin County. The species include plants, insects, birds, reptiles, and birds. In addition, migrating species may move through the area.

U.S. EPA Ground Water Protection Strategy and Classification Guidelines (U.S. EPA, 1984) is a policy to protect ground water for its highest present or potential beneficial use. The strategy designates three classifications of ground water, as follows:

- Class I – Special Ground Water: Water that is highly vulnerable to contamination and is either irreplaceable or ecologically vital as a source of drinking water.

- Class II – Current and Potential Sources of Drinking Water and Waters Having Other Beneficial Uses: Waters that are currently used or that are potentially available.

- Class III – Ground Water Not a Potential Source of Drinking Water and of Limited Beneficial Use. Class III ground water units are further subdivided into the following two subclasses:

  - Subclass IIIA includes ground water units that are highly to intermediately interconnected to adjacent ground water units of a higher class and/or surface waters. They may, as a result, be contributing to the degradation of the adjacent waters. They may be managed at a similar level as Class II ground water, depending on the potential for producing adverse effects on the quality of adjacent waters.

  - Subclass IIIB is restricted to ground water characterized by a low degree of interconnection to adjacent surface waters or other ground water units of a higher class within the Classification Review Area. These ground waters are naturally isolated from sources of drinking waters in such a way that little potential exists for producing adverse effects on quality. They have low resource values outside of mining or waste disposal.

At SWMU 01, ground water is likely considered to be Class IIIA. However, potential future, residential land use was evaluated in the RFI, and therefore the ground water was evaluated as Class II for purposes of this investigation.

The Archaeological and Historic Preservation Act (16 USC Section 469) (36 CFR 65) establishes requirements relating to potential loss or destruction of significant scientific, historical, or archaeological data as a result of any proposed remedy. The Secretary of the Interior must be notified if a federal agency finds that its activities, in connection with any federal construction project, might cause loss or destruction of such data. No historic artifacts have been nor are any expected to be uncovered at SWMU 01; however, there is some uncertainty as to whether such artifacts could be discovered during site work.

Historical Preservation and Archeology [Indiana Code (IC) 14-21] establishes requirements for the potential loss or destruction of significant scientific, historical, or archeological data as a result of a proposed remedy. This requirement establishes procedures for notifying the State Division of Historic Preservation and Archeology when activities result in the discovery of such data. No historic artifacts have been nor are any expected to be uncovered at SWMU 01; however, there is some uncertainty as to whether such artifacts could be discovered during site work.

Indiana Nongame and Endangered Species Conservation (IC 14-22-34) enables the State to develop a list of those species and subspecies of wildlife indigenous to Indiana that are determined to be endangered in Indiana. In addition, this rule governs the taking, possession, removal, capture, destruction, and management of State-listed endangered species. SWMU 01 is located primarily in Martin County. The State of Indiana has identified a list of endangered, threatened, and rare species for Martin County. The species include plants, insects, birds, reptiles, and birds. In addition, migrating species may move through the area.

Indiana Wildlife Regulation (IC 14-22-10) provides protection for wildlife from releases or discharges of contaminants or waste materials into State waters or land that may result in the destruction of wild animals. The State Department of Natural Resources has the authority and responsibility to protect and properly manage the fish and wildlife resources of the State. During the remedial activity, contaminated waste could be released on to soil and possibly result in discharge to State waters (including the intermittent drainage channels). Because all drainage channels immediately downgradient of the MGBG are intermittent, the likelihood of contaminating State waters is low to negligible.

Indiana Natural Heritage Protection Campaign (IC 14-31-2) promotes the preservation of areas of unusual natural interest for scientific, educational, recreational, cultural, and aesthetic purposes as a link to Indiana's past and future. The rules also provides for the maintenance and management of those natural areas and the rare native species for which the areas are habitat. Remedy activities at SWMU 01 may result in disturbance of natural areas inhabited by Indiana rare species.

3.3.3 Action-Specific ARARs and TBCs

This section presents a summary of potential federal and State action-specific ARARs and TBCs for SWMU 01.

The CWA (40 CFR 122), as amended, governs point-source discharges through the National Pollutant Discharge Elimination System (NPDES), discharge of dredge or fill material, and oil and hazardous waste spills to United States waters. NPDES requirements (40 CFR Part 122) will be applicable if the direct discharge of pollutants into surface waters is part of the corrective action (i.e., discharge of effluent from a ground water treatment system). These potentially applicable regulations contain discharge limitations, monitoring requirements, and best management practices. Because all drainage channels immediately downgradient of the MGBG are intermittent, the likelihood of contaminating State waters is low to negligible.

RCRA Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR 264) establish minimum national standards that define the acceptable management of hazardous waste. This regulation is applicable if hazardous waste is sent to a TSD facility or if hazardous wastes are treated on site.

RCRA Identification and Listing of Hazardous Waste (40 CFR 261) provides for determining whether a solid waste is a hazardous waste. This standard defines those solid wastes that are subject to regulation as hazardous waste under 40 CFR Parts 262 to 265 and Parts 124, 270, and 271.

RCRA Standards Applicable to Generators of Hazardous Waste (40 CFR Part 262). A generator that treats, stores, or disposes of hazardous waste on site must comply with these standards that include manifest, pre-transport (i.e., packaging, labeling, and placarding), record keeping, and reporting requirements.

Standards Applicable to Transporters of Hazardous Waste (40 CFR Part 263) are applicable to the off-site transportation of hazardous waste. These regulations include requirements for compliance with the manifest and record keeping systems and with the requirements for immediate action and cleanup of hazardous waste discharges (spills) during transportation.

Standards and Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR Parts 264 and 265) are applicable to corrective actions that may be taken at SWMU 01 and to off-site facilities that receive hazardous waste from the site for treatment and/or disposal. Standards for TSD facilities include requirements for preparedness and prevention, corrective action requirements, closure and post-closure care, use and management of containers, and design and operating standards for tank systems, surface impoundments, waste piles, landfills, and incinerators.

Department of Transportation (DOT) Rules for Hazardous Materials Transport (49 CFR Parts 107 and 171 to 179) regulate the transport of hazardous materials, including packaging, shipping equipment, and placarding. These rules are considered to be applicable to wastes shipped off site for laboratory analysis, treatment, or disposal.

Indiana Closure and Corrective Action Policy [Waste-0015-Nonrule Policy Document (NPD)] Different situations have arisen in the past where remedial activities under RCRA have closures that can be more appropriately addressed through the Indiana corrective action authorities. This nonrule policy provides procedures to be followed when one of these actions is implemented.

3.4 CORRECTIVE ACTION OBJECTIVES

CAOs are developed based on the site-specific risks to contaminated media of concern to potential receptors and ARARs. The groundwater in the shallow water-bearing zone at the MGBG site is contaminated with chlorinated VOCs at concentrations that could cause an unacceptable risk to human health if the groundwater is used as a potable source. This aquifer is likely to be designated as Class III, which is not a potential drinking water source and of limited beneficial use. However, the Navy is conservatively assuming that the ground water in this water bearing zone to be of Class II for the purposes of the CMS. The potential for development of the MGBG into a residential area in the distant future is also assumed to exist. Therefore, federal and State drinking-water standards would be relevant and appropriate.

Migration of the COC plumes is occurring at an insignificant rate (See Section 2.5.2) considering the remoteness of any downgradient receptors. Therefore, the mobility of the COCs is not a primary concern for this site.

Based on the above information, the CAO for the aquifer at the MGBG is as follows:

- Protect potential future residents and potential construction workers from exposure to chlorinated VOCs in the ground water that could cause unacceptable risks, i.e., ICLRs exceeding 1.0×10^{-4} for carcinogenic site-related contaminants, or a cumulative HI exceeding 1.0 for non-carcinogenic site-related contaminants.

Accordingly, the MCSs for ground water at the MGBG site are developed in Sections 3.5.

3.5 GROUND WATER MCSS

This section discusses the development of ground water MCSs for the MGBG. These goals consist of media cleanup standards (MCSs). Development of the MCSs involves the following steps:

1. Risk-based cleanup levels (RBCLs) are calculated for each COC. The RBCLs are based on the exposure factors and assumptions used in the MGBG risk assessment. If a chemical has both carcinogenic and noncarcinogenic effects, cleanup levels are calculated for each effect, and the lower of the two values is used for MCS development.

2. The RBCLs developed in Step 1 are then compared to federal MCLs and State of Indiana Default Closure Levels for Residential Groundwater.

3. If the MCL or State Cleanup Level exceeds the calculated RBCL, the MCL and/or State value is selected as the MCS for that constituent. This situation occurred for all compounds identified as COCs at MGBG.

Details of the MCS development are provided the following sections.

Calculation of Risk-Based Cleanup Levels

Risk-based human health ground water cleanup levels were back-calculated from the MGBG risk assessment according to the methodology used by U.S. EPA Region 9 in the development of its PRGs. Because risk assessment equations are linear in the concentration term, an acceptable remediation concentration for the site can be calculated using a ratio of the site concentration to the resulting risk estimate that was determined in the risk assessment utilizing a target cancer risk (TCR) or target hazard index (THI). Six carcinogens (1,1,1,2-PCA, 1,1,2,2-PCA, 1,2-DCA, chloroform, PCE, and TCE) and two noncarcinogens (1,1-DCE and cis-1,2-DCE) and five other chemicals were identified in the RFI risk assessment as COCs for the MGBG. The five other compounds were eliminated from further consideration in this CMS for reasons explained in Section 2.2.3.

A TCR of $1x10^{-6}$ was used to determine the remediation concentrations for carcinogens and a THI of unity (1) was used for noncarcinogens. Example calculations for each type of chemical are provided below.

Example Calculation for Carcinogenic Effects

The ground water cleanup level for carcinogens was calculated by the following equation:

$$RBCL = \frac{C_{gw} \times TCR}{Risk}$$

Where:

RBCL	=	Risk-based cleanup level (µg/L)
C_{gw}	=	Ground water exposure point concentration used in the MGBG risk assessment (µg/L)
TCR	=	Target Cancer Risk = 1×10^{-6} $(mg/kg/day)^{-1}$
Risk	=	Ground water cancer risk calculated in the MGBG Risk assessment

According to the methodology specified in the USEPA Region 9 PRG calculations, PRGs for carcinogens are based on a 30-year exposure duration (6 years for a child plus 24 years for an adult). Therefore, the risk term used in the calculations represents the sum of child and adult risks from the MGBG assessment. For example, the total residential risk for PCE (4.9×10^{-4}) presented in the risk assessment is the sum of the child (2.3×10^{-4}) and adult (2.6×10^{-4}) risks.

Example Calculation: Residential ground water RBCL for PCE

C_{gw}	=	370 µg/L
TCR	=	1.0×10^{-6} $(mg/kg/day)^{-1}$
Risk	=	4.9×10^{-4} - combined child + adult residential risk (ingestion + dermal contact)

$$RBCL = \frac{370 \times 1 \times 10^{-6}}{4.9 \times 10^{-4}}$$

RBCL (PCE) = 0.76 µg/L

Example Calculation for Noncarcinogenic Health Effects

As specified in the Region 9 PRG guidance, the RBCL for exposure to noncarcinogens in groundwater is based on exposure by an adult resident drinking 2 liters of water per day. The ground water cleanup level for noncarcinogens was calculated by the following equation:

$$RBCL = \frac{C_{gw} \times THI}{Risk}$$

Where:

RBCL	=	Risk-based cleanup level (µg/L)
C_{gw}	=	Groundwater exposure point concentration used in the MGBG risk assessment (µg/L)
THI	=	Target Hazard Index
Risk	=	Ground water risk calculated in the MGBG Risk assessment

Example Calculation: Residential ground water RBCL for cis-1,2-DCE

C_{gw}	=	500 µg/L
THI	=	1.0
Risk	=	1.45 (ingestion + dermal HI)

$$MCS = \frac{500 \times 1}{1.45}$$

RBCL (cis-1,2-DCE) = 345 µg/L

The calculated RBCLs are presented in Table 3-4. Table 3-4 also provides comparisons of the risk-based levels with MCLs and Indiana Cleanup levels. As shown in the table, the risk-based values for all COCs were less than the MCLs and Indiana levels. Therefore, federal MCLs were selected as MCSs for 1,2-DCA, chloroform, cis-1,2-DCE, PCE, and TCE. Indiana Default Closure Levels were chosen as MCSs for 1,1,1,2-and 1,1,2,2-PCA. The MCSs developed for COCs in ground water at MGBG are summarized in Table 3-4.

TABLE 3-1

SUMMARY OF CHEMICAL-SPECIFIC ARARs AND TBC CRITERIA
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Requirement	Citation	Status	Synopsis	Comment
FEDERAL				
Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) and Secondary MCLs (SMCLs) MCL Goals (MCLGs)	42 USC 300f et seq. 40 CFR 141 to 143	MCLs are relevant and appropriate; SMCLs and MCLGs are TBC	MCLs, SMCLs, and MCLGs established under this act are health-based limits for certain chemical substances in drinking water.	Can be used as MCSs or for determining Risk-based Cleanup Levels (RBCLs) for ground water.
U.S. EPA Health Advisories	EPA 822-B-96-002	TBC	U.S. EPA Office of Drinking Water guidelines for chemicals that may be encountered in public water supply systems.	Can be used for determining RBCLs for ground water.
Reference Doses (RfDs) from Integrated Risk Information System (IRIS)	NA	TBC	U.S. EPA Office of Research and Development guidelines used in the public health assessment	Can be used for determining RBCLs.
Carcinogenic Slope Factors from IRIS	NA	TBC	U.S. EPA Environmental Criteria and Assessment Office; U.S. EPA Carcinogen Assessment Group guidelines used in the public health assessment	Can be used for determining RBCLs.
EPA Region 9 PRGs	NA	TBC	U.S. EPA Region 9 has developed PRGs for contaminants in soil, air, and tap water. These risk-based concentrations are intended to assist risk assessors and others in initial screening-level evaluations of environmental measurements.	Can be used for determining RBCLs.
Indiana Department of Environmental Management (IDEM) Risk Integrated System of Closure (RISC)	NA	TBC	A non-rule policy that incorporates environmental risk assessment principles to protect human health and the environment and achieve consistent closure of contaminated soil and groundwater.	Guidance for use in risk assessment.

CFR = Code of Federal Regulations
IRIS = Integrated Risk Information System
USC = United States Code
U.S. EPA = United States Environmental Protection Agency

TABLE 3-2

SUMMARY OF LOCATION-SPECIFIC ARARs AND TBCs
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE INDIANA

Requirement	Citation	Status	Synopsis	Comment
FEDERAL				
Endangered Species Act of 1978	16 USC 1531 50 CFR 17 and 402	Potentially applicable	Requires federal agencies to ensure that any action authorized, funded, or carried out by the U.S. EPA is not likely to jeopardize the future existence or critical habitat of any endangered or threatened species.	The Indiana Bat and several bird species that are either endangered or threatened, or species of special interest may reside in the vicinity of SWMU 01. In addition, migrating species may occasionally move through the area.
U.S. EPA Ground Water Protection Strategy and Classification Guidelines	NA	To Be Considered	Provides guidance in determining the potential beneficial uses of contaminated groundwater.	Groundwater at SWMU 01 is classified as a shallow bedrock aquifer.
The Archaeological and Historic Preservation Act	16 USC 469 36 CFR 65	Potentially Applicable	Establishes requirements relating to potential loss or destruction of significant scientific, historical, or archeological data as a result of a proposed remedy.	No historic artifacts are expected to be uncovered in the vicinity of SWMU 01; however, artifacts may be discovered during site work.
STATE				
Historical Preservation and Archaeology	IC 14-21	Potentially Applicable	Establishes requirements relating to potential loss or destruction of significant scientific, historical, or archeological data as a result of a proposed remedy.	No historic artifacts are expected to be uncovered in the vicinity of SWMU 01; however, artifacts may be discovered during site work.
Nongame and Endangered Species Conservation	IC 14-22-34	Potentially Applicable	Establishes protection and conservation of State nongame and endangered species.	The Indiana Bat and several bird species are either endangered, threatened, or species of special interest may reside in the vicinity of SWMU 01. In addition, migrating species may occasionally move through the area.
Wildlife Regulation	IC 14-22-10	Potentially Applicable	Provides protection of wildlife from releases or discharges of waste material onto or in any water of Indiana that may result in the killing of wildlife.	Contaminated waste materials could be discharged into surface water and result in harm to wild animals near SWMU 01.
Indiana Natural Heritage Protection Campaign	IC 14-31-2	To Be Considered	Promotes the preservation, maintenance, and management of those natural areas and rare native species for which the areas are habitat.	Guidance for the areas that may be disturbed during remedial activities near SWMU 01.

CFR = Code of Federal Regulations
IRIS = Integrated Risk Information System
USC = United States Code
U.S. EPA = United States Environmental Protection Agency

TABLE 3-3

SUMMARY OF ACTION-SPECIFIC ARARs AND TBC CRITERIA
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Requirement	Citation	Status	Synopsis	Comment
FEDERAL				
Clean Water Act (CWA) National Pollutant Discharge Elimination System (NPDES)	40 CFR 122	Potentially applicable	NPDES permits are required for any discharge to surface water.	Any alternative that includes discharges to surface water would have to comply with the permit requirements.
National Environmental Policy Act (NEPA)	42 USC 4321 40 CFR Part 6	Potentially applicable	Requires federal agencies to evaluate the environmental impacts associated with major actions that they fund, support, permit, or implement.	Alternatives could constitute significant activities, under NEPA requirements.
Resource Conservation and Recovery Act (RCRA) Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal (TSD) Facilities	40 CFR 264	Potentially applicable	Establishes minimum national standards for acceptable management of hazardous waste.	These standards would be applicable for on-site treatment, storage, or disposal of any hazardous waste that may be generated during on-site ground water treatment.
RCRA Identification and Listing of Hazardous Waste	40 CFR 261	Potentially applicable	Regulations that govern the procedures for identifying if a solid waste is a hazardous waste.	This regulation could be used to determine whether wastes generated during ground water treatment at the site are characteristic or listed hazardous wastes.
RCRA Standards Applicable to Generators of Hazardous Waste	40 CFR 262	Potentially applicable	Establishes standards for generators of hazardous waste.	This regulation would be used if any hazardous wastes are generated at the site during ground water treatment.
RCRA Standards Applicable to Transporters of Hazardous Waste	40 CFR 263	Potentially applicable	Establishes standards for off-site transportation of hazardous waste.	This regulation would be used if any hazardous waste generated on site needs to be transported off site.
RCRA Standards and Interim Standards for Owners and Operators of Hazardous Waste TSD Facilities	40 CFR 264 and 265	Potentially applicable	Regulations that govern the treatment, storage, and disposal of hazardous waste.	This regulation would be used if any hazardous waste generated is managed onsite or offsite.

TABLE 3-3

SUMMARY OF ACTION-SPECIFIC ARARs AND TBC CRITERIA
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Requirement	Citation	Status	Synopsis	Comment
Department of Transportation (DOT) Rules for Hazardous Materials Transport	49 CFR 107 and 171 to 179	Potentially applicable	Regulations for the transportation of hazardous materials. Requirements cover packaging, marking, labeling, and transportation methods.	This regulation would be used for shipment of hazardous material to the site or away from the site during the remedial action.
STATE				
Indiana Air Screening Levels	NA	To be considered	The Indiana Department of Environmental Management Office of Air Management calculates a maximum acceptable ground-level concentration of toxic air pollutants, which is generally 0.5% of the permissible exposure limit (PEL). Site-specific exceptions may be made.	This guidance would be used for limiting particulate emissions from on-site remedial activity.
Indiana Closure and Corrective Action Policy	WASTE-0015-NPD	To be considered	This non-rule policy document provides procedures to be followed when this action is implemented.	This policy addresses scenarios and procedures in situations where remedial activities under RCRA Subtitle C closures can more appropriately be addressed through Indiana corrective action authorities.

CFR = Code of Federal Regulations
IRIS = Integrated Risk Information System
NA = Not Applicable
USC = United States Code
U.S. EPA = United States Environmental Protection Agency

TABLE 3-4

DEVELOPMENT OF MEDIA CLEANUP STANDARDS (MCSs)
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Chemical of Concern	GW Exposure Point Concentration[1]	Risk-Based Cleanup Level		Federal and State Criterion	MCS
	µg/L	Cancer µg/L	NonCancer µg/L	µg/L	µg/L
1,1,1,2-Tetrachloroethane	250	2	1,000	6.9[2]	6.9
1,1,2,2-Tetrachloroethane	38000	0.2	2,000	0.9[2]	0.9
1,1-Dichloroethene	500	7[3]	1,400	7[3]	7
1,2-Dichloroethane	250	0.5	170	5[3]	5
Chloroform	840	2	12	80[3]	80
cis-1,2-Dichloroethene	500	70[3]	340	70[3]	70
Tetrachloroethene	370	0.8	260	5[3]	5
Trichloroethene	16,000	0.1	10	5[3]	5

1. Excerpted from the MGBG RFI (Tetra Tech NUS Inc., September 2003).
2. Indiana Default Closure Level for Residential Groundwater.
3. U.S. EPA Maximum Contaminant Level (MCL) (USEPA, Summer 2004).

4.0 DEVELOPMENT OF CORRECTIVE MEASURES ALTERNATIVES

This section discusses the development of CMAs from individual technologies that could be applied towards attainment of CAOs (presented in Section 3.4) for the MGBG site. The section also discusses the details of these alternatives at a conceptual level. The development of alternatives begins with a screening of technologies for their potential applicability at the site. The screening starts with an initial identification and preliminary level of selection of technologies and process options under each technology for further discussion. The screening ends with a more detailed evaluation of the effectiveness, implementability, and relative costs of technologies and process options retained from the preliminary screening. The technologies and process options retained after the detailed evaluation are assembled into alternatives and are discussed at a conceptual level on a site-specific basis.

4.1 PRELIMINARY SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES

Table 4-1 provides the results of a preliminary screening of corrective measures technologies for VOC-contaminated ground water at SWMU 01. The preliminary technology screening is based on overall applicability to the medium of concern (contaminated ground water), COCs (chlorinated alkanes and chlorinated alkenes), and hydrogeological conditions present at SWMU 01. The purposes of this screening effort are to investigate a reasonable range of available technologies and process options and to eliminate those obviously not applicable to the site. Based on the screening ranks of the technologies (see the Notes column in Table 4-1), the following table summarizes the technologies retained from the preliminary screening:

General Action	Technology	Process Option
No Action [1]	None	Not applicable
Limited Action[2]	Institutional Controls	Passive controls: administrative Land Use Controls (LUCs)
	Monitoring	Ground water monitoring
In-Situ Treatment[3]	Physical/Chemical	Metallic reductive dehalogenation
	Biological	Intrinsic bioremediation/natural attenuation
		Anaerobic reductive dehalogenation/oxidation

Notes:
1. No Action is evaluated in Section 4.2.1.
2. Limited Action is evaluated in Section 4.2.2.
3. *In-Situ* Treatment is evaluated in Section 4.2.3.

Section 4.2 presents details concerning the characteristics that were evaluated to identify potentially useful remedial technologies. Section 4.3 lists the representative process options under each technology that were retained for development into CMAs.

4.2 DETAILED SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES

The technologies retained from the preliminary screening are broadly evaluated in this section. The evaluations are based on criteria of effectiveness, implementability, and relative cost, which are defined as follows:

- Effectiveness - This criterion focuses on the potential effectiveness of process options in protecting human health and the environment and in meeting the CAOs. This criterion considers potential impacts to human health and the environment during construction and implementation and how proven and reliable the process is with respect to COCs and site conditions.

- Implementability - Implementability is a measure of both the technical and administrative feasibility of implementing a technology. It provides a means of evaluating the ability of a technology to be adapted to site-specific conditions. Technical feasibility includes consideration of construction and operational issues, demonstrated performance, and adaptability to site conditions. Administrative feasibility considerations include the ability to obtain any necessary permits or easements or adherence to applicable laws and concerns of other regulatory agencies. General availability of necessary equipment and resources is also evaluated.

- Cost - Cost evaluations allow a relative comparison between similar technologies and play a limited role in technology screening. The cost analysis is based on engineering judgment and each technology is evaluated as to whether costs are low, medium, or high relative to the other options in the same technology type. If there is only one process option, costs are compared to other candidate technologies.

The process options presented in the above table for use at SWMU 01 are evaluated in the following sections.

4.2.1 No Action

No Action consists of maintaining the status quo at the site. No Action is considered in the CMS process to provide a baseline for comparison with other corrective measures technologies and their effectiveness in mitigating risks posed by site COCs.

Effectiveness

No Action would not be effective in meeting CAOs for SWMU 1. The Navy acknowledges that there are no human receptors that could be exposed to ground water at the site currently or in the foreseeable future under predictable land use. If land use at this site changes, there would be no active remedial measures taken to reduce COC levels to protect future potential human receptors, nor any method for assessing decreases in COC levels that could be caused by natural attenuation. Furthermore, if land use for this site changes, no control would exist that could prohibit the exposure of potential human receptors to contaminated ground water.

Implementability

There would be no implementability concerns because no action would be implemented.

Cost

No remedial actions are taken with this technology; therefore, there are no costs associated with No Action.

Conclusion

No Action was retained as a baseline for comparison with other remedial alternatives, although it would not be an effective remedial measure because it would not facilitate the attainment of RAOs. In particular, potential exposure to VOC-contaminated ground water would not be prevented.

4.2.2 Limited Action

Two technologies were retained from preliminary screening: institutional controls and ground water monitoring.

4.2.2.1 Institutional Controls

Institutional controls would consist of formulating and implementing passive controls such as administrative LUCs to prohibit future site development and ground water use. Institutional controls would also include the performance of regular site inspections to verify the continued implementation of the controls. Although hunters/trespassers may frequent the MGBG area, active controls (i.e., fencing) are not required, because the primary exposure pathway (i.e., exposure to surface soil) does not pose an unacceptable risk to those receptors.

Effectiveness

Institutional controls would allow contaminated ground water to remain on site and would not meet MCSs presented in Section 3.5. However, institutional controls would be effective in meeting the CAOs for SWMU 01 by maintaining the current status quo under which there are no receptors of concern by prohibiting site development and ground water use.

Implementability

Institutional controls would be readily implementable for SWMU 01. LUCs would be prepared and described in the Corrective Measures Design. The Navy could relatively easily prepare and implement the LUCs.

Cost

Costs of institutional controls would be relatively low because they involve simple administrative actions such as the filing of paperwork and periodic reviews of the effectiveness of the controls. Typically, costs for institutional controls are an order of magnitude less than the costs of treatment technologies when significant litigation costs are not expected.

Conclusion

Institutional controls were retained for the development of CMAs because of their relatively low cost and presumed effectiveness when properly implemented.

4.2.2.2 Monitoring

Monitoring would consist of collecting and analyzing ground water samples from monitoring wells located at the site. The analytical parameters would consist of COCs and parameters that would allow evaluation of the effectiveness of a remedial action at the site.

Effectiveness

Monitoring would not be effective by itself as a remedial technology to meet CAOs at SWMU 01. It would only provide the data necessary to evaluate whether COC concentrations continue to pose a potential risk to human receptors or if a remedial action is attaining MCSs for SWMU 01. It would also provide the data necessary to evaluate whether technology-specific parameters indicate that the selected remedial action is functioning to specifications. Furthermore, monitoring would provide the data necessary to determine whether the plume continues to migrate is occurring at an insignificant rate.

Implementability

Ground water monitoring has already been performed at SWMU 01, and adequate monitoring wells are already in place. Therefore, a new long-term monitoring program could be easily implemented.

Cost

Capital and operation and maintenance (O&M) costs of monitoring would be low (limited to sample collection, analysis of a limited list of parameters, data interpretation, and reporting).

Conclusion

Monitoring was retained for the development of CMAs.

4.2.3 *In-Situ* Treatment

This section evaluates technologies that could be applied for removal/destruction of contaminants without physical removal of ground water to the surface. Such technologies are considered to constitute "*in-situ*" treatment as opposed to above-ground treatment.

4.2.3.1 *In-Situ* Abiotic Reductive Dehalogenation with Zero Valent Iron

In-situ abiotic reductive dehalogenation of chlorinated alkanes/alkenes consists of introducing controlled amounts of a suspension of an inorganic electron donor into the contaminant plume. The metallic electron donor is typically zero-valent iron (ZVI). ZVI has been previously used in fixed beds such as permeable reactive barriers (PRBs) constructed in subsurface unconsolidated geologic materials downgradient of an advancing plume. The reaction causing the reductive dehalogenation is as follows:

$$2\ C_2HCl_3 + 8\ Fe^0 + 10\ H^+ \text{ -------> } 2\ C_2H_6 + 8\ Fe^{2+} + 6\ Cl^-$$

(Where: C_2HCl_3 is the chemical formula for TCE, and Fe^0 is the zero-valent iron)

In a variation of this technology, a suspension consisting of nanoscale particles of ZVI with or without a trace coating of a metal catalyst (typically palladium) is introduced within the most contaminated zone of the plume to aggressively seek the contaminated zone. The ZVI particle with the palladium catalyst is termed a bi-metallic nano particle (BNP).

BNP technology has been shown to cause more rapid reductive dechlorination of TCE to ethane and ethene than simple ZVI in accordance with the following chemical reaction:

$$2\ C_2HCl_3 + 8\ Fe^0 + 10\ H^+ \text{ ---}^{Pd}\text{----> } 2\ C_2H_6 + 8\ Fe^{2+} + 6\ Cl^-$$

(Where: C_2HCl_3 is the chemical formula for TCE, Fe^0 is ZVI, catalyzed by palladium, Pd)

BNP technology increases the rate of reaction because of the use of a catalyst and the increased surface area per unit volume of particle size for the ZVI. Another advantage is that the BNPs are mobile because of the small sizes of the particles, therefore widespread contact with the contaminants is favorable.

Effectiveness

In-situ treatment with metallic reductive dehalogenation using ZVI has proven effective for the treatment of a wide range of contaminants that include chlorinated VOCs, polychlorinated biphenyls (PCBs), heavy metals (hexavalent chromium, nickel, mercury), perchlorates, and nitrates (discussed in the Remedial Technologies Development Forum's Internet website at www.rtdf.org). This technology has proven useful for the treatment of contaminants that are not particularly mobile because of sorption on soil particles. A bench-scale treatability test would be required to verify the effectiveness of this technology for the treatment of the ground water at the MGBG site. The test would help verify that complete dechlorination of PCA will occur.

Implementability

The injection of a suspension would be difficult because of the low permeability of the hydrogeologic unit of interest at the MGBG site. To date, this technology has been applied at a limited number and types of full scale sites. It has been effective in source areas or concentrations plumes. The MGBG, on the contrary, is currently a relatively low concentration plume spread over several acres. It is possible that extensive hydro-fracturing of the geologic formation would be necessary if this technology were selected. The hydrofracturing of the bedrock would facilitate transport of the ZVI treatment throughout the contaminated zone. In theory, the metallic reductive dehalogenation technology would also result in a reservoir of ZVI in the ground water that could continue to form dissolved iron (a secondary contaminant) following the completion of the reaction. This, however, has not been shown to be a problem to date. The technology is innovative, and the number of contractors qualified to oversee its application are limited.

Costs

Capital and O&M costs for *in-situ* treatment with abiotic reductive dehalogenation technology would be higher than anaerobic reductive dechlorination, in part because of the relatively high cost of the catalyst-coated ZVI, but also because of the complexities of delivering the particulates to the water-bearing zone needing treatment.

Conclusion

Abiotic reductive dehalogenation technology was eliminated from further consideration because anaerobic bioremediation would be more easily implementable and more cost effective.

4.2.3.2 Natural Attenuation

Chlorinated alkenes are known to undergo natural biodegradation of various types, in addition to abiotic degradation. Also included in the term Natural Attenuation are physical processes such as advection, dilution, diffusion, sorption, volatilization, and dispersion. These natural processes are termed "intrinsic" because they occur without the need for human intervention. As discussed below, both abiotic and biotic processes can occur simultaneously, and the end results are indistinguishable. Therefore, it is more common to refer to the combined process as "natural attenuation."

Chlorinated alkenes can undergo natural biodegradation processes including reductive dechlorination and oxidation (aerobic or anaerobic) that ultimately lead to the remediation of a site. Reductive

dechlorination, as the term indicates, is a process wherein a chemical compound undergoes sequential chlorine atom removal under chemically reducing conditions. The ultimate number of chlorine atoms replaced with hydrogen atoms is determined by the degree to which the chemical environment supports continued loss of chlorine, each successive chlorine atom being more difficult to remove than the previous one. When reductive dechlorination occurs under intrinsic conditions, it is mediated by microbial metabolism. These "reducing" conditions refer to the natural balance of dissolved ions in ground water being available as electron donors for chemical reactions with the target compounds. A deficiency of such electron donors results in "oxidizing" conditions. Therefore, an important parameter that indicates conditions suitable for reductive dechlorination is the ORP of the ground water. In addition, other mechanisms such as co-metabolism can occur (U.S. EPA, 2000a).

Within the range of possible ORP conditions, a reducing environment is most suitable for complete dechlorination of PCE to TCE, and so on in a step-by-step fashion through DCEs, and vinyl chloride, and finally to ethene:

$$\text{PCE} \rightarrow \text{TCE} + Cl^- \rightarrow \text{1,1-DCE or cis-1,2-DCE} + Cl^- \rightarrow \text{VC} + Cl^- \rightarrow \text{ethene} + Cl^-.$$

Although the dechlorination process may terminate with DCE or vinyl chloride, if the intrinsic ORP conditions are suitable (i.e., sufficiently reductive), the process may proceed to dechlorination beyond vinyl chloride. This, however, is typically not a favorable degradation pathway because of the significantly lower reduction potentials required to cause the dechlorination process to go to completion

Chemical oxidation is the reverse of chemical reduction. It is a removal of electrons from the chemical compound. Easily reduced compounds are not easily oxidized and easily oxidized compounds are not easily reduced. Thus, the parent VOCs are more resistive to oxidation, while the successive daughter compounds are successively more amenable to oxidation. Therefore, natural attenuation can occur to completion by reductive dechlorination of PCE and TCE within an anaerobic zone of the site, followed by oxidation of DCE and VC in the outer fringes of the anaerobic zone.

Oxidation can occur either in the presence of dissolved oxygen (i.e., under aerobic conditions) or in the presence of other naturally occurring dissolved ions (nitrate, ferric iron, sulfate, carbon dioxide, etc.), under anoxic conditions. Under aerobic conditions, DCE compounds and VC can oxidize to carbon dioxide and chloride. Under anoxic conditions, additional compounds (i.e., nitrogen from nitrate, sulfide from sulfate, or methane from carbon dioxide) can be generated as the end product of degradation. Consequently, other important parameters that indicate conditions suitable for oxidation to occur are these dissolved ions and the end products noted above.

Chlorinated alkanes can undergo a similar process of reductive dechlorination to form an organic end product of ethane instead of ethene (as discussed above for chlorinated alkenes). Furthermore, the parent chlorinated alkanes (1,1,2,2-PCA; and 1,1,2-TCA) can also undergo a process of dicholoroelimination wherein two chlorine atoms are simultaneously cleaved and replaced by hydrogen atoms, leading to the formation of chlorinated alkenes, which can subsequently undergo reductive dechlorination to form ethene. PCA can also undergo abiotic degradation to form TCE. In summary, the reductive dechlorination of chlorinated alkanes can occur via one or more of the following pathways (Lorah, et. al., 1997):

1. PCA→TCA + Cl→ DCA + Cl→ Cl-ethane + Cl→ ethane+ Cl
2. PCA→trans-1,2-DCE+ Cl→ VC + Cl→ ethene+ Cl
3. PCA→TCE + Cl (via abiotic mechanism, followed by the step-by-step anaerobic reductive chlorination of TCE to eventually form ethene).
4. PCA→ TCA + Cl→ VC + Cl→ ethene+ Cl

Effectiveness

The natural attenuation processes consist of a complex interplay of biological and physical/chemical conditions that can be evaluated only by empirical observations, with a component of supplemental predictive results based on bench-scale studies. Therefore, the parameters indicative of ground water conditions that are discussed above and that could be used in the full-scale remediation are not comprehensive, but they are adequate for most cases noted in the literature. A more site-specific evaluation of the effectiveness of natural attenuation would require bench-scale studies. However, a preliminary evaluation of the potential effectiveness of the process at the MGBG site can be conducted using the screening table provided in Wiedemeier, et. al., (1998) and shown on Table 2-7. This evaluation indicates a limited evidence for natural attenuation to occur in the most contaminated zone of the plume. However, as discussed below, it appears that there are other localized zones of redox conditions that may be causing the overall plume COC concentrations to attenuate via natural mechanisms.

Using the data for natural attenuation parameters presented in Table 2-5, it appears that the chlorinated alkanes/alkenes have migrated from the source area (PBA) and encountered a zone of reductive conditions around monitoring well 1-15. The relative levels of the following compared to the rest of the site seem to support this: DO (lower), ORP (generally lower), dissolved hydrogen (higher), dissolved methane (higher), dissolved ethane/ethane (higher), chloride (higher), alkalinity (generally higher), and

ferrous iron (higher). Further downgradient in the northwestern direction as well as in the northeastern direction, there appear to be intermittent locations where conditions suitable for anaerobic activity (i.e., low DO) or reducing conditions (i.e., low ORP) exist, intermixed with locations where the opposite conditions (aerobic/oxidative) exist. Towards the outer (downgradient) edges of the plume, the lack of any of the volatile organic gases (methane/ethane/ethane) or hydrogen seems to indicate a prevalence of oxidative conditions, although the dissolved oxygen and ORP readings do not consistently corroborate this postulation. This latter condition is expected to occur due to the proximity of the ground water plume to atmospheric exposure near the bedrock outcrops that occur at the outer downgradient edges, as discussed in the Conceptual Site Model (Section 2.5). Moreover, the lack of any vinyl chloride anywhere in the plume indicates that either reductive dechlorination is proceeding to completion (i.e., ethane/ethane production) or the presence of pockets of oxidizing conditions interspersed within the plume and the prevalence of oxidizing conditions in its outer edges is resulting in complete aerobic oxidation (i.e., carbon dioxide production) at this site.

Although chlorinated alkenes have been more widely studied, chlorinated alkanes (PCA and its degradation products) have also been noted to undergo a similar mechanism (Bouwer, 1994, quoted in Lorah, et. al., 1997), and therefore the more widespread primary COCs at the MGBG site should be amenable to treatment by natural attenuation. The other sporadically occurring chlorinated alkanes (e.g., chloroform) should also undergo reductive dechlorination via natural attenuation under ORP values similar to those required for the dechlorination of alkenes, as shown in Cookson, 1995. Complete dechlorination of carbon tetrachloride and chloroform to carbon dioxide can occur under anaerobic conditions via sequential reductive dechlorination (Bouwer, 1994, quoted in Michelle, et. al., 1997). Therefore, reductive dechlorination would be a viable mechanism for reducing all of the COC concentrations.

Implementability

This technology is easily implementable, and consists mainly of ground water sampling, chemical analysis, data interpretation, and reporting. Monitoring well installation and ground water sampling for COCs and natural attenuation parameters is offered by several competent environmental contractors and can be easily conducted. Laboratory services for ground water analysis for the COCs and natural attenuation parameters are also widely available.

Cost

The costs associated with monitoring and reporting natural attenuation are typically low compared to other methods of active remediation. These costs are comparable to simple ground water monitoring costs, with the added evaluations necessary for assessing the effectiveness of the degradation processes.

Conclusion

Based on the relatively low costs and effectiveness, natural attenuation was retained for development of CMAs.

4.2.3.3 *In-Situ* Anaerobic Biological Reductive Dehalogenation/Oxidation (Enhanced Bioremediation)

In-situ Enhanced Bioremediation is a technology based on stimulating indigenous microorganisms to breakdown certain types of hazardous organic compounds into nontoxic or less toxic forms via sequential replacement of halogen atoms (chlorine in the case of the MGBG site) with hydrogen atoms. As discussed under Natural Attenuation, the natural process of degradation of chlorinated ethenes and ethanes, assuming conditions are suitable, occurs by reductive dechlorination. The stimulation of the indigenous organisms to increase the rate of dechlorination is the critical component of the reductive dehalogenation technology. Studies have shown that electron donor compounds such as chitin or lactate can cause complete dechlorination of TCE to ethene and chlorides (Parsons, 2000). Other studies indicate the potential for vegetable oil to serve as an electron donor compound (Borden, 2002). Similarly, PCA can also be completely dechlorinated to form ethane and chlorides under the anaerobic conditions promoted by injection of electron-donor compounds.

Certain sites where the COCs are segregated such that there is a predominance of daughter products (DCE and VC) over the parent compounds at specific locations may be more cost effectively remediated by aerobic oxidation in the presence of oxygen. In these cases, following the reduction of the parent compound concentrations to acceptable levels, the daughter compounds can be oxidized to carbon dioxide, water, and chlorides. If site conditions are suitable for complete dechlorination, such oxidation is not required as a final treatment process.

Effectiveness

In-situ anaerobic reductive dehalogenation with added electron donors is a relatively young technology for destruction of chlorinated VOCs in ground water. A bench-scale treatability study may be required to verify the effectiveness of this technology and to verify site-specific requirements such as the dosage of the electron donor compound and other supplements, if required. However, based on the evaluation of the potential effectiveness of natural attenuation (as discussed earlier under Natural Attenuation), it appears that the site conditions can be stimulated such that the microbial environment can cause a more rapid dechlorination process. As discussed under Natural Attenuation, the current site conditions appear to indicate a lack of consistency in the anaerobic/reductive conditions throughout the plume, which is postulated to be the limiting factor to the dechlorination process kinetics. Therefore, a more uniform distribution of an electron donor throughout the plume, which may potentially be achieved by adding such a donor, should improve the effectiveness of the anaerobic reductive dechlorination process. If the process results in an accumulation of vinyl chloride within the plume, it is expected that the oxidizing conditions (caused by the discharge of ground water at the bedrock outcrop) will cause its complete oxidation to carbon dioxide and water.

Implementability - difficult in FR environment

The introduction of electron donor compounds to the aquifer at the MGBG site would require a determination of the locations and screened intervals of wells. The MGBG site would very likely require pilot-scale studies to provide the necessary data for a full-scale system design because of the complex hydrogeology. Environmental consulting firms and drilling contractors are available to perform this work. The electron donor compounds that could be considered (lactate, chitin, or vegetable oil) are relatively commonly available. Introduction of chitin would be more difficult because it would need to be prepared and injected as a slurry containing high levels of solids, thereby requiring potential hydro-fracturing of the geologic formation. Typically, electron donors are introduced to an aquifer using direct push technology (DPT), however at the MGBG the hydrogeology is not amenable to this technique because the geologic formations are very tight and the ground water is in the bedrock rather than the overburden. Moreover, any attempt to apply hydraulic pressure could cause preferential pathways for ground water migration that might result in unpredictable and potentially unfavorable plume migration rates. Therefore, injection of an electron donor must occur under low pressure operating conditions such as by gravity.

Cost

Capital and O&M costs for *in-situ* anaerobic reductive dechlorination would be low to moderate compared to other *ex-situ* treatment technologies described above.

Conclusion

In-situ anaerobic reductive dechlorination was retained for the development as a possible remedial alternative.

4.3 DEVELOPMENT AND DESCRIPTION OF CORRECTIVE MEASURES ALTERNATIVES

The following corrective measures technologies and process options were retained to develop CMAs for further evaluation:

- No Action
- Institutional Controls
- Ground Water Monitoring
- Natural Attenuation
- *In-Situ* Enhanced Bioremediation

The No Action alternative was selected to serve as a baseline for evaluation of the remediation technologies. The other technologies were selected because they appear to be the most potentially cost-effective remedies of all of the technologies considered. Using these selected technologies, the following three CMAs were developed for the MGBG site:

- Alternative 1: No Action
- Alternative 2: Natural Attenuation with Monitoring and Institutional Controls
- Alternative 3: *In-Situ* Anaerobic Reductive Dechlorination with Institutional Controls and Monitoring

Other alternatives considered during the development of the RFI (such as those including *in-situ* chemical oxidation and hydro-fracturing) have not been developed because the technologies are expected to be infeasible, as discussed in Section 4.2.)

4.3.1 Alternative 1: No Action

This alternative would not address the ground water contamination. Existing monitoring programs would be discontinued, and in the event of base closure, the site would presumably be available for unrestricted use. Therefore, leaving the contamination in place will be impractical.

4.3.2 Alternative 2: Natural Attenuation with Monitoring, and Institutional Controls

Alternative 2 would consist of two major components: (1) Institutional Controls and (2) Monitoring for natural attenuation. The first component is an administrative measure to prohibit human exposure to the contaminated ground water, and the second component is conducted to obtain data to evaluate the changes in concentrations of COCs and the natural mechanisms that cause these changes. Some of these data have already been collected as part of the RFI and the recent CMS data collection effort.

Component 1: Natural Attenuation with Monitoring

There are two subcomponents to monitoring in associated with the natural attenuation process. The first is monitoring to establish temporal concentration trends; the second is monitoring to verify that plume migration is not occurring at a significant rate.

Monitoring would consist of periodically collecting ground water samples from selected wells, followed by analyses for the COCs and parameters used to indicate whether natural attenuation of these COCs (commonly called natural attenuation parameters) continues to occur. The COCs at the MGBG site are as follows:

- 1,1,1,2-PCA
- 1,2,2,2-PCA
- 1,1-DCE
- 1,2-DCA
- Chloroform
- cis-1,2-DCE
- PCE
- TCE.

The natural attenuation parameters which would be considered for evaluation in a monitoring program include the following:

- Dissolved oxygen
- ORP
- Ethane
- Ethene
- Methane

- Alkalinity
- Chloride
- Dissolved carbon dioxide
- Dissolved ferrous iron
- Dissolved manganese
- Dissolved hydrogen
- pH and temperature

(Nitrate, nitrite, sulfate, sulfide, volatile fatty acids, and volatile organic gases of higher molecular weight than those listed above were considered and excluded because these natural attenuation results (two rounds of ground water data) have not proven useful for evaluating natural attenuation processes at the MGBG site).

Monitoring would take place until the attainment of ground water MCSs is demonstrated, however, for cost estimation purposes, a 30-year duration has been assumed. The monitoring would consist of collecting ground water samples from a total of 10 shallow monitoring wells, consisting of a minimum of four within the plume and four at the periphery or outside the plume. One of the four monitoring wells at the periphery would be newly installed at the northwestern edge of the plume. All of the shallow monitoring wells would yield data to monitor the ground water in the upper sandstone water-bearing unit.

The history of the plume concentrations indicate that concentrations decrease slowly over time (except at well 01-02) and therefore, a frequency of monitoring greater than once per year is not necessary to monitor the trend. The frequency would be evaluated on an annual basis and new recommendations (e.g., frequency of sampling and parameters to be monitored) would be presented, as appropriate.

A comprehensive, shallow VOC plume status would be obtained by sampling an additional 21 existing shallow wells at selected locations (for a total of 31 shallow wells), once every 4 years. This would provide adequate time to evaluate the data and to present it in the five-year review that is required under RCRA regulations. The estimated duration for attainment of MCSs would also be reevaluated during this review to assist in the decision-making process for the site. For example, if MCSs are not projected to be achieved within a reasonable time period, or if land use changes in a way that alters risk exposure pathways, a different remedial action may be considered.

The four deep wells (01-06, 01C01, 01T03, and 01T04) have consistently yielded no detectable COC concentrations or concentrations that were approximately equal to detection limits but less than MCSs.

This indicates that the deep wells are not significantly affected by the VOC contamination (the few detectable concentrations of VOCs could even have represented laboratory contamination). Presumably, the deep wells will have less and less potential for exhibiting contamination as time passes and contaminant concentrations decrease throughout the plume. Therefore, these wells would be sampled infrequently (i.e., every 4 years) with the intent of verifying that contamination has not migrated into the deeper water-bearing geologic units.

The actual number of wells to be monitored, the frequencies of monitoring, and the analytical parameters noted above are assumptions for the conceptual level of design and costing. The specifics, including the decisions that would be made regarding the effectiveness of the alternative would be developed using a structured planning process such as the U.S. EPA Data Quality Objectives process (U.S. EPA, 2000b). This would be documented in the work plan to be developed to govern implementation of the corrective action.

Component 2: Institutional Controls

Institutional controls would consist of formulating and implementing controls that would prohibit ground water use until ground water MCSs are attained. As part of institutional controls, annual site inspections would be conducted to verify and enforce the continued application of these controls. Results of these annual inspections would be reported to regulatory agencies.

4.3.3 Alternative 3: *In-Situ* Enhanced Bioremediation with Institutional Controls and Monitoring

Alternative 3 would consist of three major components: (1) *in-situ* enhanced bioremediation, (2) institutional controls, and (3) ground water monitoring. The first component is an active remedial measure that enhances the bioremediation of COCs via biostimulation of the naturally occurring biological consortia. The second component is an administrative measure to prohibit human exposure to contaminated ground water until the remedy attains the required MCSs. The third component is conducted to obtain data to evaluate the changes in COC concentrations and to ensure that the *in-situ* remediation is being implemented effectively and to evaluate possible plume migration to verify that the migration rate is insignificant.

Component 1: *In-Situ* Enhanced Bioremediation

This component would consist of injecting an electron donor such as a soluble lactate into the sandstone water-bearing unit at uniformly spaced locations and under pressure. The injections would be conducted

periodically into the upper sandstone water-bearing unit during the first year of operation and repeated as necessary to address any rebound of COC concentration. It is expected that following a rapid reduction in COC concentrations resulting from the first year of treatment, a gradual rebound of concentrations would occur because of dissolution of pockets of higher concentrations or partitioning from pockets of non-aqueous phase liquids entrapped with zones of fractured bedrock that have not been influenced by the biostimulation process. The concentrations of COCs and natural attenuation parameters would be monitored by sampling and analysis of ground water from selected monitoring wells at the site, as discussed under Component 3 below.

The conceptual design of the system assumes that the attainment of MCSs for TCE and 1,1,2,2-PCA would ensure the attainment of MCSs for all of the other COCs, because these two compounds are present at relatively higher concentrations, are more prevalent, and have similar or more stringent MCSs than the other COCs. The MCSs for TCE and 1,1,2,2-PCA are 5 µg/L and 0.9 µg/L, respectively.

Description of Treatment System

The treatment system would address the remediation of approximately 283,000 square feet of the 1,1,2,2-PCA plume area using injections of a soluble lactate compound at a spacing of 15 feet. The TCE plume spans an area of approximately 258,750 square feet. Approximately 12,000 square feet of source area are estimated to be present in the southeastern portion of these plumes. Approximately 1,284 injection points, spaced 15 feet apart, are expected to allow the soluble lactate to migrate at an estimated flow rate of 15 feet per year to target a complete coverage of these plumes.

The injection points would be drilled to an average depth of 30 feet bgs. The injection points would be drilled using the air-rotary drilling method through approximately 15 feet of overburden followed by bedrock drilling through approximately 15 feet of saturated zone. The holes within the saturated zone would be expected to remain open because of the stability of the rock formation; therefore, well screens would not be required. However, a 15-foot-length well casing [Schedule 40 polyvinyl chloride (PVC) material] with grouting of the annular space to the depth of bedrock would be used to minimize the possibility of loose overburden material being dislodged and blocking the hole. The well casing would be provided with a screw-on PVC cap, and the surface opening would be completed with a manhole and flush-mounted cover. A 1-inch PVC riser would be installed to deliver the lactate compound within the casing. The riser would be installed through a hole drilled through the casing cap, and the annulus would be sealed to prevent overflow of injected fluids.

Treatment in Year 1 and Following Years

Injections of the soluble lactate compound would be conducted during Year 1 at 2-month intervals for 12 months of operating time, excluding 3 months of winter shutdown. After an evaluation of the groundwater monitoring data following the Year 1 treatment, it is assumed that a rebound of COC concentrations would require treatment in Year 6 covering 50 percent of the plume area. It is further assumed that subsequent evaluation of the groundwater monitoring data following the Year 6 treatment activity would entail the need for a final treatment in Year 11 covering a residual of 25 percent of the plume area, following which, it is assumed that natural attenuation would attain the MCSs for the COCs by Year 15.

Vendor estimates for the target lactate dosage are 4,000 mg/L in the PBA and 1,000 mg/L in the outer plume with a total injected mass of 57,000 pounds of 60% lactate solution. The lactate would be obtained as sodium lactate and stored on site in storage, mixing, and pumping facilities installed at selected locations on the site. The concentrated lactate would be diluted at a 10:1 volumetric ratio within mixing tanks using potable water, and the diluted lactate would be delivered via injection pumps into PVC pipe headers leading to flexible polyethylene laterals connected to each PVC riser at each injection point location. Each injection point is estimated to require approximately 40 gallons of diluted lactate in the PBA, and 10 gallons elsewhere throughout the plume requiring remediation.

Appendix F presents the conceptual estimation of the process requirements and a preliminary list of equipment required to support the preliminary cost estimates for Alternative 3. The detailed design and specifications for this alternative would be prepared following a pilot study and evaluation of the results from the study.

Year	Target Lactate Concentrations in the Subsurface (mg/L)		Duration of Active Remediation (months)	Number of Injection Events	Number of Injection Points		Injection Volume per Injection Point per Event (gallons)	
	PBA	Outer Plume			PBA	Outer Plume	PBA	Outer Plume
Year 1	4,000	1,000	12	6	53	1231	24	6
Year 6	4,000	1,000	12	6	26	615	24	6
Year 11	4,000	500	12	6	13	307	24	6

Note:

The dosages, durations, frequency of injection events and the resultant estimates are conceptual and must be adjusted based on results from a pilot-scale study.

Component 2: Institutional Controls

Institutional controls would consist of formulating and implementing controls as part of the Corrective Measures Design (CMD).

Component 3: Ground water Monitoring

Monitoring would consist of periodically collecting ground water samples from selected wells, followed by analyses for the COCs and natural attenuation parameters similar to those discussed under Alternative 2, with a few process-specific exceptions, as discussed further below.

The COCs at the MGBG site are as follows:

- 1,1,1,2-PCA
- 1,2,2,2-PCA
- 1,1-DCE
- 1,2-DCA
- Chloroform
- cis-1,2-DCE
- PCE
- TCE.

The monitored natural attenuation parameters may include the following:

- Dissolved oxygen
- ORP
- Ethane
- Ethene
- Methane

- Alkalinity
- Chloride
- Dissolved carbon dioxide
- Dissolved ferrous iron
- Dissolved manganese
- Dissolved hydrogen
- pH and temperature

Monitoring during the duration of remediation would consist of collecting ground water samples from a total of 10 monitoring wells with a minimum of four within the plume and six at the periphery or outside the plume. One of the four monitoring wells at the periphery would be newly installed at the northwestern edge of the plume. All of the monitoring wells would yield data to evaluate COC concentrations in ground water in the upper sandstone aquifer. The frequency of monitoring would vary depending on the phase of remedial activity as discussed below. Periodically, a comprehensive status of the groundwater at the site would also be verified using samples collected from the upper sandstone aquifer as well as from selected deeper wells, also as discussed below.

During the active treatment periods of Years 1, 6, and 11, the plume would be monitored every quarter. At the end of Years 1, 2, and 11, a comprehensive evaluation of plume status would be conducted. Also, at the end of Years 5, 10, and 15, a comprehensive plume status would be obtained in preparation for the 5-year site status review (in Years 6 and 11) or to support further decisions for the site after Year 15. A comprehensive plume status would be obtained by sampling an additional 21 shallow wells (for a total of 31 shallow wells), and the four deep wells, and analyzing the samples for COCs.

The number of wells to be monitored, the frequencies of monitoring, and the analytical parameters noted above are assumptions for the conceptual level of design and costing. The specifics, including the decisions that would be made regarding the effectiveness of the alternative would be developed using a data quality objectives process in the work plan for the corrective action.

TABLE 4-1

PRELIMINARY SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES AND PROCESS OPTIONS FOR GROUND WATER
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

General Action	Technology	Process Options	Description	General Screening	Notes
No Action	No Action	No Action	No activities conducted at site to address contamination.	No action would not be effective in meeting corrective action objectives but must be considered as a baseline of comparison with other corrective measure technologies.	1
Limited Action	Institutional Controls	Passive Controls	Administrative controls to restrict ground water use and future site activities.	Passive controls would be effective in controlling ground water use and future site uses.	1
		Active Controls	Fencing to restrict site access to trespassers/hunters. Site inspections to verify that site model for risk assessment continues to be valid.	Fencing is not required for this site because of the remoteness of its location and the unlikelihood of site development in the foreseeable future. In addition, fencing is not required for preventing exposure of casual visitors such as hunters/trespassers to surface soil, because surface soil does not present an unacceptable risk to those receptors.	3
	Monitoring	Ground Water Monitoring	Ground water sampling and analysis to evaluate potential migration of chemicals of concern (COCs) in ground water and to evaluate natural attenuation of COCs.	Ground water monitoring would be effective in evaluating potential migration of the VOC plume and to evaluate natural attenuation.	1
Containment	Hydraulic Barriers	Well Pumps	Manipulation of hydraulic gradient to contain the COC plume.	Plume migration is not of primary concern because migration has been observed to be minor in recent years. The hydrogeology of the bedrock system renders the effectiveness of hydraulic containment questionable.	3

TABLE 4-1

PRELIMINARY SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES AND PROCESS OPTIONS FOR GROUND WATER
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

General Action	Technology	Process Options	Description	General Screening	Notes
Removal	Extraction	Well Pumps	Removal of contaminated groundwater at/near the source	Would be effective for reducing the contaminant mass in the aquifer if adequate capture of contaminant plume is achieved. However, the hydrogeology of the bedrock renders the effectiveness of plume capture questionable. Extracted water would require treatment/disposal or treatment/amendment followed by reinjection. Low hydraulic permeability may render the effectiveness questionable.	3
In-Situ Treatment	Physical/ Chemical	Metallic Reductive Dehalogenation	Reductive dehalogenation of chlorinated alkanes/alkenes to innocuous end products by introducing metallic reducing agents with catalysts into the aquifer.	Relatively innovative technology, shown to be effective for chlorinated alkenes under consideration, relatively less proven for chlorinated alkanes. Requires site-specific data for evaluation of effectiveness. Pilot-scale studies are typically recommended for design of full-scale system.	1
		Chemical Oxidation	Oxidation of chlorinated alkanes/alkenes to innocuous end products by introducing strongly oxidizing chemicals into the aquifer.	Shown to be effective at other sites for chlorinated alkenes. Limited effectiveness for PCA. Requires site-specific data for evaluation of effectiveness. Pilot-scale studies are typically recommended prior to design of a full-scale system.	3
		Air Sparging/Vapor Extraction	Removal of chlorinated alkanes/alkenes by volatilization caused by injection of air into the aquifer, followed by vacuum extraction of gases for above-ground treatment.	Typically effective for COCs under consideration. However, air distribution and removal of volatilized gases is expected to be very unpredictable in the bedrock water bearing zone.	3

TABLE 4-1

PRELIMINARY SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES AND PROCESS OPTIONS FOR GROUND WATER
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

General Action	Technology	Process Options	Description	General Screening	Notes
In –Situ Treatment (Continued)	Biological	Natural attenuation	Reductive dehalogenation of parent chlorinated alkenes followed by oxidation of daughter compounds to potentially innocuous end products by existing biological consortia and inorganic constituents under natural conditions.	For chlorinated alkenes, effectiveness for complete dehalogenation, or partial dehalogenation followed by complete oxidation under natural conditions is known to be site-specific. For chlorinated alkanes, the process is less widely proven. However, for both types of COCs, the process cannot be predicted with certainty over a long duration, neither can it be controlled.	1
		Anaerobic reductive dehalogenation/ oxidation	Reductive dehalogenation of chlorinated alkenes to potentially innocuous end products by stimulating existing biological consortia using non-toxic organic material. Partial dehalogenation followed by stimulated oxidation to innocuous end products may also be performed.	For chlorinated alkenes, effectiveness for complete dehalogenation or partial dehalogenation followed by complete oxidation is known to be site-specific. For chlorinated alkanes, the effectiveness is less widely demonstrated. For both types of COCs, site-specific data are needed for evaluation of effectiveness, however the process can be controlled. Pilot-scale studies are typically recommended prior to design of a full-scale system.	1
Ex-Situ Treatment	Physical/ Chemical	Ultraviolet-light enhanced Chemical Oxidation	Destruction of chlorinated alkenes/alkanes by the use of ultra-violet light catalyzed, hydrogen peroxide- or ozone-based oxidizing agents in groundwater in an above-ground treatment system.	Typically effective for chlorinated alkenes. Less effective for chlorinated alkanes, however the process can be adjusted to attain discharge requirements. Requires extraction of groundwater.	4

TABLE 4-1

PRELIMINARY SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES AND PROCESS OPTIONS FOR GROUND WATER
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

General Action	Technology	Process Options	Description	General Screening	Notes
Ex-Situ Treatment (Continued)	Physical/ Chemical (Continued)	Air stripping	Removal of VOCs by volatilization by counter-current contact of groundwater and forced air in an above-ground treatment system. Off-gas treatment will be required.	Typically effective for COCs under consideration. Requires extraction of groundwater.	4
		Granular Activated Carbon (GAC) Adsorption	Removal of organics by adsorption onto solid media having high surface area-to-volume ratio. Spent activated carbon will need to be regenerated.	Typically effective for COCs under consideration. Requires extraction of groundwater.	4
		Precipitation/settling/ filtration	Removal of dissolved solids and/or suspended particulates that could potentially interfere with treatment.	Would be required as a pre-treatment stage for air stripping or oxidation in an above-ground treatment process	3
	Biological	Biological Treatment	Anaerobic or aerobic biodegradation of chlorinated alkanes/alkenes in an above-ground reactor.	Typically less predictable and less effective than physical/chemical technologies in achieving the removal of COCs under consideration.	4

TABLE 4-1

PRELIMINARY SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES AND PROCESS OPTIONS FOR GROUND WATER
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

General Action	Technology	Process Options	Description	General Screening	Notes
Disposal	Off-Site Disposal	Wastewater treatment at TSDF	Contaminated groundwater would be treated/disposed of at an offsite treatment facility.	Would be effective, however volume and duration of groundwater pumping would be critical in determining whether this technology should be considered.	4

NOTES:
1 Potentially applicable as a primary technology.
2 Potentially applicable as a secondary technology (i.e., as a pre- or post-treatment step for a primary technology).
3 Not applicable as a primary technology. Technology is not be retained for further evaluation
4 The technology will be effective but it will require ground water extraction. Therefore, if ground water extraction has not been retained, this technology will not be retained.

Chlorinated alkanes: 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,2-dichloroethane, chloroform, which are COCs for the MGBG site
Chlorinated alkenes: tetrachloroethene, trichloroethene, 1,1-dichloroethene, cis-1,2-dichloroethene, which are COCs for the MGBG site
TSDF: Treatment/Storage/Disposal Facility: typically refers to a licensed RCRA facility that can be used for terminal disposal of hazardous wastes.
PCA: Perchloroethane (1,1,1,2-tetrachloroethane or 1,1,2,2-tetrachloroethane).
COC: Chemical of Concern.

5.0 EVALUATION OF THE CORRECTIVE MEASURES ALTERNATIVES

This section presents an evaluation of the CMAs presented in Section 4.3. The alternatives are evaluated using criteria set forth in the Office of Solid Waste and Emergency Response (OSWER) Guidance Document 9902.3-2A, RCRA Corrective Action Plan (U.S. EPA, 1995) as follows:

- Protection of human health and the environment
- Attainment of MCSs
- Control of release sources
- Compliance with applicable standards for waste management
- Other factors including:
  - Long-term reliability and effectiveness
  - Reduction in toxicity, mobility, or volume of wastes
  - Short-term effectiveness
  - Implementability
  - Cost

Two additional criteria will also be evaluated when the required information is available prior to the selection and implementation of a corrective action measure. These are regulatory and community acceptance of the proposed alternative, as follows:

- Regulatory Acceptance: The Navy will respond to comments and resolve issues with the IDEM and U.S. EPA throughout the finalization of this CMS and other reports pertaining to the corrective measures selection and implementation process.

- Community Acceptance: The Navy has established a Restoration Advisory Board that meets semi-annually with the local public to provide updates on the environmental activities at NWSC Crane. Reports on environmental activities are also maintained as part of the Administrative Record, and access to the reports is available upon request to the NSWC Crane Environmental Department. This mechanism of conducting periodic meetings and providing access to reports will be used to obtain input from the local community on this CMS and other reports pertaining to the corrective measures selection and implementation process. The Statement of Basis (SOB), which will be generated following approval of the CMS report, will be the official document of record in which the proposed corrective action is first made available to the public. The public will have opportunity to comment on the SOB, and the comments will be considered when selecting the final remedial alternative.

5.1 ALTERNATIVE 1: NO ACTION

5.1.1 Protection of Human Health and the Environment

Alternative 1 is considered primarily for comparison to the other corrective measures. Although there are no current or foreseeable future groundwater users at the site, this alternative would not be protective of human health in the short to moderately long term. The reason is, in the event of base closure, the site could be available for unrestricted use. Moreover, because of the lack of monitoring of ground water, there would be no mechanism to determine whether contaminant concentrations are continuing to naturally attenuate to attain MCSs.

5.1.2 Attainment of MCSs

Alternative 1 would not attain the MCSs within 30 years, which is the longest time used to evaluate the attainment of MCSs.

5.1.3 Source Control

Although a source has not definitively been identified at the MGBG site, the suspected area of release of contaminants in the PBA would not be addressed in this corrective measure.

5.1.4 Compliance with Waste Management Standards

There are no actions to be implemented for Alternative 1 and therefore, no waste would be generated.

5.1.5 Other Factors

Long-Term Reliability and Effectiveness

This alternative would not be effective in the long term because the site usage could change in the future, and unrestricted site access and development could result in a potential residential receptor being exposed to unacceptable levels of ground water contamination.

Reduction in Toxicity, Mobility, and Volume

Alternative 1 would involve no active remediation for reduction of toxicity in the ground water. Alternative 1 would involve no mechanism to determine whether intrinsic biodegradation/natural attenuation is

causing a reduction in COC concentrations. Mobility and volume of contaminated media are not of primary of concern to meet CAOs for this site.

Short-Term Effectiveness

Alternative 1 would involve no action and therefore would not pose any risks to onsite workers during implementation, and no environmental impacts would be expected from the implementation of this alternative.

Implementability

Because no actions would occur, this alternative would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

Cost Analysis

There are no costs associated with the No Action alternative.

5.2 ALTERNATIVE 2 - NATURAL ATTENUATION WITH MONITORING AND INSTITUTIONAL CONTROLS

5.2.1 Protection of Human Health and the Environment

Alternative 2 would be protective of human health and the environment. Although there are no current or foreseeable future ground water users at the site, in the event of base closure, institutional controls would prohibit ground water use at the site and thereby protect potential human receptors. Ground water monitoring would provide data to evaluate the effectiveness of natural attenuation in attaining MCSs for COCs and to assess any potential migration of COCs.

5.2.2 Attainment of MCSs

Alternative 2 would attain the MCSs, however, the duration to attain MCSs could exceed 30 years if contaminant concentrations rebound unexpectedly.

5.2.3 Source Control

Alternative 2 would not actively remediate the PBA area, where the release of VOC contamination is believed to have occurred. However, ground water monitoring would provide the data necessary to

determine whether natural attenuation is causing the COC concentrations in the PBA area to decrease to MCSs.

5.2.4 Compliance with Waste Management Standards

Alternative 2 would not involve any removal or treatment of contaminated media. However, installation of new monitoring wells could generate some residues (e.g., drill cuttings) that would have to be disposed appropriately. The volume of residues generated would be small, and waste management regulations would be easily met.

5.2.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative 2 would be effective and reliable in the long-term and is anticipated to achieve the CAOs. Site inspections would be used to ensure the continued effectiveness of institutional controls. Five-year reviews would be used to evaluate whether additional measures are required to protect human health and the environment due to changing site conditions or in the event of a future determination that natural attenuation is no longer occurring.

Reduction in Toxicity, Mobility, and Volume

Alternative 2 would not reduce toxicity through active treatment. However, Alternative 2 would include a mechanism (i.e., groundwater monitoring) to obtain data to determine whether intrinsic biodegradation/natural attenuation is causing a reduction in COC concentrations. Mobility and volume of contaminated media are not of primary of concern to meet CAOs for this site.

Short-Term Effectiveness

Alternative 2 would involve administration of institutional controls and ground water monitoring. The short-term human health risks associated with these limited remedial activities would be minimal. Sampling personnel would undergo site-specific health and safety training and would wear appropriate personal protective equipment (PPE). Implementation of this alternative would not result in any threat to the surrounding community or ecological receptors.

Implementability

The technical implementation of Alternative 2 would be very simple. Monitoring well installation and ground water monitoring would also be straightforward, and the necessary resources are readily available. The administrative implementation of Alternative 2 would also be very simple because the MGBG site is located within a government-operated facility where LUCs can be strictly enforced. Restrictions for future ground water use would involve legal assistance and regulatory approval. However, this alternative requires long-term (indefinite duration) maintenance of institutional controls and ground water monitoring. However, the ground water monitoring data over several years can be used to predict the duration of implementation of this alternative.

Cost Analysis

The following costs are estimated for Alternative 2:

Capital Cost:	$114,000
O&M Costs every 2 years:	$19,000
30-Year Net Present Worth (NPW):	$350,000

~ seems low even for monitoring

The above costs have been rounded to the nearest $1,000 to reflect the preliminary nature of the estimates. Detailed cost estimates are included in Appendix G.

5.3 ALTERNATIVE 3: *IN-SITU* ENHANCED BIOREMEDIATION WITH INSTITUTIONAL CONTROLS AND MONITORING

5.3.1 Protection of Human Health and the Environment

Alternative 3 is the most aggressive of the three selected remedial alternatives and would be protective of human health and the environment. This alternative would eventually attain the MCSs for COCs, following which, the site would be available for unrestricted use. Until that time, institutional controls would ensure the protection of future potential site users.

5.3.2 Attainment of MCSs

Based on the current uncertainties in the data caused partly by the large gap in VOC concentration data between 1986 and 2001, the time required to attain MCSs is uncertain. However, data from continued groundwater monitoring could be used to more precisely predict attainment of MCSs in the future.

Furthermore, the data could be used to engineer the scope and aggressiveness of follow-up treatments (in Years 6 and 11) such that aquifer zones showing rebound of concentrations are adequately addressed to attain MCSs within an acceptable (to be determined in the future) window of time.

5.3.3 Source Control

Alternative 3 would treat the groundwater within the entire site, including the PBA, where VOC contaminants are believed to have been released.

5.3.4 Compliance with Waste Management Standards

Alternative 3 would comply with applicable waste management standards. Disposal of drill cuttings from the installation of injection points and monitoring wells would meet necessary waste disposal standards.

5.3.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative 3 would be effective and reliable in the long term and would achieve the CAOs. Institutional controls would be used to ensure that if the site conditions change, ground water usage would continue to be prohibited.

Reduction in Toxicity, Mobility, and Volume

The reduction of toxicity is difficult to predict accurately because of the uncertainties associated with the distribution of the data. However, using median concentrations for 1,1,2,2-PCA and TCE in the plume, and the attainment of MCSs (Table 3-4), the treatment system would target 96 percent reduction of TCE, and 98 percent reduction of 1,1,2,2-PCA to form relatively innocuous end products owing to complete biodegradation.

The calculations are presented in Appendix E.

Short-Term Effectiveness

The short-term impact of Alternative 3 would be minimal. The potential for worker exposure to drill cuttings during injection point installation or monitoring well construction would be minimized by the

wearing of appropriate PPE and compliance with applicable Occupational Safety and Health Administration (OSHA) regulations and proper site-specific health and safety procedures.

Implementability

The implementation of Alternative 3 would require a pilot-scale study prior to remedial design. The injection dosages, rates of dispersion, and zones of influence of wells are significant design parameters will be obtained from the pilot study. However, the duration of pilot study to determine the zones of influence of each injection point can be on the order of several months because of the low permeability of the aquifer. All of the options would require multiple drill rigs and oversight personnel to ensure that the installation of the entire remedy occurs within a reasonable period of time, i.e., a few months, because of the large number of injection points that would be drilled into bedrock. (For example, assuming that on average two injection points can be drilled and installed in a day by one rig, it is estimated that the time required for the installation of all injections points would range from 2 to 6 months assuming that four drill rigs are operated simultaneously.)

After the installation of the injection points, the time required for delivering the electron donor (e.g., lactate) solution to the aquifer at each point is also expected to pose a concern. Based on estimated target dosages provided by a vendor of bioremediation products, volumes of lactate to be injected were estimated for the PBA area and the remainder of the plume, as presented in the conceptual design calculations in Appendix G. It is likely that because of the higher dosages proposed in the PBA, larger volumes of lactate would be required and consequently, the void volume within the injection point would be overfilled if all of the estimated dosage is injected at once. To address the potential overflow problem in the PBA injection points and as a conservative approach for the other areas, fluid levels would need to be checked in each injection point while the solution is dispensed via a flexible polyethylene pipe in several batches during an injection event. It is estimated that each injection event would require approximately 7 days for the estimated injection volume to be dispersed from each injection point in the PBA. Process automation (i.e., electronic level sensors with automatic valve controls for each injection point) would entail considerable expenditure and maintenance by trained personnel, which is not warranted for the large numbers of injection points and 2-year duration of operation. (These options may be revisited during detailed design, wherein dosages and injection hole diameters may be refined using results from a pilot study).

Injection events would occur every 2 months over a treatment period of 12 operating months (exclusive of winter months) in Years 1, 6, and 11. (It is assumed that 3 months of winter shutdown will be required per year). During Years 5 and 10, data collected from groundwater monitoring would need to be

evaluated and a determination made whether rebound levels of COC concentrations warrant a repeat treatment in the subsequent year. If repeat treatment is required, the existing treatment system would need to be inspected for damage from natural causes and repairs of mechanical equipment (tanks, pumps, piping, etc.) and redevelopment of injection holes (possibly including redrilling of collapsed holes, if any) may be required. If repeat treatment is determined to not be required due to attainment of MCSs, then no further action would be needed. However, if repeat treatment is determined to not be required because rebound levels are not high enough such that the predicted natural attenuation rate would achieve MCSs in an acceptable time frame, then continued monitoring would be needed.

Approximately 1200 injection points are estimated to be required for this alternative. The administrative implementation of Alternative 3 involves the acquisition of injection well permits.

Cost Analysis

The following costs are estimated for Alternative 3:

Cost Item	Cost
Capital ($)	$9,000,000
O&M (per year)	$45,000 (annual average for O&M over 15 years)
Present-Worth	$9,400,000 (15 years)

Detailed cost estimates are provided in Appendix G.

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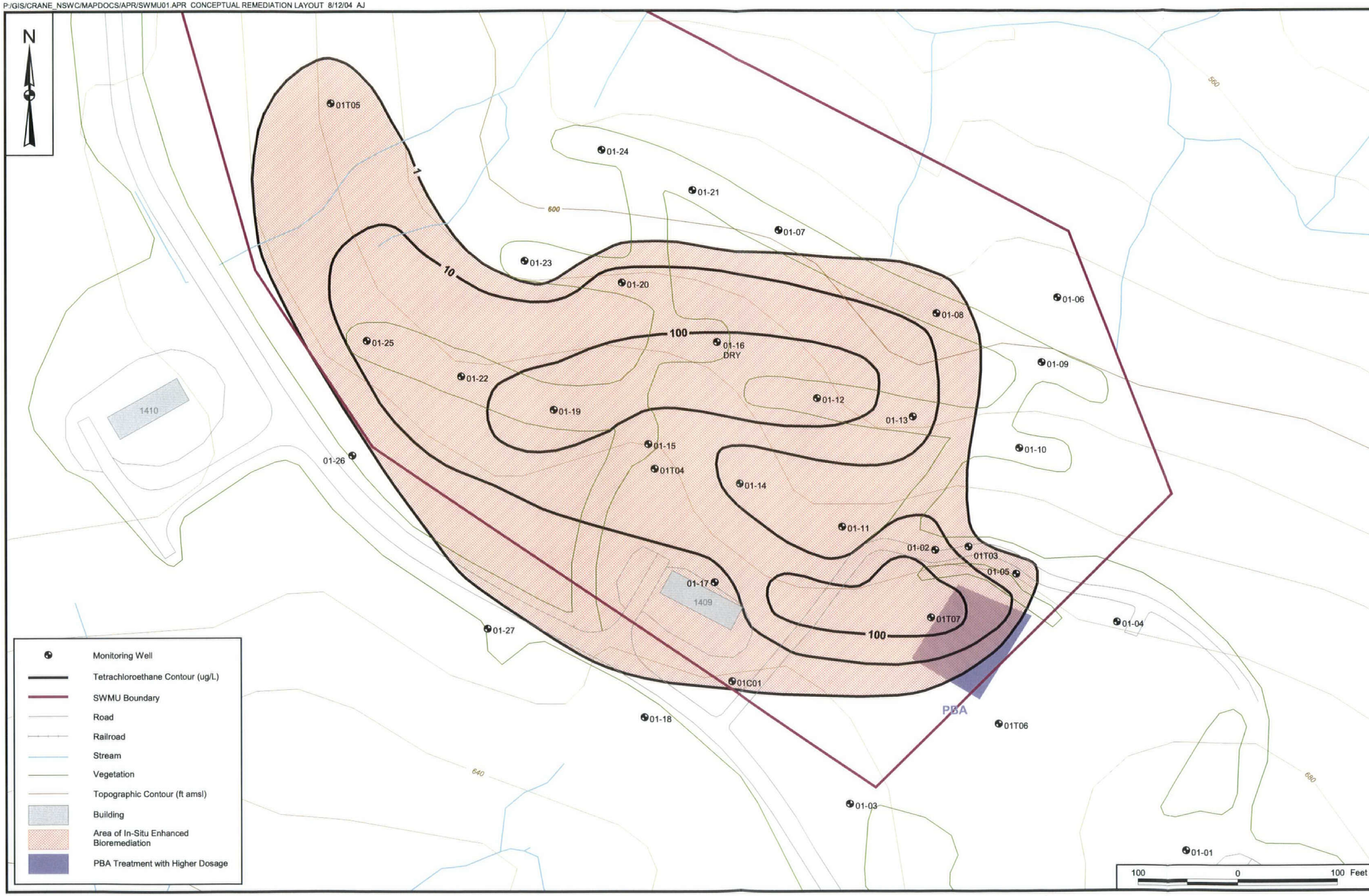

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CONCEPTUAL LAYOUT OF REMEDIATION
ALTERNATIVE 3 FOR MGBG CMS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

DEPARTMENT OF THE NAVY ★ SOUTHERN DIV. FACILITIES ENGINEERING COMD

DRAWN BY A. JANOCHA	DATE 8/04/04	CHECKED BY V. PLACHY	DATE 8/12/04
COST/SCHED-AREA		SCALE AS NOTED	

6.0 COMPARATIVE ANALYSIS AND RECOMMENDATION

The following sections provide a comparative analysis of the three CMAs using the same criteria used to evaluate the alternatives in Section 5.0. This comparative analysis is summarized in Section 6.5.5.

6.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative 1 would not be sufficiently protective of human health and the environment because it would not prevent potential future exposure to COCs in the ground water in the event of site development wherein the ground water is used as a potable source. The primary reason for the ineffectiveness of this alternative is the slow degradation rates of the ground water VOCs in the absence of any treatment. Alternative 2 would be protective of human health and the environment because it would prohibit the use of ground water at the site for potable purposes and provide the data to evaluate whether the COC concentrations continue to approach MCSs over time by virtue of natural attenuation. Alternative 2 would also provide the data to pursue other alternative remedial strategies should the site conditions change or imminent human health or environmental risks be perceived. Alternative 3 would also be protective because it would actively remediate the ground water to attain MCSs, over a more predictable and possible controllable duration.

6.2 ATTAINMENT OF MCSs

Alternative 1 would not attain MCSs within an acceptable timeframe. Alternative 2 would attain MCSs over the long term (at least 30 years) via natural attenuation, and institutional controls would prevent unacceptable exposures to ground water VOCs in the interim. Whereas there is no control on the duration of attainment of MCSs, Alternative 2 would provide the information needed to take a more aggressive action in the future to attain MCSs in a more timely manner, should the need arise. Under Alternative 3, the attainment of MCSs can be better predicted and controlled, possibly within 15 years.

6.3 SOURCE CONTROL

The PBA is believed to be the source of contamination based on site history and recent investigations. Further attempts to prove that the PBA is the source are not expected to be fruitful because the bedrock, rather than the thin veneer of overburden, is the apparent VOC source.

Alternative 1 would not address contamination in the PBA, hence the source of contamination would not be monitored for changes in migration pattern, concentration changes, etc. Under Alternative 2, the PBA

would be addressed via natural attenuation. Moreover, the data obtained from monitoring would indicate whether natural attenuation is adequate for plume treatment. Early indications are that the VOCs, without treatment, have degraded significantly since their release(s), but they are not degrading rapidly enough to attain MCSs within 30 years. Under Alternative 3, the PBA would be addressed via active remediation.

6.4 COMPLIANCE WITH WASTE MANAGEMENT STANDARDS

Alternative 1 would not generate any waste material. All of the other alternatives are expected to comply with waste management standards. Alternative 2 would generate minimal amounts of waste from drill cuttings and sampling-related wastes. Alternative 3 would generate the most amounts of these wastes and additional wastes from the treatment process. Under Alternative 3, hazardous wastes, if any, would be minimal because the main chemical that would be used for the treatment process is a food-grade product.

6.5 OTHER FACTORS

6.5.1 Long-Term Reliability and Effectiveness

Alternative 1 would not be long-term effective and reliable nor would it meet the CAOs. Alternative 2 would be long-term effective and reliable, and it would meet the CAOs through continued enforcement of institutional controls and monitoring of ground water to ensure that natural attenuation is occurring. Moreover, Alternative 2 would provide the data necessary to select a different remedy that would offer greater long-term reliability and effectiveness, should the need arise because of site conditions or risks. Alternative 3 would be more long-term effective and reliable and would better meet the CAOs than Alternative 2 because active remediation would occur in the implementation of Alternative 3, which would ensure a rapid reduction in COC concentrations.

6.5.2 Reduction in Toxicity, Mobility, and Volume

Reduction of toxicity from human receptor exposure to ground water is the primary concern at the MGBG site. Alternative 1 would not actively reduce the toxicity of the ground water caused by COCs, although VOC concentrations should be expected to continue to decline very slowly through natural mechanisms. Alternative 2 would not employ active remediation to reduce the toxicity of ground water caused by COCs; however, it would provide the data necessary to evaluate whether natural attenuation is causing the toxicity to decrease to acceptable levels, and it would prevent unacceptable exposure to ground water. Alternative 3 would reduce the toxicity of ground water caused by the COCs by active remediation.

6.5.3 Short-Term Effectiveness

Alternative 1 would not result in any short-term risks to human health or the environment, assuming that the land use does not change. Alternative 2 would result in minimal short-term risks to personnel during installation of monitoring wells (as required) and during sampling. The primary risks would most likely derive from well installation and sampling operations rather than from exposure to ground water. Alternative 3 poses the greatest concerns during drill rig operation for installation of injection points because of the stability challenges in areas of steeply sloping ground surfaces, especially towards the northwestern and northeastern sides of the MGBG. Extensive deforestation of mature woods would also be required to access the injection point locations, whose spacing is every 15 feet. Under Alternative 3, tree felling and brush removal can pose physical, reptilian, and entomological hazards to the operator. Also, the areas where tree and brush removal have occurred would need erosion control measures and restorative seeding to mitigate the loss of vegetation. In addition, the loss of forest and understory may be a concern because of the concomitant loss of habitat, e.g., for the Indiana bat and other species that use the forest for nesting, foraging, etc. Therefore, Alternative 3 poses adverse effects that transcend the achievement of short-term effectiveness.

6.5.4 Implementability

Alternative 1 would be the easiest to implement because no action would occur.

The monitoring and institutional control components of Alternative 2 would be very easy to implement because SWMU 01 is located within a government-owned facility where such controls are relatively easy to enforce.

Alternative 3 would be more difficult to implement than Alternative 2 because it would require deforestation, drilling and installation of injection wells in difficult terrain, construction and operation of an onsite chemical feed system, and intensive operator attention during the injection events to ensure that a large network of piping and injection points is functioning adequately. In particular, the injection of the viscous solution to promote in-situ reductive dechlorination in certain areas would require particular attention to fluid levels and potential overflow because the volume of solution to be pumped into the water-bearing zone during an injection event would exceed the volume of the void space in the injection point. The use of high-pressure pumps would entail checking for leaks and maintenance of unions at several locations. Alternative 3 may also require periodic maintenance of the treatment system over several years and repeated treatment to ensure attainment of MCSs.

6.5.5 Cost

Cost Item	Alternative 2	Alternative 3
Present-Worth	$350,000 (30 years)	$9,402,000 (15 years)

The table above compares the costs for Alternatives 2 and 3. Alternative 1 (No Action) entails no cost. Detailed costs are provided in Appendix G.

The large cost of Alternative 3, is related primarily to the number of injection wells. Because of the tight geologic formation in the treatment stratum, the wells must be spaced close together, thus a large number of wells are needed. The travel time for treatment chemicals in the formation of concern will be relatively long for the chemicals to reach any given point compared to wells in overburden, for example.

6.6 RECOMMENDED CORRECTIVE MEASURE

Alternative 2 is the recommended corrective measure. For a site such as the MGBG, the need for active remedial measures is questionable, because of the lack of any risk to human health or the environment in the foreseeable future. In light of the expense of a possibly more effective and aggressive remedial alternative, and the degree of deforestation involved, the more cost-effective approach appears to be maintenance of institutional controls and monitoring the groundwater at the site until a change in site conditions or potential risks dictate a need for a more aggressive remedial approach.

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APPENDIX A

FIELD REPORT

APPENDIX A

FIELD REPORT

This appendix describes the sampling activities, procedures, and documentation utilized during field operations conducted in January 2004 for Naval Surface Warfare Center (NSWC) Crane Solid Waste Management Unit (SWMU) 01 – Mustard Gas Burial Ground (MGBG).

A.1 OVERVIEW

All field activities for this investigation were conducted from January 13 through January 28, 2004, and with few exceptions were performed in accordance with the procedures and methodologies described in the QAPP Addendum No. 1 for MGBG (TtNUS, 2004). That document includes, either directly or by reference, the standard operating procedures (SOPs) that governed the field activities. Details of the field events are described in the sections below. Any field work deviations from the QAPP Addendum No. 1 are identified and explained in the applicable text below.

Two additional ground water monitoring wells (01T06 and 01T07) and eight test pits (01TP01 through 01TP08) were installed (See Figure 1-4 of the text). Because the MGBG [especially the Primary Burial Area (PBA)] was once contaminated with radioactive thorium, monitoring for gross gamma radiation levels using handheld instruments was conducted during the soil test pitting activities. Field personnel working in and around the PBA wore thermoluminescent detectors (TLDs) to monitor their radiation exposure. Natural attenuation field parameters were analyzed at 11 of the ground water wells. These wells are identified on Figure 1-4 of the text. Photographs of the test pits are presented in Figures A-1 through A-4. Copies of all field forms, records, and field logbooks associated with this field investigation are provided in Appendix B.

A.2 MOBILIZATION / DEMOBILIZATION

Following approval of the QAPP Addendum No. 1 for MGBG, TtNUS began mobilization activities. All field team members reviewed the approved QAPP Addendum No. 1, associated appendices, and the Health and Safety Plan (HASP) prior to the start of project activities. The Task Order Manager (TOM) requested and received from NSWC Crane a digging permit for the intrusive activities. In addition, the field operations leader (FOL) held field team orientation meetings to ensure that personnel were familiar with the scope of the field activities. Equipment required for the field activities was shipped to the site and

tested prior to use. Upon completion of field activities, equipment was decontaminated and returned to vendors, as applicable.

During demobilization, the ground surface was too hard and too snow/ice covered to perform site restoration and revegetation; therefore, this activity was postponed until the Spring of 2004. The restoration was completed on April 27, 2004.

A.3 TEST PITTING AND SOIL SAMPLING

Soil trenching (i.e., test pitting) was conducted during this investigation in an aggressive attempt to locate a volatile organic compound (VOC) source in soils. These operations were located in and near the PBA, which is considered to be the most likely location of the VOC contamination source. One significant question remaining for this Corrective Measures Study (CMS) was whether the VOC source exists in overburden soils, in bedrock, or both.

Advantages of test pitting over soil boring sampling for this purpose include the ability to: (1) directly observe soil conditions and horizons in the sidewalls of the trench in more detail than is possible in soil borings, (2) directly observe lateral changes in the soil materials in the trenches, and (3) screen a greater volume of soils for the presence of VOCs and radiation with the handheld field instruments. Disadvantages of test pitting include: (1) the large volumes of potentially hazardous soil and decontamination waste that are generated, (2) the potential loss of volatile components if the soils due to disturbance during trenching, (3) the amount of time necessary to install a trench, and (4) the greater degree of site restoration required because of the breadth of disturbance of the site. The advantages were considered to outweigh the disadvantages for this investigation because of the need to understand whether overburden soils or bedrock are the primary source of VOCs in ground water. The increased spatial coverage for radiation measurements was also considered to be a considerable advantage in this case.

Eight trenches, each approximately 4 feet wide by 10 feet long, were dug with a backhoe to the top of the bedrock. All test pit locations are depicted on Figure 1-4 of the text, and a summary of analyses is documented in Table 2-1 of the text. All excavated soils were scanned with a photoionization detector (PID) and a 2-inch x 2-inch sodium iodide gamma detector in the backhoe bucket before placing the soil beside the trench. Visual observations and field screening measurements were made outside of the trenches for safety reasons. The field geologist documented the physical characteristics of the excavated soil including color, moisture content, and grain size distribution. During excavation, no unusual observations were noted, and all VOC concentrations and radiation levels were within background levels. Despite the observed background levels, a grab sample was collected near the middle of each of six

trench bottoms for laboratory VOC analysis as a verification of the VOC concentrations. After sample collection or inspection of each pit, the pit was backfilled with the excavated soil, the soil was tamped down, and the area was returned as close to original grade as possible. The two ends of each trench were marked with a wooden lath and flagging, and the trench location ID was marked on the lath. Vertical and horizontal survey points were measured at the center of each end of each trench

A surface vent (metal pipe approximately 8 inches in diameter and 2 feet long) associated with previous mustard gas remediation activities was identified in the PBA based on conversations with facility personnel and the TOM. The decision was made to install a test pit to facilitate removal of the vent pipe because any residual mustard gas left from previous exhumations should have been completely inactivated by now Test Pit 8 was excavated in the vent area and a white silty material, sand and gravel were encountered beneath the pipe. These materials were left in place except for the quantities excavated to reach bedrock. No VOCs or elevated radiation levels were detected in the these materials. A small amount of water was encountered in just one test pit, Test Pit 8. It did not warrant sampling however, because it was not clear that the water would be representative of water located at the bedrock-overburden interface and because no VOCs had been detected through field screening.

A.4 MONITORING WELL INSTALLATION AND DEVELOPMENT

Wells 01T06 and 01T07 were installed using a rotosonic drilling technique and were set at total depths of 30 feet below ground surface (bgs). Details of the drilling and well installation operations are provided in this section.

A.4.1 Well Installation

After each boring was drilled to the desired depth, a 2-inch-diameter polyvinyl chloride (PVC) Schedule 40 well screen and riser pipe was lowered into the boring through a steel isolation casing. All well screens were approximately 10 feet in length with a slot size of 0.20 inch. After the screen and the riser pipe were in place, the annulus of the boring was backfilled with clean silica sand from the bottom of the boring to 1 to 2 feet above the top of the well screen. A bentonite seal was then installed either in pellet (shallow wells) or slurry (deep wells) form and allowed to hydrate in accordance with the manufacturer's recommendations. The remainder of the annulus of the borehole (from the bentonite seal to the ground surface) was filled with cement/bentonite grout to land surface elevation.

The depth of the backfill materials was continuously monitored during the installation of the wells using a weighted steel tape measure to ensure that the sand pack or bentonite did not bridge during the installation process. Well construction logs were completed for each well and are presented in Appendix B.1.1. Monitoring well construction information and water level measurements are presented in Table 1-1 of the text.

The new monitoring wells were developed in accordance with SOP CTO315-12 prior to sampling. See Figure 1-4 of the text for the SWMU 01 monitoring well locations.

A.4.2 Monitoring Well Protection

After each monitoring well was installed and the annulus was grouted to the land surface, a 4-inch square steel protective casing with a locking cap was cemented in place over the riser pipe. This stick-up-type protective casing extended approximately 3 feet above and 2 feet below the ground surface. A drain hole was drilled into the protective casing approximately 6 inches above the ground surface. Pea gravel was used to fill the space between the outer protective casing and the riser pipe. A 4-foot-square and 6-inch-thick concrete apron was cemented in place around the protective casing, and four safety yellow barrier posts (nominal 4-inch-diameter, 5-foot-long steel pipes buried 2 feet deep and filled with concrete) were cemented just outside the four corners of the concrete apron. Stainless steel well plates indicating well ID, depth, date, etc., will be installed on the outside of each protective well casing.

To maintain well security, a locking cap was placed on each well.

A.4.3 Monitoring Well Repair and Development

All existing wells at SWMU 01 were inspected and repaired as needed. Well inspection reports are included in Appendix B.2.4 of this document. The well pad surrounding the existing wells could not be inspected due to the amount of ice/snow at the site. No significant repairs were made during this field investigation. The minor repairs included the following:

- Replacement of a broken well cap at existing monitoring well 01-06.
- Replacement of risers for three existing wells, 01-06, 01-07, and 01-15, that did not have protective outer casings.

The two newly installed monitoring wells were developed by the surging and bailing method no sooner than 24 hours after installation to remove fine material from around the well screen and the sand pack that surrounds the well screen. Monitoring well development records can be found in Appendix B.2.5 of this

document. The period of development for each well was approximately 1 hour. Wells were developed by surging the well with a bailer for approximately 10 to 15 minutes then continuing to purge the well dry by withdrawing approximately three well volumes of ground water. Section A.14 describes the disposal of all investigation-derived waste (IDW) including development fluids.

A.5 GROUND WATER SAMPLING

All ground water sample locations are depicted on Figure 1-3 of the text, and a summary of analyses is included in Table 2-1 of the text. One ground water sample was collected from each of 31 existing wells and from each of the two wells installed during this field effort. In addition, five ground water field duplicates were collected to yield a total of 38 samples.

Purging and stabilization of wells prior to sampling was accomplished using low-flow techniques in accordance with SOP CTO315-14 (Appendix B of QAPP Addendum No. 1 for MGBG). Sampling was accomplished in accordance with SOP CTO315-15 (Appendix B of QAPP Addendum No. 1 for MGBG).

Wells were purged prior to sampling using a peristaltic pump or bladder pump, depending on the static water level, well depth, and recharge information obtained during well development and/or historical sampling information. In general, bladder pumps were used to sample wells with a water level greater than 28 feet bgs, and peristaltic pumps were used to sample wells having a water level less than 28 feet bgs. Disposable Teflon® tubing was used with both pump types, and new, dedicated tubing was used for each well.

Ground water quality parameters including pH, specific conductance, temperature, dissolved oxygen (DO), and oxidation-reduction potential (ORP) were measured during purging at 5- to 10-minute intervals using a YSI Model 600 series multi-parameter water-quality meter and flow-through cell. Longer intervals may have been used for slower pumping wells, depending on well-specific conditions. Turbidity readings were measured using a LaMotte 2020 turbidity meter. Water levels and pumping rates were also measured during purging at 5- to 10-minute intervals. Purging continued until a minimum of one well volume was removed and the above parameters stabilized or after 4 hours of purge time, in accordance with SOP CTO315-14 (Appendix B) of the QAPP Addendum No. 1 for MGBG (TtNUS, 2004). Copies of the monitoring well low-flow purge data sheets and ground water sample log sheets are provided in Appendix B.2.2 of this document.

The pumping rates were adjusted to prevent drawdown from exceeding 0.3 foot during purging. Well purging continued until all parameters stabilized and the minimum purge volume (stabilized well volume plus the extraction tubing volume) was removed. If the water quality parameters did not stabilize within 4

hours of purging, this information was recorded on the well low-flow purge log sheet and sampling was initiated.

Monitoring wells were sampled with the same pump (peristaltic or bladder) and tubing used during well purging. Immediately following the purging process and before sampling, the temperature, pH, specific conductance, DO, ORP, and turbidity of each water sample were measured and recorded on the ground water sample log sheet (included in Appendix B.2.2 of this document).

Sample containers were filled by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence. VOC samples were collected and immediately sealed in 40-mL vials so that no headspace existed.

Several wells were also sampled for Monitored Natural Attenuation (MNA) parameters. Field analyses included DO, alkalinity, carbon dioxide, ferrous iron, hydrogen sulfide, total sulfide, nitrite, and manganese. Samples obtained for laboratory MNA parameter analysis included nitrate plus nitrite (as reported as nitrogen), chloride, sulfate, total hardness (as CaCO3), dissolved organic gasses, dissolved hydrogen, total organic carbon, total inorganic carbon, and volatile fatty acids. Natural attenuation measurement records are provided in Appendix B.2.2 of this document.

Some sampling difficulties were encountered at times due to the low temperatures, which caused the water to freeze a few times in the transfer tubing between the wells and the sampling containers. The 24-hour average daily minimum temperature reported by the nearby Bloomington, Indiana weather station was 17.5 °F (-8.1 °C). The corresponding average daily maximum temperature was 33.1 °F (0.63 °C). Daily minimum and maximum temperatures are presented in Table A-1. When freezing occurred, 6 to 12 inches of tubing were pulled out of the well, the frozen section of tubing was cut off, and clean tubing was spliced into the sampling train. The sampling line was flushed and sampling continued. Freezing did not occur during VOC sampling because the volumes collected and times required for sampling were less than for other analytical fractions.

Only well 01-16, a historically dry well, did not yield enough water to be sampled during this event. Refer to Appendix B for sampling details.

A.6 FIELD SAMPLE DOCUMENTATION

Sample documentation consisted of boring logs, matrix-specific sample log sheets, sample bottle tags, chain-of-custody records, field task modification request forms (FTMRs), equipment calibration log sheets, field logbooks, and health and safety documentation. Any unusual circumstances encountered during

sample collection were noted on the appropriate form. Sample log sheets can be found in Appendix B.2.1 of this document. Chain-of-custody (COC) records (see Appendix B.2.3) were used to track each sample from collection to receipt and analysis at the laboratory. FTMRs (see Appendix B.2.7) were used to document any deviations from the QAPP Addendum No. 1 for MGBG. Equipment calibration log sheets are discussed in Section A.9.1 and are found in Appendix B.2.8 of this document. Copies of all field logbooks are contained in Appendix B.3.1. Copies of the health and safety logs are maintained in the project file. Upon completion of sample analyses, sample bottle tags were forwarded by laboratory personnel to the NSWC Crane Environmental Protection Department via Tetra Tech NUS, Inc. (TtNUS).

A.7 SAMPLE HANDLING, PACKAGING, AND SHIPPING

Filled sample containers were sealed in Ziploc® plastic bags, and glass containers were wrapped in plastic bubble wrap to minimize the possibility of breakage during transport. The sample containers were then placed in a cooler lined with a large plastic garbage bag. The cooler was packed with a cushioning material (bubble wrap) to prevent container breakage. Samples were cooled immediately after collection with ice placed over the sample containers. A temperature blank was placed in each cooler prior to shipment. The plastic garbage bag was sealed with a knot, and the COC form was sealed in a Ziploc® bag and taped to the inside of the cooler lid. A signed and dated custody seal was applied to each end of the cooler and then covered with strapping tape to provide a tamper-evident seal. A Federal Express® airbill was applied to the shipping cooler. TtNUS maintained custody of the samples until they were relinquished to Federal Express®. The Federal Express® tracking number (airbill number) was recorded on the COC form, and the sender's copy of the airbill was maintained for shipment tracking, if needed. All samples were shipped to the laboratories for overnight delivery and were received within sample holding times. The procedures for sample preservation, packing, and shipment can be found in Section 3.7.1 of the QAPP Addendum No. 1 for MGBG (TtNUS, 2004). The procedure used for sample labeling and custody can be found in Sections 3.7.2 and 3.7.5 of the QAPP Addendum No. 1 for MGBG (TtNUS, 2004) and in SOPs CTO315-01 and CTO315-03.

A.8 QUALITY CONTROL SAMPLES

Quality assurance/quality control (QA/QC) samples were collected and generated during sampling activities to monitor both field and laboratory procedures. These procedures are detailed in the approved QAPP. QA/QC samples included field duplicates, equipment rinsate blanks, trip blanks, source water blanks, and temperature blanks. Field duplicate data are tabulated in Appendix C, Table C-5 of this document. These types of QA/QC samples are briefly described in the MGBG QAPP (TtNUS, 2004):

A.9 FIELD MEASUREMENTS

Field measurements taken and recorded during field sampling operations included water temperature, pH, specific conductance, ORP, DO, turbidity, and ground water level. Ambient air measurements included monitoring of organic vapors in the breathing zone during intrusive field investigation activities and monitoring of organic vapors emanating from site sources such as soil samples and well casings. In addition, test pit soils were screened for radiation and VOCs. Several instruments were used during field activities to obtain these measurements including the following:

- PID
- Gross gamma scaler/ratemeter
- YSI Model 6 series, Multi-Parameter Water Quality Meter
- LaMotte 2020 Turbidity Meter
- M-scope water level meter

No readings exceeded background levels, so only the default set of VOC soil samples prescribed in the MGBG QAPP Addendum No. 1 were collected for laboratory analyses. Consideration of the low daily temperatures provides insight into the lack of detectable VOC vapors at the suspected source of ground water VOC contamination. At low temperatures, the volatility of VOCs is less than at warmer temperatures. The background levels for gamma radiation were consistent with the site history, which indicates that all known radioactive material had been previously exhumed and disposed.

A.9.1 Equipment Calibration

Instruments used in the field were calibrated prior to each use according to manufacturers' requirements and in accordance with applicable SOPs. Equipment calibration logs can be found in Appendix B.2.8.

A.9.2 Field Investigation Preventive Maintenance Procedures/Schedule

The specific preventive maintenance procedures followed for field equipment were those recommended by the equipment manufacturers.

An appropriate maintenance check was performed daily on each piece of equipment. If damaged or defective parts were identified during the maintenance check, and it was determined that the damage could have an impact on the instrument's performance, the instrument was removed from service until the defective parts were repaired or replaced. Specifically, one of the three LaMotte Turbidity Meters could not be calibrated to the required specifications. One of the bladder pump controllers also malfunctioned

during use, so this instrument was removed from service. Critical spare parts were kept on site to reduce downtime. Spare parts included batteries, a DO-probe membrane kit (membranes and a bottle of solution), and air particle filters for the PID. Back-up instruments and equipment were available on site or were shipped within 1 day via overnight courier to avoid delays in the field schedule.

A.9.3 Visual observations for VOC contamination

Because of previously detected VOC concentrations in ground water near the 20,000 µg/L level and higher, the field crew attempted to detect non-aqueous phase liquids by several methods. These methods included visual observations, odor, and use of a relatively new material called a NAPL FLUTe™ liner. None of these methods yielded detectable VOC results. The rock cores from well drilling were extruded from the core barrel into the NAPL FLUTe liner and encased in an outer polyethylene sleeve. The encased cores were set on their sides for at least an hour to provide an opportunity for any NAPL present in the core to contact the liner. Such contact would be indicated by a stain that bleeds from the interior to the exterior of the liner and would be easily observed. No staining was observed. In addition, VOC measurements were made by slicing the liners in a few different locations (after vapors had had time to accumulate) and inserting the VOC instrument sampling tube. The results were recorded on the boring log (provided in Appendix B.1.1). No NAPLs were detected. The field crew concluded that no NAPL was present in the soil cores.

A.10 SURVEYING

All of the groundwater monitoring wells and the test pit locations were surveyed. The top of the riser pipe (where the uncapped well riser is marked), the top of the protective casing, and the ground surface elevation at each monitoring well location were surveyed to within 0.01-foot vertical accuracy. For all other locations, the ground surface elevation was surveyed to the nearest 0.10-foot. Vertical elevations were referenced to the 1988 North American Vertical Datum (NAVD88). Existing survey monuments at NSWC Crane were used as reference points. Horizontal locations of wells and test pits were surveyed to Indiana State Plane coordinates to the nearest 0.10 foot and referenced to the 1927 North American Datum (NAD27).

The corner posts that mark the boundaries of the MGBG site may be removed in the future, or they may decay to the point where they will fall apart. Therefore, the four corners of the MGBG were scheduled to be surveyed to verify that the MGBG site boundaries are known accurately today and into the future. The surveyor did not find the northeastern corner post of the MGBG and surveyed another point instead. The surveyor did find the three other corners and surveyed them. The coordinates for these three corners are

consistent with previously established coordinates. Therefore, previously established coordinates for the fourth corner are assumed to be correct. There is no plan to resurvey the northeastern corner.

All surveying was subcontracted to Bledsoe Tapp & Riggert, Inc. of Bloomington, Indiana, a professionally licensed surveyor in the State of Indiana. Copies of the survey data can be found in Appendix B.3.3.

A.11 DECONTAMINATION

The nondedicated, nondisposable equipment involved in field sampling activities was decontaminated before beginning work, during drilling and sampling activities, and at the completion of the field activities in accordance with SOP CTO315-19 contained in Appendix B of the QAPP Addendum No. 1 for MGBG. This equipment included drilling rigs, down-hole tools, augers, and soil and water sampling equipment.

A.11.1 Major Equipment

All down-hole equipment, including down-hole drilling tools, were steam cleaned with high-pressure hot water prior to beginning work, between borings, and at the conclusion of each shift of drilling.

Well riser pipe and screens were supplied at the site in certified-clean packaging. All decontamination activities took place at a predetermined area within NSWC Crane.

A.11.2 Sampling Equipment

All nondedicated (reusable) equipment used for collecting samples was decontaminated before field sampling, between sample collections, and at the end of each sampling event. This equipment included stainless steel trowels, stainless steel mixing bowls, bladder pumps, etc. The following decontamination steps were taken:

- Potable water and phosphate-free detergent wash (scrub if necessary)
- Potable water rinse
- Deionized (DI) water rinse
- Air dry (if possible)
- Wrap in aluminum foil (if not to be used immediately)

An isopropanol rinse was not necessary because no oily residue was evident on the sampling equipment.

Field analytical equipment such as pH, conductivity, and temperature probes were rinsed first with analyte-free water then with the sample prior to making measurements. Water level measurement devices were rinsed with DI water.

A.12 WATER LEVEL MEASUREMENTS

A.12.1 Ground Water Level Measurements

Water level measurements were obtained from each monitoring well prior to development and purging. In addition, a synoptic round of water levels was taken at all the wells and staff gages, including the two new wells 01T06 and 01T07, at the end of field activities (January 28, 2004). The synoptic water level measurements were obtained within a 4-hour time period. Measurements were taken with an electrical water level indicator (M-scope), using the top of the riser pipe as the reference point to determine water depth for monitoring wells and using a surveyed mark for staff gauge measurements. All measurements were taken in accordance with SOP CTO 315-18 contained in Appendix B of the QAPP Addendum No. 1 for MGBG (TtNUS, 2004). A mark was placed at the top of each riser pipe to ensure that measurements were taken from a consistent reference point. Water level measurements were recorded to the nearest 0.01 foot on a ground water level measurement form, provided in Appendix B.2.6 of this document.

A.13 FIELD CORRECTIVE ACTION

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or "out of quality control" performance that can affect data quality.

Corrective action in the field typically results when substantive changes were made to the sampling network (i.e., more/fewer samples collected, sampling locations other than those specified, etc.) and when sampling procedures or field analytical procedures require modification. Project personnel were directed to report all suspected technical or QA nonconformance or suspected deficiencies of any activity or issued document to the FOL or designee. No such reports were made. The TOM was responsible for assessing any suspected problems in consultation with the project QA/QC Manager and for making a decision based on the potential for the situation to affect the quality of the project. If it was determined that the situation warranted a reportable nonconformance requiring corrective action, a nonconformance report would be initiated by the TOM. No nonconformances or suspected deficiencies occurred during this field investigation.

A.14 INVESTIGATION-DERIVED WASTE HANDLING

The field investigations generated several types of potentially contaminated wastes including personal protective equipment (PPE), decontamination fluids from the drill rig, backhoe, and bulldozer, sampling equipment decontamination fluids, direct-push technology (DPT) plastic sleeves, development and purge water, and soil cuttings. Management of each residue was performed as follows:

PPE, Pump Tubing, and DPT Plastic Sleeves – All PPE, tubing, and plastic sleeves were decontaminated, double bagged, and placed in NSWC Crane trash receptacles (i.e., dumpsters).

Purge Water, Development Water, Drill and Sampling Equipment Decontamination Fluids – All well development and purge waters and equipment decontamination fluids were collected and discharged to the NSWC Crane permitted waste treatment plant.

Waste Cuttings and Rock Cores from Drilling Activities – For each boring, the cuttings produced were scanned for VOCs and gamma radiation. VOC and radiation readings were at background levels for all borings, and cuttings were therefore used as backfill if the boring terminated above the water table. Any remaining cuttings were spread on the ground in the immediate vicinity of the boring. Rock cores are stored in Magazine No. 1970, which is located in another area of NSWC Crane.

Additional requirements for IDW handling can be found in SOP CTO315-20 contained in Appendix B of the QAPP Addendum No. 1 for MGBG (TtNUS, 2004).

A.15 SITE MANAGEMENT AND FACILITY SUPPORT

The FOL was designated as responsible for coordinating all day-to-day activities during the investigation. The FOL was responsible for ensuring that all field team members (including subcontractors) were familiar with the Addendum No. 1 to the approved QAPP and the site-specific HASP. Additionally, the FOL was responsible for all sampling operations, QA/QC, field documentation requirements, and field change orders. The FOL reported to the TOM on a daily basis regarding the status of fieldwork. These reports were forwarded periodically to the Navy Engineer in Charge.

All site preparation, mobilization/demobilization, and sampling activities were coordinated through NSWC Crane personnel.

A.16 RECORDKEEPING

Various hardcover, bound record books were maintained for each field activity in accordance with SOP CTO315-03. The Master Site Logbook served as the overall record of field activities. Information recorded daily in the Master Site Logbook included daily field activities, weather conditions, identity of and arrival and departure times of personnel, management issues, etc. Various field notebooks were also maintained. For example, the site geologist supervising monitoring well installation operations maintained a field notebook. Copies of field log books are included in Appendix B of this document.

The FOL was responsible for the maintenance and security of all field records. Eventually, all field records, COC forms, sample log sheets, field forms, logbooks, and notebooks were docketed and incorporated in the central project file for CTO 315.

TABLE A-1

DAILY TEMPERATURE DATA DURING SAMPLING EFFORT
(BLOOMINGTON, INDIANA STATION)
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

		Air Temperature, °F	
Date	Time, EST[2]	Minimum	Maximum
1/13/2004	820	29	39
1/14/2004	700	23	38
1/15/2004	700	23	46
1/16/2004	700	23	32
1/17/2004	725	26	37
1/18/2004	800	30	40
1/19/2004	750	11	31
1/20/2004	700	10	23
1/21/2004	600	13	26
1/22/2004	200	22	35
1/23/2004	700	7	29
1/24/2004	715	11	38
1/25/2004	700	16	30
1/26/2004	700	16	22
1/27/2004	700	15	32
1/28/2004	735	5	32
	Average =	17.5	33.125

1 Data dowlnoaded from Internet on 3/22/04.
2 EST = Eastern Standard Time.

Figure A-1. Mustard Gas Burial Ground Test Pit Photographs January 2004

Test pit 01TP01 facing north.

Test pit 01TP02 facing western wall.

Test pit 01TP01 facing east.

Test pit 01TP02 facing south.

Test pit 01TP03 facing west.

Test pit 01TP03 southern wall.

Test pit 01TP04 facing eastern wall.

Test pit 01TP04 facing north.

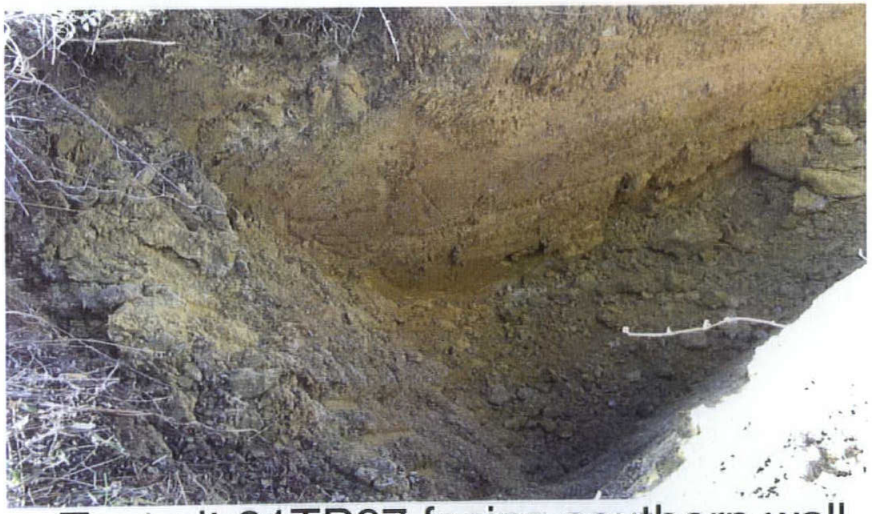
Test pit 01TP05 facing west.

Test pit 01TP05 facing southern wall.

Test pit 01TP06 facing southern wall.

Test pit 01TP06 facing west.

Test pit 01TP07 facing west.



Test pit 01TP07 facing southern wall.

Test pit 01TP08 overview.

Test pit 01TP08 facing northwest.

APPENDIX B

FIELD LOGS, PERMITS AND CERTIFICATES

APPENDIX B.1.1

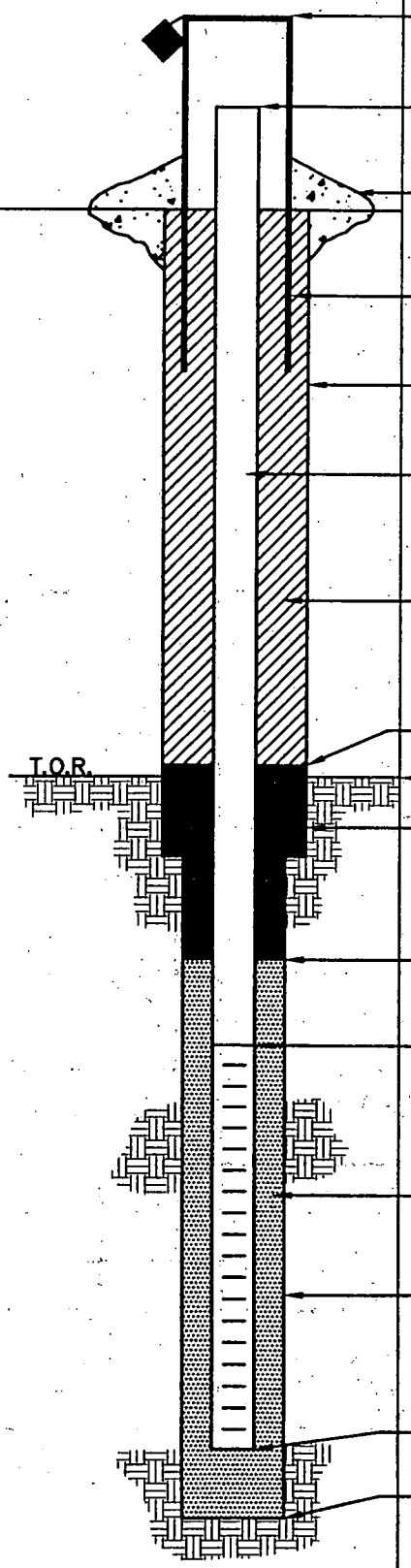
SWMU 01 Boring Logs and Monitoring Well Construction Diagrams

WELL NO.: 01T06

Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT NSWC CRANE	LOCATION SWMU 1(MGB6)	DRILLER JOE McCLOUD
PROJECT NO. 0845	BORING 01T06	DRILLING METHOD ROTO-SONIC
DATE BEGUN 1-14-04	DATE COMPLETED 1-15-04	
FIELD GEOLOGIST FRED W RAMSER		DEVELOPMENT METHOD BAILER
GROUND ELEVATION 674.89	DATUM NAVD 88	



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: 677.13/2.24

ELEVATION/HEIGHT TOP OF RISER: 677.06/2.17

TYPE OF SURFACE SEAL: CONCRETE

I.D. OF SURFACE CASING: 4"x4" SQ.

DIAMETER OF HOLE: 7" TO 10', 5" FROM 10' TO 30'

RISER PIPE I.D.: 2"
TYPE OF RISER PIPE: SCH 40 PVC

TYPE OF BACKFILL: BENTONITE CHIPS "PURE GOLD" GEL

ELEVATION/DEPTH TOP OF SEAL: 672.89/2'

ELEVATION/DEPTH TOP OF BEDROCK: 667.89/7'

TYPE OF SEAL: BENTONITE CHIPS "PURE GOLD" GEL

ELEVATION/DEPTH TOP OF SAND: 658.89/16'

ELEVATION/DEPTH TOP OF SCREEN: 655.89/19'
TYPE OF SCREEN: SCH 40 PVC
SLOT SIZE x LENGTH: 0.020 x 10'
I.D. SCREEN: 2"

TYPE OF SAND PACK: GLOBAL QTZ

DIAMETER OF HOLE IN BEDROCK:
CORE/REAM: 5"

ELEVATION/DEPTH BOTTOM SCREEN: 645.89/29'
ELEVATION/DEPTH BOTTOM OF SAND: 644.89/30'
ELEVATION/DEPTH BOTTOM OF HOLE: 644.89/30'
BACKFILL MATERIAL BELOW SAND: NONE

ACAD: FORM_MWINBR.dwg 07/20/99 INL

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: Crane NSWC
PROJECT NUMBER: 0845
DRILLING COMPANY: BOWSER-MORNER
DRILLING RIG: VERSA-SONIC

BORING No.: 01T06
DATE: 1-15-04
GEOLOGIST: FRED W RAMSER
DRILLER: JOE

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
						DK BRN							
						YEL	SILT + CLAY	CL		0	0	0	0
						BRN							
										0	0	0	0
	7												
					MED SOFT		WEATHERED BORE	V.BR	NO STAINING				
S-1		20%					ROCK FRAGS, SANDSTONE		FLUTE				
	10		3/3				SILTY						
					MED	BLK	SANDY SILTSTONE	BR	NO STAINING				
					HARD	YEL BRN	ORG BRN f.g FINE LAMINATED		FLUTE	0			0
					TO	GREY	POORLY BEDDED						
					MED SOFT		VARIEGATED						0
							SLIGHT WEATHERED						
S-2		50%								0			0
													0
										0			
	20		10/10										
					MED SOFT		AS ABOVE	V.BR	NO STAINING				
									FLUTE	0			
S-3		50%											
	25		5/5							0			

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm):

Remarks: USING FLUTE LINER FOR VOC/PRODUCT DETECTION
PHOTO # 547

Converted to Well: Yes ✓ No _____ Well I.D. #: 01T06

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: Crane NSWC
PROJECT NUMBER: 0845
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: VERSA-SONIC

BORING No.: 01T06
DATE: 1-15,16-04
GEOLOGIST: FRED WRAMSER
DRILLER: JOE McCLOUD

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	26				MED SOFT		AS ABOVE	BR	NO STAIN ON FLUTE	0			
									WL = 20' BGS				
S-4		0%							1-16-04 (OVER	0			
									NIGHT)				
	30		2/4		MED HARD	GREY	MUDSTONE						
						LT GREY							
							INSTALL						
							WELL						
							19 - 29 SCREEN						
							16 - 20 SAND						
							3' - 16' BENTONITE						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm):

Remarks: USING FLUTE LINER FOR VOC/PRODUCT DETECTION

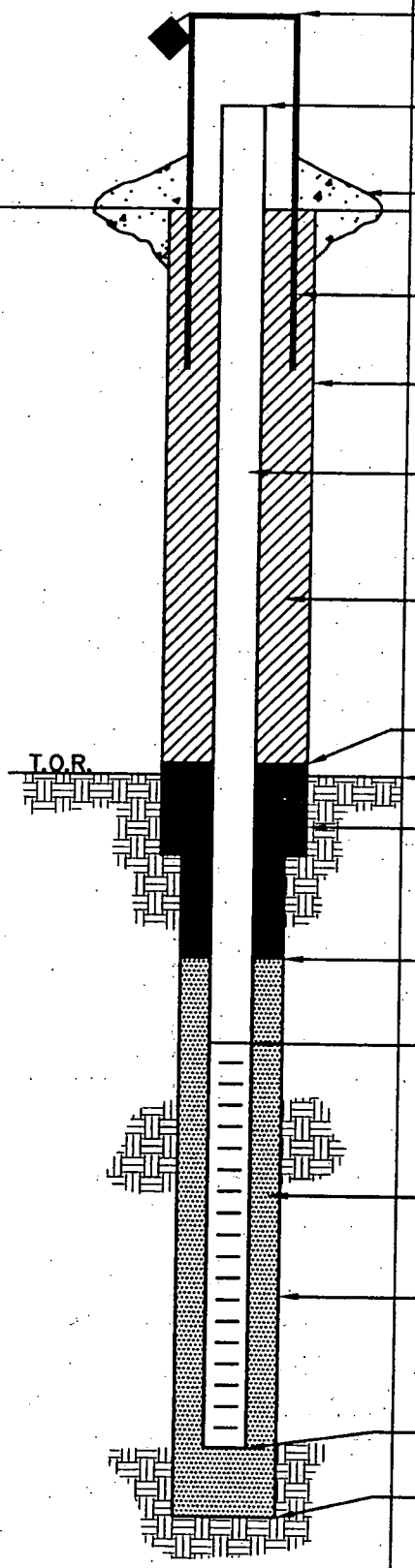
Converted to Well: Yes ✓ No ____ Well I.D. #: 01T06

WELL NO.: 01T07

Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT NSWC CRANE	LOCATION SWMU 1	DRILLER JOE McCLOUD
PROJECT NO. 0845	BORING 01T07	DRILLING METHOD ROTO-SONIC
DATE BEGUN 1-17-04	DATE COMPLETED 1-17-04	DEVELOPMENT METHOD BAILER
FIELD GEOLOGIST FRED WRAMSER		
GROUND ELEVATION 671.73	DATUM NAVD 88	



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: 673.88/2.15

ELEVATION/HEIGHT TOP OF RISER: 673.47/1.74

TYPE OF SURFACE SEAL: CONCRETE

I.D. OF SURFACE CASING: 4" x 4" SQ STEEL

DIAMETER OF HOLE: 7" TO 10', 5" FROM 10' TO 30'

RISER PIPE I.D.: 2"
TYPE OF RISER PIPE: SCH 40 PVC

TYPE OF BACKFILL: BENTONITE CHIPS "PURE GOLD" GEL.

ELEVATION/DEPTH TOP OF SEAL: 669.73/2'

ELEVATION/DEPTH TOP OF BEDROCK: 663.73/8'

TYPE OF SEAL: BENTONITE CHIPS PURE GOLD GEL

ELEVATION/DEPTH TOP OF SAND: 655.73/16'

ELEVATION/DEPTH TOP OF SCREEN: 652.73/19
TYPE OF SCREEN: PVC SCH 40
SLOT SIZE x LENGTH: 0.020 x 10'
I.D. SCREEN: 2"

TYPE OF SAND PACK: GLOBAL QTZ SAND "17C" ~10/20 MED SAND

DIAMETER OF HOLE IN BEDROCK:
CORE/REAM: 5"

ELEVATION/DEPTH BOTTOM SCREEN: 642.73/29
ELEVATION/DEPTH BOTTOM OF SAND: 641.73/30
ELEVATION/DEPTH BOTTOM OF HOLE: 641.73/30
BACKFILL MATERIAL BELOW SAND: NONE

ACAD:FORM_MWINBR.dwg 07/20/99 INL

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: Crane NSWC
PROJECT NUMBER: 0845
DRILLING COMPANY: BOWSER - MORNER
DRILLING RIG: VERSA-SONIC

BORING No.: 01T07
DATE: 1-17-04
GEOLOGIST: FRED W RAMSER
DRILLER: JOE McCLOUD

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DKBRN							
							YEL BRN			2.2			
							SILT +		*RAD = 80x10^+2			0	
							CLAY						
	5									3.5			
										25		0	
						YEL	STRONGLY						
	10					BRN	WEATHERED SANDSTONE			3.0		0	
					SOFT	YEL BRN	SANDY SILTSTONE	V.BR		2.5		2.5	
							INTERLAYERED		*RAD = 80x10^+2				
							W/MED. BRN		NO STAINING				
							SILTY SANDSTONE	V.BR	ON FLUTE				
S-1	15	0%					WEATHERED		LINER				
										3		3	
							GRADES TO						
							SANDSTONE		*RAD = 80x10^+2				
	20		10.0 / 10.0							5		2.5	
					SOFT	BRN	SANDSTONE	YBR	DUE TO				
							INTERLAYED		RAIN PID				
							W/SILTSTONE		MALFUNCTIONING				
S-2		0%					+ CLAYSTONE		NO STAINING				
	25						WEATHERED		ON FLUTE LINER				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 2.5

Remarks: USING FLUTE LINERS ON CORES. *BG = 80x10^+2
ROTO-SONIC RIG, RAIN CAUSES FALSE POSITIVES ON PID
DRILLING METHOD STRONGLY DISTURBS CORE, NOTE RQD = 0%

Converted to Well: Yes ✓ No _____ Well I.D. #: 01T07

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: Crane NSWC
PROJECT NUMBER: 0845
DRILLING COMPANY: BOWSER-MORNER
DRILLING RIG: VERSA-SONIC

BORING No.: 01T07
DATE: 1-17-04
GEOLOGIST: FRED W RAMSER
DRILLER: JOE McCLOUD

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
					MED SOFT		SANDSTONE	V.B	NO STAINING				
					↓		INTERLAYER W/ SILT	↓	ON FLUTE				
							↓		LINER.				
					SOFT		VERIEGATED SILTSTONE	BR					
	30		10/10				↓ LAMINATIONS ALT. BLK, GREY + ORN BRN	↓					
							INSTALLED WELL						
							SCREEN: 19.-29.						
							SAND 16. -30						
							BENTONITE: 3' - 16						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: RAN PHOTO LOC # 546

Drilling Area Background (ppm):

Converted to Well: Yes ✓ No _____ Well I.D. #: 01T07

B.1.2

SWMU 01 Test Pits and Radiation logs

TEST PIT LOG

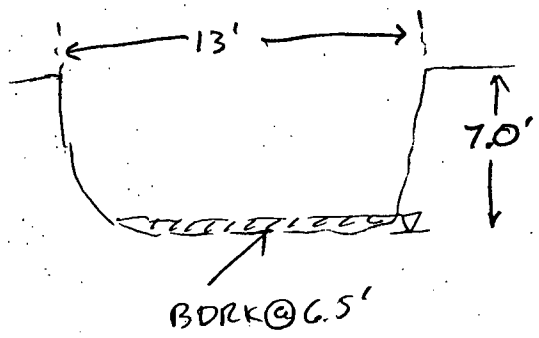
Tetra Tech NUS, Inc.

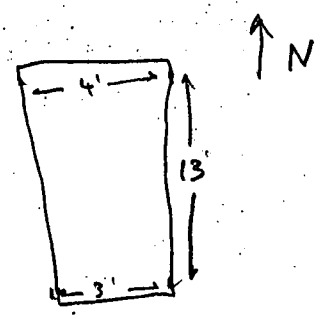
PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N0845
LOCATION: SWMU 01 / MGBG

TEST PIT No.: 01TP01
DATE: 1-14-09
GEOLOGIST: Fred Ramser

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING Source (ppm)	PID/FID READING BZ (ppm)
		DK BRN SILTY SAND W TR CLAY	CL/SC	TOP SOIL	0	0
2		YEL BRN CLAY + SILT MOTTLED GREY	CL		0	0
				B3 ~ 2.5' BGS	0	0
4		RELIC BEDROCK LAMINATIONS/LAYERS 3.5'		B5 ~ 3.5'-4.0'	0	0
		LGT YEL BRN SANDY SILT TR CLAY		MOIST	0	0
6		WEATHERED BDRK SILTY SAND + CLAY	CL/SS	IN 6 ~ 6'	0	0
				TOP OF RK @ 6.5'	0	0
		NO ELEVATED RAD + VOCS READINGS COLLECTED SOIL @ 6'-7' @ 1530		H_2O IN HOLE @ 6.8'-7.0' BGS		

TEST PIT CROSS SECTION AND / OR PLAN VIEW





REMARKS:

PHOTO LOG: 528 + 529 FACING NORTH TP1, 530 SIDE VIEW

TEST PIT LOG

Tetra Tech NUS, Inc.

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N0845
LOCATION: SWMU 01 / MGBG

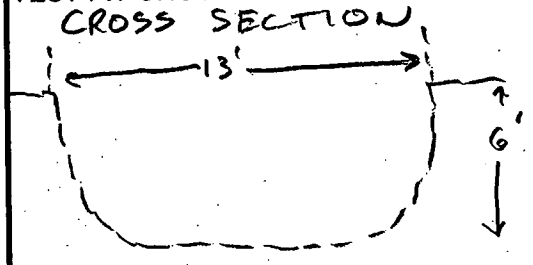
TEST PIT No.: 01TP02
DATE: 1-14-04
GEOLOGIST: Fred Ramser

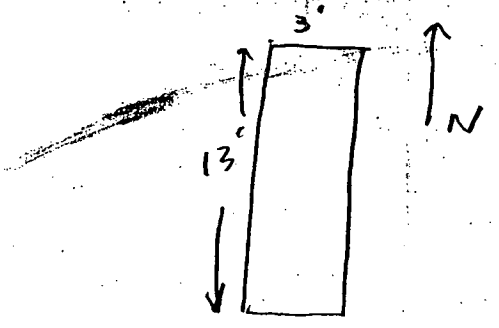
Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING: Source (ppm)	PID/FID READING: BZ (ppm)
				1E: 0.5	0	0
2		YEL BRN SILT + CLAY TR fg SAND	CL	1W: 0.5	0	0
		MOTTLED GREY		2E+W ~ 1.5-2.0	0	0
4		RELIC LAMINATIONS (STRONGLY		3E+W ~ 3.0	0	0
		WEATHERED & DRK ~ 4'		6E+6W @ ~5'	0	0
6		YEL BRN, ORANGE, GREY MOTTLED	CL/SC	BED ROCK @ 6'	0	0
				BEGIN TO BACKFILL @ 1435		

TEST PIT CROSS SECTION AND / OR PLAN VIEW

START TEST PIT @ 1400 HRS

CROSS SECTION





REMARKS: COLLECTED SPL @ 6' TOP OF ROCK MOIST
NO H_2O IN HOLE

PHOTO LOG: #1 + #2 [1 = FACING SOUTH 526 N→SOUTH ORIENTATION] 2 = FACING WEST

TEST PIT LOG

Tetra Tech NUS, Inc.

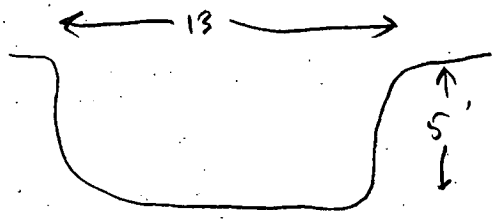
PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N0845
LOCATION: SWMU 01 / MGBG

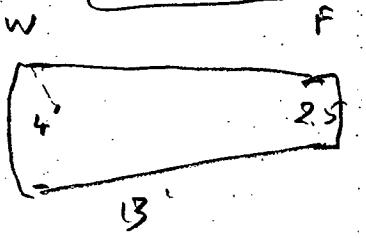
TEST PIT No.: 01TP03
DATE: 1-15-04
GEOLOGIST: Fred Ramser

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING: Source (ppm)	PID/FID READING: BZ (ppm)
		DK BRN SILT + CLAY TR SAND	cl/sc	TOPSOIL	0	0
2		YEL BRN SILT + CLAY	CL	2IV + 2S @ 2'	0	0
		YEL BRN MOTTLED GREY SILT			0	0
4		+ CLAY TR GRAVEL SAND			0	0
		BRD ROCK @ 4-4.			0	0
6	TD @ 5'					
		NO SAMPLE COLLECTED FROM THIS TESTPIT FOR LAB. ANALYSIS.				

TEST PIT CROSS SECTION AND / OR PLAN VIEW

START @ 0935
FINISH BACKFILLING @ 1015





REMARKS:

PHOTO LOG: 535 FACING W., 536 SOUTH WALL

TEST PIT LOG

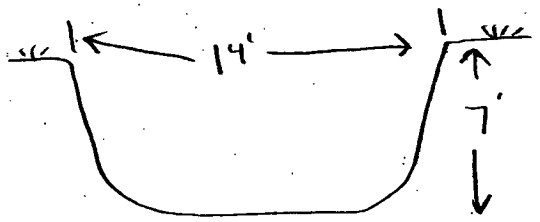
Tetra Tech NUS, Inc.

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N0845
LOCATION: SWMU 01 / MGBG

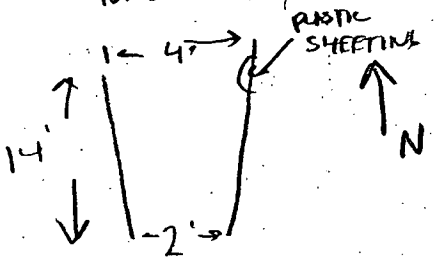
TEST PIT No.: 01TP04
DATE: 1-14-04
GEOLOGIST: Fred Ramser

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING: Source (ppm)	PID/FID READING: BZ (ppm)
		DK BRN SILT+CLAY+SAND TOPSOIL	CL	EI+NI 1~1' MOIST	0	0
2		YEL BRN SILT+CLAY LESS SAND	CL	MOIST	0	0
		GREY MOTTLING		CLEAR PLASTIC SHEETING BNC	0	0
4				ON EAST WALL @ 2'	0	0
				ES+WS @ 5'	0	0
6		WEATHERED BDRK	CL/SC		0	0
7		BDRK @ 6.5 SANDSTONE		IRON STAINED	0	0
	TD			YEL ORG + BRN		

TEST PIT CROSS SECTION AND / OR PLAN VIEW



START PIT @ 1610
END DIGGING 1640
BEGIN TO BACKFILL



REMARKS:

PHOTO LOG: 531 FACING NORTH, 532 FACING EAST

TEST PIT LOG

Tetra Tech NUS, Inc.

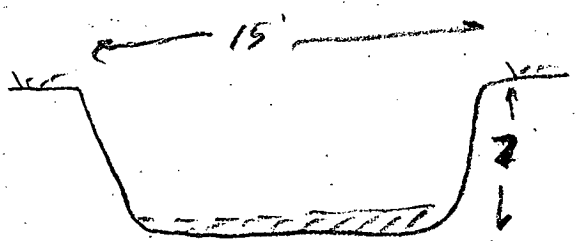
PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N0845
LOCATION: SWMU 01 / MGBG

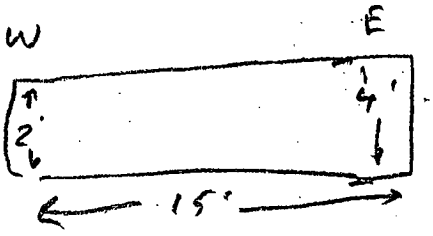
TEST PIT No.: 01TP05
DATE: 1-15-04
GEOLOGIST: Fred Ramser

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING Source (ppm)	PID/FID READING BZ (ppm)
		DK BRN SILT CLAY + SAND		TOP SOIL	0	0
2		SILT + CLAY YEL BRN MOTTLED		MOIST	0	0
		GREY		N3/S3 @ 2.5'	0	0
4				N5/S5 @ 4.0'	0	0
				N7/N8 @ 6'	0	0
6		ORG REDDISH BRN STRONGLY WEATHERED			0	0
7		BED ROCK CLASTS OF S.S.		N9 @ 7'	0	0
	TD @ 7'					
		NO H_2O IN HOLE				
				COLLECT SPL @ 915		

TEST PIT CROSS SECTION AND / OR PLAN VIEW

START @ 846
BEGIN TO BACKFILL @ 0920





REMARKS:

PHOTO LOG: 533 (1) FACING W 534 (2) FACING SOUTH

TEST PIT LOG

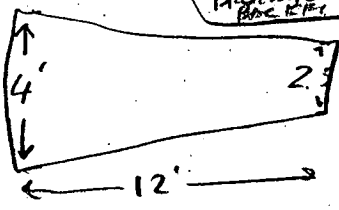
Tetra Tech NUS, Inc.

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N0845
LOCATION: SWMU 01 / MGBG

TEST PIT No.: 01TP06
DATE: 1-15-04
GEOLOGIST: Fred Ramser

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING: Source (ppm)	PID/FID READING: BZ (ppm)
		DK BRN SILT + CLAY TR SAND	SC/CL		0	0
2		YELLOW BRN SILT + CLAY	CL	N2/62@2'	0	0
		MOTTLED GREY			0	0
4		↓	↓		0	0
		SAND STONE CLASTS			0	0
6					0	0
		TD @ 6' NO H_2O IN HOLE				
				COLLECTED		
				SPL 1050		
				01TP060506		

TEST PIT CROSS SECTION AND / OR PLAN VIEW



START 1030
BACKFILLED 1055
END BF @ 1110.

REMARKS:

PHOTO LOG: 537 FACING WEST, 538 SOUTH WALL

TEST PIT LOG

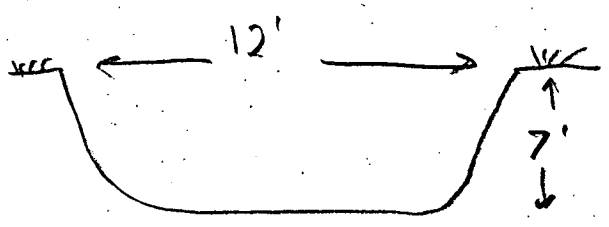
Tetra Tech NUS, Inc.

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N0845
LOCATION: SWMU 01 / MGBG

TEST PIT No.: 01TP07
DATE: 1-15-04
GEOLOGIST: Fred Ramser

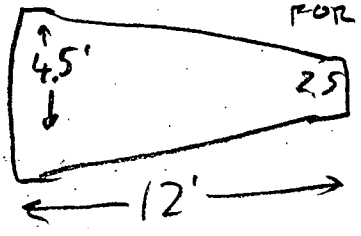
Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING: Source (ppm)	PID/FID READING: BZ (ppm)
		DK BRN SILT + CLAY + SAND	CL/SC		0	0
2		YEL BRN SILT + CLAY	CL		0	0
		MOTTLED GREY			0	0
4				N4+S4 @ 3.5'	0	0
				N5+S5 @ 4'	0	0
6				MOIST	0	0
		YEL BRN, ORN BRN SILT + CLAY + SAND	CL/SC	NO H_2O IN	0	0
	7'	TD @ 7' BED ROCK @ 7'		HOLE		
		NO SAMPLE COLLECTED				
		FOR LAB. ANALYSIS				

TEST PIT CROSS SECTION AND / OR PLAN VIEW



START @ 1115
BEGIN BACKFILL @ 1150
FINNISH BACKFILL 1200

DRILLERS BREAK FOR LUNCH 1205



REMARKS:

PHOTO LOG: 539 FACING WEST 540 SOUTH WALL

TEST PIT LOG

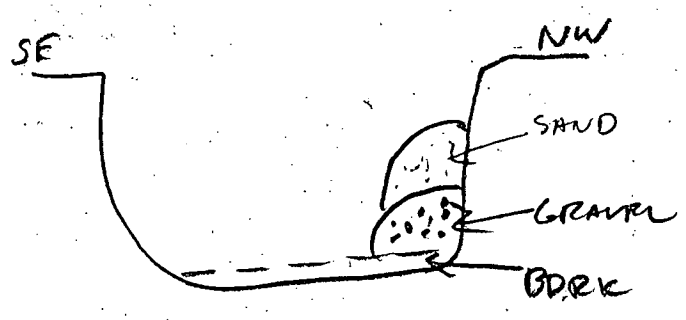
Tetra Tech NUS, Inc.

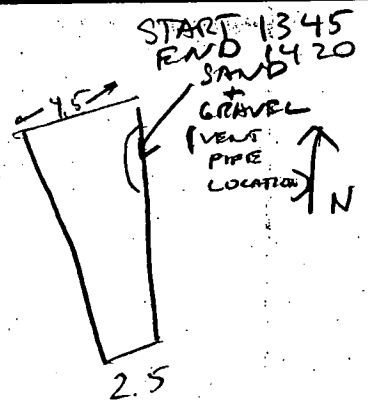
PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N0845
LOCATION: SWMU 01 / MGBG

TEST PIT No.: 01TP08
DATE: 1-15-04
GEOLOGIST: Fred Ramser

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING: Source (ppm)	PID/FID READING: BZ (ppm)
		DK BRN SILT + CLAY	CL		0	0
2					0	0
		MED SAND AT NORTHERN END	CL/SC	NO PID	0	0
4		GRAVEL NORTHEAST WALL 6	SP	HITS AT SAND	0	0
		WEATHERED BDRK CLAY + SILT	GW	(4½ SW/NW)	0	0
6		TR SAND	GP	WHT SILTY	0	0
		BEDROCK @ 6' SANDSTONE		MATERIAL		
		H_2O IN HOLE, COMING				
		IN FROM SAND/GRAVEL VENT				
		PIPE SUMP?				

TEST PIT CROSS SECTION AND / OR PLAN VIEW





REMARKS: TEST PIT DUG AT "VENT PIPE" LOCATION

PHOTO LOG: FACING NW 541 + 542, 543 DOWNWARD

DIGGING PERMIT
NSWC CRANE 11000/3 (REV. 8/02)

4343

REQUESTED BY: Tetra Tech NVS, Inc. Tom Brent 6160

DATE: 10/16/03

WORK REQUEST ON E/S NO.: 108127

SWMU 01 Mustard Gas Burial Ground

WORK WILL BE PERFORMED BY: Tetra Tech NVS, Inc. / Dr. Tom Johnston

DATE (Start - on or about): 10/23/03

WORK DESCRIPTION: Soil Borings to obtain surface & subsurface samples at SWMU 01 Mustard Gas Burial Ground

EQUIPMENT TYPE

☐ HAND TOOLS ☐ CORE DRILL ☐ TRENCHER ☐ BACKHOE ☐ HEAVY EQUIPMENT

UNDERGROUND UTILITIES LOCATED IN WORK SITE

UTILITY	PRESENT	MARKED	NOT LOCATED	REMARKS
COMPRESSED AIR	N/A			10/16/03 dg
HIGH VOLTAGE ELECTRICAL	N/A			10/16/03 RAT
FIRE ALARM	N/A			10/16/03 SL
GROUNDING	N/A			10/16/03 SL
NATURAL GAS	N/A			10/16/03 dg
SECURITY ALARM	N/A			10/16/03 SL
SEWER	N/A			10/16/03 SL
STEAM	N/A			10/16/03 SL
TELEPHONE	N/A			10/16/03 SL
WATER	N/A			10/16/03 SL
SECOND ELECTRICAL	NA			10/16/03 RAT
GENERAL DYNAMICS/NMCI	N/A			10/16/03 dg

In addition to the general precautions for excavating where underground utilites are present, comply with the following:

PERMIT HOLDER SIGNATURE: [signature] DATE: 10/20/03

DIGGING PERMIT APPROVED BY: Donna L. Zollman DATE: 10/20/03

DISTRIBUTION:

ORIGINAL - Code 09Z5 File
YELLOW - Supv. At work site
PINK - Permit requestor

DIGGING PERMIT
NSWC CRANE 11000/3 (REV. 8/02)

4343

REQUESTED BY: Tetra Tech NVS, Inc. Tom Brent 6160	DATE: 10/16/03
WORK REQUEST ON E/S NO.: 108127	SWMU 01 Mustard Gas Burial Ground
WORK WILL BE PERFORMED BY: Tetra Tech NVS, INC. / Dr Tom Johnston	DATE (Start - on or about): 10/23/03

WORK DESCRIPTION:
Soil Borings to obtain surface & subsurface samples at SWMU 01 Mustard Gas Burial Ground

EQUIPMENT TYPE
- [ ] HAND TOOLS
- [ ] CORE DRILL
- [ ] TRENCHER
- [ ] BACKHOE
- [ ] HEAVY EQUIPMENT

UNDERGROUND UTILITIES LOCATED IN WORK SITE

UTILITY	PRESENT	MARKED	NOT LOCATED	REMARKS
COMPRESSED AIR	N/A			10/16/03 dg
HIGH VOLTAGE ELECTRICAL	N/A			10/16/03 RKK
FIRE ALARM	N/A			
GROUNDING	N/A			
NATURAL GAS	N/A			10/16/03 dg
SECURITY ALARM	N/A			
SEWER	N/A			
STEAM	N/A			
TELEPHONE	N/A			
WATER	N/A			
SECOND ELECTRICAL	NA			10/16/03 RKK
GENERAL DYNAMICS/NMCI	NA			10/16/03 dg

In addition to the general precautions for excavating where underground utilites are present, comply with the following:

PERMIT HOLDER SIGNATURE: [signature]	DATE: 10/20/03
DIGGING PERMIT APPROVED BY: Donna L. Zollman	DATE: 10/20/03

DISTRIBUTION:

ORIGINAL - Code 09Z5 File
YELLOW - Supv. At work site
PINK - Permit requestor

DIGGING PERMIT
NSWC CRANE 11000/3 (REV. 8/02)

4343

REQUESTED BY: Tetra Tech NVS, Inc. Tom Brent 6160

DATE: 10/16/03

WORK REQUEST ON E/S NO.: 08127

SWMU 01 Mustard Gas Burial Ground

WORK WILL BE PERFORMED BY: Tetra Tech NVS, Inc. / Dr. Tom Johnston

DATE (Start - on or about): 10/23/03

WORK DESCRIPTION: Soil Borings to obtain surface & subsurface samples at SWMU 01 Mustard Gas Burial Ground

EQUIPMENT TYPE

- [ ] HAND TOOLS
- [ ] CORE DRILL
- [ ] TRENCHER
- [ ] BACKHOE
- [ ] HEAVY EQUIPMENT

UNDERGROUND UTILITIES LOCATED IN WORK SITE

UTILITY	PRESENT	MARKED	NOT LOCATED	REMARKS
COMPRESSED AIR	N/A			10/16/03 dg
HIGH VOLTAGE ELECTRICAL	N/A			10/16/03 KMT
FIRE ALARM	N/A			10/16/03 SL
GROUNDING	N/A			10/16/03 SL
NATURAL GAS	N/A			10/16/03 dg
SECURITY ALARM	N/A			10/16/03 SL
SEWER	N/A			10/16/03 SL
STEAM	N/A			10/16/03 SL
TELEPHONE	N/A			10/16/03 SL
WATER	N/A			10/16/03 SL
SECOND ELECTRICAL	NA			10/16/03 RAQ
GENERAL DYNAMICS/NMCI	N/A			10/16/03 dg

In addition to the general precautions for excavating where underground utilites are present, comply with the following:

PERMIT HOLDER SIGNATURE: [signature] DATE: 10/20/03

DIGGING PERMIT APPROVED BY: Donna L. Zollman DATE: ~~10/20/03~~ 1/12/04

DISTRIBUTION:

ORIGINAL - Code 09Z5 File
YELLOW - Supv. At work site
PINK - Permit requestor

RADIATION LOG SCREENING SHEET

PAGE 1 OF 1

PROJECT: NSWC CRANE **PROJECT #:** 0845 **SITE:** MGBG **TEST PIT ID:** OITP01

Analyst FRED W RAMSER Date 1-14-04

Source Check:
Radionuclide: Cs-137 S/N: NA
Activity (dpm): — on — (Date)
4uR/h

γ Ratemeter Calibration:
Model: LUDLUM #12
S/N: 102818
Cal. due date: 6-27-04

Probe γ):
Model: LUDLUM 44-10
S/N: PR150784

Backgrounds Determined on: 1-14-04 **(Date)**

Background Readings (Gamma)
#1 (γ): $100 \times 10^{+2}$ cpm
#2 (γ): $100 \times 10^{+2}$ cpm
#3 (γ): $70 \times 10^{+2}$ cpm
Average Background (γ) = $90 \times 10^{+2}$ cpm (=[#1 + #2 + #3)]/3)

γ Instrument Efficiency, Eff (cpm/dpm x 100%): NA Percent

SOIL SAMPLE SCREENING FOR DETERMINING RADIOACTIVITY STATUS

A	B	C	A	B	C
SAMPLE ID /BUCKET #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)	Sample ID /Bucket #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)
E1	$80 \times 10^{+2}$	BELOW BG	W7	$90 \times 10^{+2}$	@ BG
W1	$80 \times 10^{+2}$	" "	E8	$90 \times 10^{+2}$	" "
E2	$80 \times 10^{+2}$	" "			
W2	$90 \times 10^{+2}$	@ BG			
~2.5' E3	$90 \times 10^{+2}$	" "			
W3	$90 \times 10^{+2}$	" "			
E4	$90 \times 10^{+2}$	" "			
W4	$90 \times 10^{+2}$	" "			
E5	$90 \times 10^{+2}$	" "			
W5	$90 \times 10^{+2}$	" "			
E6	$90 \times 10^{+2}$	" "			
W6	$90 \times 10^{+2}$	" "			
E7	$90 \times 10^{+2}$	" "			

Reviewed by: T. ROJAHN **Title:** FOL **Date:** 3/4/04

IDENTIFICATION OF SAMPLE COLLECTED FOR LABORATORY ANALYSIS: NA

NOTE: @BG = at background

100304/P

CTO 0315

RADIATION LOG SCREENING SHEET

PAGE 1 OF 1

PROJECT: NSWC CRANE **PROJECT #:** 0845 **SITE:** MGBG **TEST PIT ID:** 01TP02

Analyst FRED W RAMSER Date 1-14-04

Source Check:
Radionuclide: Cs^{137} S/N: NA
Activity (~~dpm~~): 4μCi on - (Date)

γ Ratemeter Calibration:
Model: LUDLUM #12
S/N: 102818
Cal. due date: 6-27-04

Probe γ):
Model: LUDLUM 44-10
S/N: PR150784

Backgrounds Determined on: 1-14-04 (Date)

Background Readings (Gamma)
#1 (γ): $100 \times 10^{+2}$ cpm
#2 (γ): $100 \times 10^{+2}$ cpm
#3 (γ): $70 \times 10^{+2}$ cpm
Average Background (γ) = $90 \times 10^{+2}$ cpm (=[#1 + #2 + #3)]/3)

γ Instrument Efficiency, Eff (cpm/dpm x 100%): NA Percent

SOIL SAMPLE SCREENING FOR DETERMINING RADIOACTIVITY STATUS

A	B	C	A	B	C
SAMPLE ID /BUCKET #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)	Sample ID /Bucket #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)
#1E	$80 \times 10^{+2}$	Below BG	7E	$80 \times 10^{+2}$	Below BG
#1W	$90 \times 10^{+2}$	@ BG			
#2E	$100 \times 10^{+2}$	$10 \times 10^{+2}$			
#2W	$95 \times 10^{+2}$	$5 \times 10^{+2}$			
3E	$100 \times 10^{+2}$	$10 \times 10^{+2}$			
3W	$100 \times 10^{+2}$				
3Wa	$100 \times 10^{+2}$				
4E	$100 \times 10^{+2}$				
4W	$100 \times 10^{+2}$				
5E	$80 \times 10^{+2}$	Below BG			
5W	$90 \times 10^{+2}$	@ BG			
6E	$80 \times 10^{+2}$	Below BG			
6W	$80 \times 10^{+2}$	" "			

Reviewed by: T. Rolahn Title: FOC Date: 3/4/04

IDENTIFICATION OF SAMPLE COLLECTED FOR LABORATORY ANALYSIS: NA

Note: @ BG = At Background

RADIATION LOG SCREENING SHEET

PAGE 1 OF 1

PROJECT: NSWC CRANE PROJECT #: 0845 SITE: MGBG TEST PIT ID: 01TP03

Analyst FRED W RAMSER Date 1-15-04

Source Check:
Radionuclide: Cs 137 S/N: NA
Activity (dpm): 4 upc on — (Date)

γ Ratemeter Calibration:
Model: LUDLUM #12
S/N: 102818
Cal. due date: 6-27-04

Probe γ):
Model: LUDLUM 44-10
S/N: PR 150784

Backgrounds Determined on: 1-15-04 (Date)

Background Readings (Gamma)
#1 (γ): $100 \times 10^{+2}$ cpm
#2 (γ): $100 \times 10^{+2}$ cpm
#3 (γ): $60 \times 10^{+2}$ cpm
Average Background (γ) = $87 \times 10^{+2}$ cpm (=[#1 + #2 + #3)]/3)

γ Instrument Efficiency, Eff (cpm/dpm x 100%): NA Percent

SOIL SAMPLE SCREENING FOR DETERMINING RADIOACTIVITY STATUS

A	B	C	A	B	C
SAMPLE ID /BUCKET #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)	Sample ID /Bucket #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)
1N	$80 \times 10^{+2}$	BELOW BG			
1S	$90 \times 10^{+2}$	$3 \times 10^{+2}$			
2N	$90 \times 10^{+2}$	$3 \times 10^{+2}$			
2S	$90 \times 10^{+2}$	$3 \times 10^{+2}$			
3N	$90 \times 10^{+2}$	$3 \times 10^{+2}$			
3S	$90 \times 10^{+2}$	$3 \times 10^{+2}$			
4N	$90 \times 10^{+2}$	$3 \times 10^{+2}$			
4S	$90 \times 10^{+2}$	$3 \times 10^{+2}$			
5N	$90 \times 10^{+2}$	$3 \times 10^{+2}$			
5S	$90 \times 10^{+2}$	$3 \times 10^{+2}$			
6N	$95 \times 10^{+2}$	$8 \times 10^{+2}$			

Reviewed by: T. ROJAHN Title: FOL Date: 3/4/04

IDENTIFICATION OF SAMPLE COLLECTED FOR LABORATORY ANALYSIS: NA

Note: BG = Background

RADIATION LOG SCREENING SHEET

PAGE 1 OF 1

PROJECT: NSWC CRANE **PROJECT #:** 0845 **SITE:** MGBG **TEST PIT ID:** 01TP04

Analyst FREDWRAMSER Date 1-14-04

Source Check:
Radionuclide: Cs-137 S/N: NA
Activity (~~dpm~~): 4μci on – (Date)

γ Ratemeter Calibration:
Model: LUDLUM 12
S/N: 102818
Cal. due date: 6-27-04

Probe γ):
Model: LUDLUM 44-10
S/N: PR150784

Backgrounds Determined on: 1-14-04 **(Date)**

Background Readings (Gamma)
#1 (γ): $100 \times 10^{+2}$ cpm
#2 (γ): $100 \times 10^{+2}$ cpm
#3 (γ): $70 \times 10^{+2}$ cpm
Average Background (γ) = $90 \times 10^{+2}$ cpm (=[#1 + #2 + #3)]/3)

γ Instrument Efficiency, Eff (cpm/dpm x 100%): NA Percent

SOIL SAMPLE SCREENING FOR DETERMINING RADIOACTIVITY STATUS

A	B	C	A	B	C
SAMPLE ID /BUCKET #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)	Sample ID /Bucket #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)
E1	$90 \times 10^{+2}$	@ BG	W7	$80 \times 10^{+2}$	BELOW BG
W1	$90 \times 10^{+2}$	" "	E8	$80 \times 10^{+2}$	" "
E2	$90 \times 10^{+2}$	" "			
W2	$90 \times 10^{+2}$	" "			
E3	$90 \times 10^{+2}$	" "			
W3	$90 \times 10^{+2}$	" "			
E4	$90 \times 10^{+2}$	" "			
W4	$90 \times 10^{+2}$	" "			
E5	$90 \times 10^{+2}$	" "			
W5	$90 \times 10^{+2}$	" "			
E6	$90 \times 10^{+2}$	" "			
W6	$80 \times 10^{+2}$	BELOW BG			
E7	$80 \times 10^{+2}$	" "			

Reviewed by: T. ROJAHN **Title:** FOL **Date:** 3/4/04

IDENTIFICATION OF SAMPLE COLLECTED FOR LABORATORY ANALYSIS: NA

Note: @ BG = at Background

RADIATION LOG SCREENING SHEET

PROJECT: NSWC CRANE **PROJECT #:** 0845 **SITE:** MGBG **TEST PIT ID:** 01TP05

Analyst Fred W. Ramser Date 1-15-04

Source Check:
Radionuclide: Cs-137 S/N: NA
Activity (dpm): 40pi on – (Date)

γ Ratemeter Calibration:
Model: LUDLUM 12
S/N: 102818
Cal. due date: 6-27-04

Probe γ):
Model: LUDLUM 44-10
S/N: PR150784

Backgrounds Determined on: 1-15-04 **(Date)**

Background Readings (Gamma)
#1 (γ): $100 \times 10^{+2}$ cpm
#2 (γ): $100 \times 10^{+2}$ cpm
#3 (γ): $60 \times 10^{+2}$ cpm
Average Background (γ) = $87 \times 10^{+2}$ cpm (=[#1 + #2 + #3)]/3)

γ Instrument Efficiency, Eff (cpm/dpm x 100%): NA Percent

SOIL SAMPLE SCREENING FOR DETERMINING RADIOACTIVITY STATUS

A	B	C	A	B	C
SAMPLE ID /BUCKET #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)	Sample ID /Bucket #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)
N1	$90 \times 10^{+2}$	$3 \times 10^{+2}$	S7	$100 \times 10^{+2}$	$13 \times 10^{+2}$
S1	$100 \times 10^{+2}$	$13 \times 10^{+2}$	N8	$100 \times 10^{+2}$	$13 \times 10^{+2}$
N2	$100 \times 10^{+2}$	$13 \times 10^{+2}$	S8	$100 \times 10^{+2}$	$13 \times 10^{+2}$
S2	$90 \times 10^{+2}$	$3 \times 10^{+2}$	N9	$100 \times 10^{+2}$	$13 \times 10^{+2}$
N3	$90 \times 10^{+2}$	$3 \times 10^{+2}$			
S3	$100 \times 10^{+2}$	$13 \times 10^{+2}$			
N4	$100 \times 10^{+2}$	$13 \times 10^{+2}$			
S4	$100 \times 10^{+2}$	$13 \times 10^{+2}$			
N5	$100 \times 10^{+2}$	$13 \times 10^{+2}$			
S5	$100 \times 10^{+2}$	$13 \times 10^{+2}$			
N6	$100 \times 10^{+2}$	$13 \times 10^{+2}$			
S6	$100 \times 10^{+2}$	$13 \times 10^{+2}$			
N7	$100 \times 10^{+2}$	$13 \times 10^{+2}$			

Reviewed by: T. Rojahn **Title:** FOL **Date:** 3/4/04

IDENTIFICATION OF SAMPLE COLLECTED FOR LABORATORY ANALYSIS: NONE

RADIATION LOG SCREENING SHEET

PAGE 1 OF 1

PROJECT: NSWC CRANE **PROJECT #:** 0845 **SITE:** MGBG **TEST PIT ID:** 01TP06

Analyst FRED W RAMSER Date 1-15-04

Source Check:
Radionuclide: Cs 137 S/N: –
Activity (dpm): 4uci on – (Date)

γ Ratemeter Calibration:
Model: LUDLUM 12
S/N: 102818
Cal. due date: 6-27-04

Probe γ):
Model: LUDLUM 44-10
S/N: PR150784

Backgrounds Determined on: 1-15-04 **(Date)**

Background Readings (Gamma)
#1 (γ): $100 \times 10^{+2}$ cpm
#2 (γ): $100 \times 10^{+2}$ cpm
#3 (γ): $60 \times 10^{+2}$ cpm
Average Background (γ) = $87 \times 10^{+2}$ cpm (=[#1 + #2 + #3)]/3)

γ Instrument Efficiency, Eff (cpm/dpm x 100%): NA Percent

SOIL SAMPLE SCREENING FOR DETERMINING RADIOACTIVITY STATUS

A	B	C	A	B	C
SAMPLE ID /BUCKET #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)	Sample ID /Bucket #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)
N1	$95 \times 10^{+2}$	$8 \times 10^{+2}$			
S1	$95 \times 10^{+2}$	$8 \times 10^{+2}$			
N2	$90 \times 10^{+2}$	$3 \times 10^{+2}$			
S2	$90 \times 10^{+2}$				
N3	$90 \times 10^{+2}$				
S3	$90 \times 10^{+2}$				
N4	$90 \times 10^{+2}$				
S4	$90 \times 10^{+2}$				
N5	$90 \times 10^{+2}$				
S5	$90 \times 10^{+2}$				
N6	$90 \times 10^{+2}$				
S6	$90 \times 10^{+2}$				
N7	$90 \times 10^{+2}$				

Reviewed by: T. ROJAHN **Title:** FOL **Date:** 3/4/04

IDENTIFICATION OF SAMPLE COLLECTED FOR LABORATORY ANALYSIS: NONE

RADIATION LOG SCREENING SHEET

PAGE 1 OF 1

PROJECT: NSWC CRANE **PROJECT #:** 0845 **SITE:** MGBG **TEST PIT ID:** 01TP07

Analyst FRED W Ramsey Date 1-15-04

Source Check:
Radionuclide: Cs137 S/N: –
Activity (dpm): 4 uci on – (Date)

γ Ratemeter Calibration:
Model: LUDLUM 12
S/N: 102818
Cal. due date: 6-27-04

Probe γ):
Model: LUDLUM 44-10
S/N: PR150784

Backgrounds Determined on: 1-15-04 **(Date)**

Background Readings (Gamma)
#1 (γ): $100 \times 10^{+2}$ cpm
#2 (γ): $100 \times 10^{+2}$ cpm
#3 (γ): $60 \times 10^{+2}$ cpm
Average Background (γ) = $87 \times 10^{+2}$ cpm (=[#1 + #2 + #3)]/3)

γ Instrument Efficiency, Eff (cpm/dpm x 100%): NA Percent

SOIL SAMPLE SCREENING FOR DETERMINING RADIOACTIVITY STATUS

A	B	C	A	B	C
SAMPLE ID /BUCKET #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)	Sample ID /Bucket #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)
N1	$90 \times 10^{+2}$	$3 \times 10^{+2}$	S7	$90 \times 10^{+2}$	$3 \times 10^{+2}$
S1	$90 \times 10^{+2}$	↓			
N2	$85 \times 10^{+2}$	BELOW BG			
S2	$90 \times 10^{+2}$	$3 \times 10^{+2}$			
N3	$90 \times 10^{+2}$				
S3	$90 \times 10^{+2}$				
N4	$90 \times 10^{+2}$				
S4	$90 \times 10^{+2}$				
N5	$90 \times 10^{+2}$				
S5	$90 \times 10^{+2}$				
N6	$90 \times 10^{+2}$				
S6	$90 \times 10^{+2}$				
N7	$90 \times 10^{+2}$				

Reviewed by: T. ROJAHN **Title:** FOL **Date:** 3/4/04

IDENTIFICATION OF SAMPLE COLLECTED FOR LABORATORY ANALYSIS: NONE

RADIATION LOG SCREENING SHEET

PAGE 1 OF 1

PROJECT: NSWC CRANE **PROJECT #:** 0845 **SITE:** MGBG **TEST PIT ID:** 01TP08

Analyst FRED W. RAMSEY Date 1-15-04

Source Check:
Radionuclide: Cs 137 S/N: –
Activity (dpm): 4μci on – (Date)

γ Ratemeter Calibration:
Model: LUDLUM 12
S/N: 102818
Cal. due date: 6-27-04

Probe γ):
Model: LUDLUM 44-10
S/N: PR150784

Backgrounds Determined on: 1-15-04 **(Date)**

Background Readings (Gamma)
#1 (γ): $100 \times 10^{+2}$ cpm
#2 (γ): $100 \times 10^{+2}$ cpm
#3 (γ): $60 \times 10^{+2}$ cpm
Average Background (γ) = $87 \times 10^{+2}$ cpm (=[#1 + #2 + #3)]/3)

γ Instrument Efficiency, Eff (cpm/dpm x 100%): NA Percent

SOIL SAMPLE SCREENING FOR DETERMINING RADIOACTIVITY STATUS

A	B	C	A	B	C
SAMPLE ID /BUCKET #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)	Sample ID /Bucket #	Sample (γ), cpm	Net Sample (γ), cpm: (Column B) – Background (γ)
N1	$90 \times 10^{+2}$	$3 \times 10^{+2}$			
S1	$90 \times 10^{+2}$				
N2	$90 \times 10^{+2}$				
S2	$90 \times 10^{+2}$				
N3	$90 \times 10^{+2}$				
S3	$90 \times 10^{+2}$				
N4	$90 \times 10^{+2}$				
S4	$90 \times 10^{+2}$				
N5	$90 \times 10^{+2}$				
S5	$90 \times 10^{+2}$				
N6	$90 \times 10^{+2}$				

Reviewed by: T. ROJAHN **Title:** FOL **Date:** 3/4/04

IDENTIFICATION OF SAMPLE COLLECTED FOR LABORATORY ANALYSIS: NONE

B.1.3

SWMU 01 Monitoring Well Materials Certificates of Conformance

FLAME TOOL/HOT WORK PERMIT
NSWC CRANE 11320/19 (REV. 1-02)

ITEM	FROM	TO	ISSUED TO
EFFECTIVE DATES	1-14-04	1-25-04	☐ NSWC ☐ CAAA ☑ CONTRACTOR ☐ TENANT
			NAME OF TRADE/CONTRACTOR/TENANT ACTIVITY: TETRA-TEC

TYPE OF EQUIPMENT TO BE USED *(Cutting Torch, Arc Welder, etc.)*

GASOLINE MOTORS, TORCH DIESEL MOTORS

PURPOSE OF USE

TOST FOR MUSTARD GAS / DIBBIRD

WHERE USED *(Building/Structure/Other location)*

HWY 351 MUSTARD GAS AREA

☐ INSIDE
☑ OUTSIDE

INSTRUCTIONS OF THE FIRE SUPPRESSION/PREVENTION BRANCH, FIRE DEPARTMENT

☑ GENERAL FIRE PREVENTION INSTRUCTIONS ON REVERSE SIDE MUST BE COMPLIED WITH.

☑ IN ADDITION TO THE GENERAL FIRE PREVENTION INSTRUCTIONS ON REVERSE SIDE, YOU SHALL COMPLY WITH THE FOLLOWING:

☑ REMOVE ALL COMBUSTIBLES 35 FEET, ALL FLAMMABLE LIQUIDS 50 FEET, AND ALL EXPLOSIVES (UNLESS APPROVED TO STAY BY THE SAFETY DEPARTMENT (CAAA OR NAVY ESO) AND FIRE PREVENTION) 100 FEET FROM THE HOT WORK AREA.

1) FIRE WATCH REQUIRED
2) NO REFUELING OF VEHICLES IN GRASS - MUST BE ON ROAD
3) NO HOT WORK (TORCH) IN GRASS - MUST BE ON ROAD
4) NO SMOKING

PERSON DESIGNATED AS FIRE WATCH *(NOT SAME PERSON AS PERMIT HOLDER)*

REQUIRED FIRE EXTINGUISHER AT WORK SITE		OTHER FIRE PROTECTION STANDBY REQUIREMENT(S)
TYPE	SIZE	
☐ WATER ☐ CO_2 ☑ DRY CHEMICAL	20LB ABC	

I have read, understand and will comply with the above "Instructions of the Fire Suppression/Prevention Branch, Fire Department"

SIGNATURE *(Permit Holder)* — DATE 1-14-04

HAZARDOUS AREAS ONLY

I agree that the "Instructions of the Fire Suppression/Prevention Branch, Fire Department" stated above are adequate and area is safe to work in.

SIGNATURE *(Building Supervisor/Forman/Representative)* — DATE

Permission is hereby granted the Trade/Contractor/Tenant Activity named above to use specified equipment in accordance with the "Instructions of the Suppression/Prevention Branch, Fire Department as stated above.

SIGNATURE *(Fire Department/Representative)* — DATE 1-14-04

DISTRIBUTION: Original *(Code 0631 File)*
Yellow *(Work Site)*

Tetra Tech NUS. Inc.
CERTIFICATE OF CONFORMANCE

Well Designation: 01T06
Site Name: MGBG
Date Installed: 1/15/04
Project Name: NSWC CRANE

Site Geologist: Fred Ramser
Drilling Company: Bowser Morner
Driller: Joe McCloud
Project Number: 0845

Material	Brand/Description	Source/Supplier	Sample Collected ?
Well Casing	Boart Longyear ASTM F480-88A PVC	Global Well Supplies	No
Well Screen 2"X 10'	Boart Longyear ASTM F480-88A PVC	Global Well Supplies	No
End Cap	Boart Longyear	Global Well Supplies	No
Drilling Fluid	Potable water	Bldg. #3245 distribution system	Yes
Drilling Fluid Additives	Not used	NA	NA
Backfill Material			
Annular Filter Pack	Global NSF Qtz Sand SEP/18 B	Global Well Supplies	No
Bentonite Seal	CETCO, Pure Gold Med. Chips NSF	Global Well Supplies	No
Annular Grout	Portland Cement & Baroid Bentonite	Global Well Supplies	No
Surface Cement	Concrete Mix Pak Mix	Global Well Supplies	No
Protective Casing	Prepainted	Global Well Supplies	No
Paint	NA	NA	NA
Rod Lubricant	Jet Lube, Inc. – Well Guard	Global Well Supplies	No
Compressor Oil	-	-	-

To the best of my knowledge, I certify that the above described materials were used during installation of this monitoring well.

Signature of Site Geologist: Fred M Ramser

Tetra Tech NUS. Inc.
CERTIFICATE OF CONFORMANCE

Well Designation: 01T07
Site Name: MGBG
Date Installed: 1/17/04
Project Name: NSWC CRANE

Site Geologist: Fred Ramser
Drilling Company: Bowser Morner
Driller: Joe McCloud
Project Number: 0845

Material	Brand/Description	Source/Supplier	Sample Collected ?
Well Casing	Boart Longyear ASTM F480-88A PVC	Global Well Supplies	No
Well Screen 2"X 10'	Boart Longyear ASTM F480-88A PVC	Global Well Supplies	No
End Cap	Boart Longyear	Global Well Supplies	No
Drilling Fluid	Potable water	Bldg. #3245 distribution system	Yes
Drilling Fluid Additives	Not used	NA	NA
Backfill Material			
Annular Filter Pack	Global NSF Qtz Sand SEP/18 B	Global Well Supplies	No
Bentonite Seal	CETCO, Pure Gold Med. Chips NSF	Global Well Supplies	No
Annular Grout	Portland Cement & Baroid Bentonite	Global Well Supplies	No
Surface Cement	Concrete Mix Pak Mix	Global Well Supplies	No
Protective Casing	Prepainted	Global Well Supplies	No
Paint	NA	NA	NA
Rod Lubricant	Jet Lube, Inc. – Well Guard	Global Well Supplies	No
Compressor Oil	-	-	-

To the best of my knowledge, I certify that the above described materials were used during installation of this monitoring well.

Signature of Site Geologist: Fred Ramser

B.2

Log Sheets and Forms

B.2.1

SWMU 01 Soil Sample Log Sheets (from test pits)

Tetra Tech NUS, Inc.

SOIL SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845 CTO 0315

[] Surface Soil
[X] Subsurface Soil
[] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: 01TP010607
Sample Location: 01TP01
Sampled By: F. Ramser / T. Rojahn
C.O.C. No.: 4384

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date: 1-14-04 Time: 1530 Method: ~~DPT~~ BACKHOE BUCKET Monitor Reading (ppm): 0.0	6'-7'	LIGHT YEL BRN + GREY	SANDY SILT TR CLAY MOIST

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
NA	NA	NA	NA	NA
Method: NA				
Monitor Readings (Range in ppm): NA			VOID	

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
VOCs (8260B)	(3) Encore Samplers x 2.	Yes	✓
Percent Moisture	(1) 2oz. Jars x 2	Yes	✓
Gamma Spectroscopy	(1) 16oz. Jars	~~Yes~~ No	

OBSERVATIONS / NOTES:

Soil Group No. 8

Gamma in sample = 0 cpm

MAP:

See Revised Figure 3-1

Circle If Applicable:

MS/MSD	Duplicate ID No.:
—	01FD01140401

Signature(s): Terry Lagal

Tetra Tech NUS, Inc.

SOIL SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845 CTO 0315

[] Surface Soil
[X] Subsurface Soil
[] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: 01TP020506
Sample Location: 01TP02
Sampled By: F. Ramser / T. Rojahn
C.O.C. No.: 4384

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

Date: 1-14-04	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 1430	5'-6'	YEL BRN ORG + GREY	E.g. SANDY SILT TR CLAY
Method: DPT BACKHOE BUCKET			
Monitor Reading (ppm): 0.0			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
NA	NA	NA	NA	NA
Method: NA				
Monitor Readings (Range in ppm): NA				

PUR

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
VOCs (8260B)	(3) Encore Samplers	Yes	✓
Percent Moisture	(1) 2oz. Jars	Yes	✓
Gamma Spectroscopy	(1) 16oz. Jars	~~Yes~~/No	

OBSERVATIONS / NOTES:

Soil Group No. 8

Gamma in sample = _____ cpm LESS THEN BACKGROUND

MAP:

See Revised Figure 3-1

Circle If Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Tetra Tech NUS, Inc.

SOIL SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845 CTO 0315

[] Surface Soil
[X] Subsurface Soil
[] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: 01TP040607
Sample Location: 01TP04
Sampled By: F. Ramser / T. Rojahn
C.O.C. No.: 4384

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date: 1-14-04 Time: 1640 Method: ~~DPT~~ BACKHOE Monitor Reading (ppm): 0.0	6-7'	YEL BRN + GREY	SILT, CLAY, F-g SAND MOIST

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
NA	NA	NA	NA	NA
Method: NA				
Monitor Readings (Range in ppm): NA				

FMR

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
VOCs (8260B)	(3) Encore Samplers	Yes	✓
Percent Moisture	(1) 2oz. Jars	Yes	✓
Gamma Spectroscopy	(1) 16oz. Jars	~~Yes~~/No	

OBSERVATIONS / NOTES:

Soil Group No. 8

Gamma in sample = — cpm LESS THAN BACKGROUND

MAP:

See Revised Figure 3-1

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s): Tony Rojahn

Tetra Tech NUS, Inc.

SOIL SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845 CTO 0315

[] Surface Soil
[X] Subsurface Soil
[] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: 01TP050607
Sample Location: 01TP050607 FUR
Sampled By: F. Ramser / T. Rojahn
C.O.C. No.: 4385

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date: 1-15-04 Time: 0915 Method: ~~DPT~~ BACKHOE Monitor Reading (ppm): 0.0	6'-7'	YEL-BRN ORG-BRN	SILTY SAND W/TRCCHY

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
NA	NA	NA	NA	NA
Method: NA				
Monitor Readings (Range in ppm): NA				

FUR VOID

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
VOCs (8260B)	(3) Encore Samplers	Yes	✓
Percent Moisture	(1) 2oz. Jars	Yes	✓
Gamma Spectroscopy	(1) 16oz. Jars	Yes / No	

OBSERVATIONS / NOTES:

Soil Group No. 9

Gamma in sample = $13 \times 10^{+2}$ cpm

MAP:

See Revised Figure 3-1

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s): Fred M Ramser

Tetra Tech NUS, Inc.

SOIL SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845 CTO 0315

[] Surface Soil
[X] Subsurface Soil
[] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: 01TP060506
Sample Location: 01TP 06
Sampled By: F. Ramser / T. Rojahn
C.O.C. No.: 4385

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date: 1-15-04 Time: 1050 Method: ~~DPT~~ BACKHOE BUCKET Monitor Reading (ppm): 0.0	5'-6'	YEL BRN ORN BRN	SILT + CLAY TR SAND

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
NA	NA	NA	NA	NA
Method:				
NA				
Monitor Readings				
(Range in ppm):			VOLD FUR	
NA				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
VOCs (8260B)	(3) Encore Samplers	Yes	✓
Percent Moisture	(1) 2oz. Jars	Yes	✓
Gamma Spectroscopy	(1) 16oz. Jars	Yes/ No	

OBSERVATIONS / NOTES:

Soil Group No. 8

Gamma in sample = $3 \times 10^{+2}$ cpm

MAP:

See Revised Figure 3-1

Circle if Applicable:

MS/MSD —

Duplicate ID No.: —

Signature(s):

Fred W Ramser

Tetra Tech NUS, Inc.

SOIL SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845 CTO 0315

[] Surface Soil
[X] Subsurface Soil
[] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: 01TP 080506
Sample Location: 01TP 08
Sampled By: F. Ramser / T. Rojahn
C.O.C. No.: 4385

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date: 1-15-04 Time: 1420 Method: ~~DPT~~ BACKHOE BUCKET Monitor Reading (ppm): 0	05-06	YELBRN	SILT+CLAY MOIST TO WET

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
NA	NA	NA	NA	NA
Method: NA				
Monitor Readings (Range in ppm): NA				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
VOCs (8260B)	(3) Encore Samplers	Yes	✓
Percent Moisture	(1) 2oz. Jars	Yes	✓
Gamma Spectroscopy	(1) 16oz. Jars	Yes/(No)	

OBSERVATIONS / NOTES:

Soil Group No. 8

Gamma in sample = $3 \times 10^{+3}$ cpm

MAP:

See Revised Figure 3-1

Circle if Applicable:

MS/MSD ✓

Duplicate ID No.: —

Signature(s):

Fred M Ramser

B.2.2

SWMU 01 Ground Water Sample Log Sheets

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW 01 03
Sample Location: 01-01
Sampled By: Gorski
C.O.C. No.: 4389 & 4390
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-23-04								
Time: 1255								
Method: Bladder	Clear	6.31	.796	11.08	5.6	0.16	—	-14.6

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-23-04								
Method: Bladder								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 51'	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 28.31								
One Casing Volume(gal/L) 14.0								
Start Purge (hrs): 1108								
End Purge (hrs): 1248								
Total Purge Time (min): 110								
Total Vol. Purged (gal/L) 15.0								

SAMPLE COLLECTION INFORMATION:

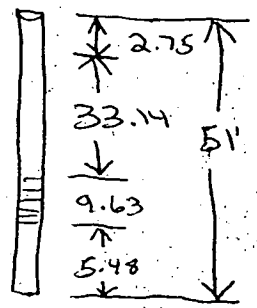
Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials ✓	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	Yes
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	Yes
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	Yes
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	Yes
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	Yes
Total Organic Carbon (SW-846 9069)	H2SO4 4° C	(1) 250ml HDPE	Yes
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	Yes
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	Yes

OBSERVATIONS / NOTES:

Depth of pump intake 40.71'

51.00
28.31
22.69 (.163) = 3.70 gal
= 14.00 L.

▲ 28.31



Circle if Applicable:

MS/MSD	Duplicate ID No.:	Signature(s):
—	DIFD0123040 1	

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9080~~ N0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 01-01
DATE: 1-23-04
WEATHER: Partly Sunny 25°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1108	—	—	—	—	—	—	—	—	—	Start Purge
1118	28.45	1.5	150	6.86	.411	95	0.53	8.58	-12.1	sl. cloudy
1128	28.62	3.0	150	6.86	.411	85	0.58	11.31	44.3	"
1138	28.72	4.5	150	6.38	.800	60	0.42	11.42	44.7	"
1148	28.78	6.0	150	6.30	.776	34	0.27	11.33	-11.4	"
1158	28.82	7.5	150	6.30	.777	28	0.23	11.17	-12.7	clear
1208	28.85	9.0	150	6.31	.782	16	0.20	10.94	-13.3	"
1218	28.89	10.5	150	6.31	.789	11	0.20	11.17	-13.9	"
1228	28.91	12.0	150	6.30	.785	9.7	0.20	11.08	-14.3	"
1238	28.92	13.5	150	6.31	.794	8.2	0.19	11.08	-14.9	"
1248	28.94	15.0	150	6.31	.796	5.6	~~0.18~~ 0.18	11.08	-14.6	Stop Purge

Water Quality Meter (S/N) 98605088A
Control Box Type (S/N) 1057
Turbidity Meter (S/N) 4531-3303

Pump Intake Depth 40.71'

SIGNATURE(S): [signature]

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: NSWC CRANE
Project No.: 0845
Sampled By: Goulet
Field Analyst: Goulet
Field Form Checked as per QA/QC Checklist (initials): QD

Sample ID No.: 01GW0103
Sample Location: 01-01
Duplicate: ☐
Blank: ☐

SAMPLING DATA:

	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	ORP (Eh) (+/- mv)
Date: 1-23-04								
Time: 1255								
Method: Bladder	Clear	6.31	.796	11.08	5.6	0.16	—	-14.6

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)

Electrode Make & Model: YSI

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Concentration: 0.6 ppm

Range Used:	Range	Method	Concentration ppm
☑	0 to 1 ppm	K-7510	
☐	1 to 12 ppm	K-7512	

Analysis Time: 1408

Notes:

Alkalinity:

Equipment: Chemetrics Test Kit

Concentration: 175 ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-9810	
☑	50 to 500 ppm	K-9815	
☐	100 to 1000 ppm	K-9820	

Analysis Time: 1412

Filtered: ☐

Notes:

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Concentration: 40 ppm

Range Used:	Range	Method	Concentration ppm
☑	10 to 100 ppm	K-1910	
☐	100 to 1000 ppm	K-1920	
☐	250 to 2500 ppm	K-1925	

Analysis Time: 1416

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-850 DR-8 __ Range: 0 - 3.00 mg/L

Program/Module: 500nm 33

Concentration: 0.86 ppm

Analysis Time: 1423

Filtered: ☐

Notes:

Hydrogen Sulfide (H_2S): Range: 0 - 5 mg/L

Equipment: HS-C Other:

Exceeded 5.0 mg/L range on color chart: ☐

Concentration: 0.0 ppm

Analysis Time: 1426

Notes:

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name:	NSWC CRANE	Sample ID No.:	01GW0103
Project No.:	0845	Sample Location:	01-01
Sampled By:	Goerdt	Duplicate:	☐
Field Analyst:	Goerdt	Blank:	☐

Sulfide (S^{2-}):

Equipment: DR-850 DR-8 __ Range: 0 - 0.70 mg/L Concentration: 0.0 ppm

Program/Module: 610nm 93 Analysis Time: ~~1444~~ 1434 Filtered: ☐

Notes:

Nitrite (NO_2^--N):

Equipment: DR-850 DR-8 __ Range: 0 - 0.350 mg/L Concentration: 0.0 ppm

Program/Module: 62 Analysis Time: 1417 Filtered: ☐

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Notes:

Manganese (Mn^{2+}):

Equipment: DR-850 DR-8 __ Range: 0 - 20.0 mg/L Concentration: 3.4 ppm

Program/Module: 525nm 41 Analysis Time: 1440 Filtered: ☐

Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☑

Correct measurement units are cited in the SAMPLING DATA block: ☑

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☑

Mulitplication is correct for each *Multiplier* table: ☑

Final calulated concentration is within the appropriate *Range Used* block: ☑

Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☑

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☑

Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: NA

Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☑

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW0203
Sample Location: 01-02
Sampled By: TIROJAHN
C.O.C. No.: 4392 & 4393
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-26-04								
Time: 1240								
Method: SAME	CLEAR	6.33	0.177	8.12	4.4	*	—	+238

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-26-04								
Method: PERISTALTIC								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 25.8	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 10.91								
One Casing Volume(gal/L): 9.2								
Start Purge (hrs): 1045								
End Purge (hrs): 1235								
Total Purge Time (min): 110								
Total Vol. Purged (gal/L): 9.8								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	H_2SO_4/ 4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 15.34'

Top of screen = 10.74'
Bottom " " = 20.1

20.1
−10.91
9.21 ft wt col. in screen

25.8 − 10.91 = 14.89 × 0.163 = 2.4 gal or 9.2 L

10.74
+ 4.6
15.34'

* PROBLEM W/ PROBE

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	01FD012604 01

Signature(s): Terry Rojahn

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ 0845
PROJECT SITE NAME: MGB6

WELL ID.: 01-02
DATE: 1-26-04
WEATHER: OVERCAST & COLD

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	* DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1045	10.91	–	–	–	–	–	–	–	–	START PURGE
1055	11.38	1.1	110	6.36	0.177	24	11.42	7.05	+ 202	CLEAR
1105	11.32	1.7	60	6.35	0.171	22	*	4.75	+ 211	"
1115	11.50	2.6	90	7.84	0.177	15	*	7.84	+ 214	"
1125	11.51	3.5	90	6.36	0.178	15	*	7.83	+ 218	"
1135	11.56	4.4	90	6.36	0.177	14	*	7.77	+ 221	"
1145	11.61	5.3	90	6.36	0.177	13	*	7.71	+ 224	"
1155	11.66	6.2	90	6.37	0.177	13	*	7.65	+ 227	"
1205	11.69	7.1	90	6.37	0.178	9.8	*	8.21	+230	"
1215	11.72	8.0	90	6.37	0.178	6.6	*	8.03	+232	"
1225	11.76	8.9	90	6.34	0.178	5.9	*	8.13	+234	"
1235	11.79	9.8	90	6.33	0.177	4.4	*	8.12	+238	"
1240	–	–	–	–	–	–	–	–	–	START SAMPLING

Water Quality Meter (S/N) 01M0616 AA
Control Box Type (S/N) NA
Turbidity Meter (S/N) 0918-4298

Pump Intake Depth 15.34'

* PROBLEM W/DO PROBE

SIGNATURE(S): Terry Rogers

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name: NSWC CRANE
Project No.: N0845
Sampled By: T. ROSAHAL
Field Analyst: TR
Field Form Checked as per QA/QC Checklist (initials): QD

Sample ID No.: 01GW0203
Sample Location: 01-02
Duplicate: ☐
Blank: ☐

SAMPLING DATA:

Date: 1-26-04 / Time: 1240	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	ORP (Eh) (+/- mv)
Method: Peristaltic	Clear	6.33	0.177	8.12	4.4	*	—	238

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)

Electrode Make & Model: YSI

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Concentration: 5.5 ppm

Range Used:	Range	Method	Concentration ppm
☐	0 to 1 ppm	K-7510	
☑	1 to 12 ppm	K-7512	5.5

Analysis Time: 1405

Notes:

Alkalinity:

Equipment: Chemetrics Test Kit

Concentration: 68 ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-9810	
☑	50 to 500 ppm	K-9815	68
☐	100 to 1000 ppm	K-9820	

Analysis Time: 1412

Filtered: ☐

Notes:

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Concentration: 15 ppm

Range Used:	Range	Method	Concentration ppm
☑	10 to 100 ppm	K-1910	15
☑	100 to 1000 ppm	K-1920	—
☐	250 to 2500 ppm	K-1925	

Analysis Time: 1420

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-850 DR-8 __ Range: 0 - 3.00 mg/L

Program/Module: 500nm 33

Concentration: 0.0 ppm

Analysis Time: 1428

Filtered: ☐

Notes:

Hydrogen Sulfide (H_2S): Range: 0 - 5 mg/L

Equipment: HS-C Other: _____

Exceeded 5.0 mg/L range on color chart: ☐

Concentration: 0.0 ppm

Analysis Time: 1450

Notes:

* problem w/ DO probe

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name:	NSWC CRANE	Sample ID No.:	01GW 0203
Project No.:	N0845	Sample Location:	01-02
Sampled By:	T. ROJAHN	Duplicate:	☐
Field Analyst:	TR.	Blank:	☐

Sulfide (S^{2-}):

Equipment: DR-850 DR-8 __ Range: 0 - 0.70 mg/L Concentration: 0.03 ppm

Program/Module: 610nm 93 Analysis Time: 1437 Filtered: ☐

Notes:

Nitrite (NO_2^--N):

Concentration: 0.004 ppm

Equipment: DR-850 DR-8 __ Range: 0 - 0.350 mg/L Analysis Time: 1421 Filtered: ☐

Program/Module: 62

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Notes:

Manganese (Mn^{2+}):

Concentration: 0.1 ppm

Equipment: DR-850 DR-8 __ Range: 0 - 20.0 mg/L Analysis Time: 1444 Filtered: ☐

Program/Module: 525nm 41

Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☑

Correct measurement units are cited in the SAMPLING DATA block: ☑

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☑

Mulitplication is correct for each *Multiplier* table: ☑

Final calulated concentration is within the appropriate *Range Used* block: ☑

Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☑

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☑

Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: NA

Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☑

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW - 0303
Sample Location: 01-03
Sampled By: J. Goerdt
C.O.C. No.: 4387
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-19-04								
Time: 1748								
Method: Peristaltic	Clear	6.60	~~.105~~ .105	5.42	24	3.96	—	37.2

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-19-04								
Method: Peristaltic	20.15	6.60	.105	5.42	24	3.96	—	37.2
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 21.6	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 3.2								
One Casing Volume(gal/L): 11.36								
Start Purge (hrs): 1344								
End Purge (hrs): 1744								
Total Purge Time (min): 240								
Total Vol. Purged (gal/L): 20.15								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	No
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	H2SO4/ 4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 10.13'

$$\begin{array}{r} 21.6 \\ 3.2 \\ \hline 18.4 \end{array} (.163) = 3.0 \text{ gal} = 11.36 \text{ L}$$

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ N0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 01-03
DATE: 1-19-04
WEATHER: Partly cloudy 23°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1344	3.20	—	0.90	—	—	—	—	—	—	Start purge
1354	3.91	.9 —	0.90	6.64	.117	120	2.36	6.88	-24.7	slightly cloudy
1404	3.99	1.65	0.75	6.60	.115	90	2.32	6.73	-26.3	"
1414	4.10	2.40	0.75	6.57	.114	100	2.20	6.89	-27.9	"
1424	4.19	3.15	0.75	6.58	.111	70	2.47	6.67	-28.9	"
1434	3.75	3.90	0.75	6.62	.107	85	2.68	4.06	-28.7	"
1444	3.94	4.65	0.75	6.60	.110	78	2.60	6.30	-27.3	"
1454	4.25	5.40	0.75	6.61	.108	65	2.72	5.74	-28.1	"
1504	3.64	6.15	0.75	6.62	.101	50	3.21	5.73	-27.2	clear
1514	4.08	6.80	0.75	6.59	.108	52	2.49	6.54	-27.4	"
1524	4.49	7.55	0.75	6.62	.110	55	2.70	6.67	-28.3	"
1534	4.61	8.45	0.90	6.57	.108	55	2.90	6.27	-27.7	"
1544	4.55	9.35	0.90	6.61	.107	50	3.33	6.03	-25.0	"
1554	4.55	10.25	0.90	6.60	.108	47	3.18	6.58	37.6	"
1604	4.69	11.15	0.90	6.60	.168	44	3.20	6.31	38.1	"
1614	4.64	12.05	0.90	6.60	.108	40	3.27	6.30	38.2	"
1624	4.65	12.95	0.90	6.59	.107	39	3.40	6.05	38.0	"
1634	4.60	13.85	0.90	6.60	.108	34	3.41	6.03	37.2	"
1644	4.62	14.75	0.90	6.60	.107	32	3.44	6.00	37.7	"
1654	4.60	15.65	0.90	6.61	.107	30	3.52	5.90	37.3	"
1704	4.60	16.55	0.90	6.60	.106	31	3.60	5.85	37.7	"
1714	4.60	17.45	0.90	6.60	.107	30	3.62	5.71	37.2	"

Water Quality Meter (S/N) 98G0508 AA
Control Box Type (S/N) N/A
Turbidity Meter (S/N) 4531 3303

Pump Intake Depth 10.13'

SIGNATURE(S): [signature]

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ N0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 01-03
DATE: 1-19-04
WEATHER: P. Cloudy 23°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1729	4.60	18.35	0.90	6.60	.107	30	3.69	5.54	37.3	Clear
1734	4.60	19.25	0.90	6.60	.105	32	3.85	5.50	37.2	"
1744	4.60	20.15	0.90	6.60	.105	24	3.96	5.42	37.2	End Purge

Water Quality Meter (S/N) 98G0508AA
Control Box Type (S/N) N/A
Turbidity Meter (S/N) 4531 3303

Pump Intake Depth 10.13'

SIGNATURE(S):

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW 0403
Sample Location: 01 04
Sampled By: J. Goardt
C.O.C. No.: 4387
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-20-04								
Time: 1150								
Method: Peristaltic	Clear	6.83	~~722~~ .722	8.52	0.5	5.58	—	6.5

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-20-04								
Method: Peristaltic	10.70	6.83	.722	8.52	0.5	5.58	—	6.5
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 34.0	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 16.72								
One Casing Volume(gal/L): 10.66								
Start Purge (hrs): 0910								
End Purge (hrs): 1140								
Total Purge Time (min): 150								
Total Vol. Purged (gal/L): 10.70								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	No
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 23.98'

34.00
-16.72
17.28 (.163) = 2.82 gal = 10.66 L

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s): J. Goardt

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ N0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 01-04
DATE: 1-20-04
WEATHER: P. Sunny 14°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
0910	16.72	–	–	–	–	–	–	–	–	Start purge
0920	17.00	.90	.900	6.78	.724	8.9	6.17	8.80	14.3	clear
0930	17.12	1.60	.700	6.79	.717	1.2	5.90	8.40	13.1	"
0940	17.25	2.30	.700	6.79	.712	0.9	5.90	8.02	12.1	"
0950	17.36	3.00	.700	6.79	.711	0.7	5.72	8.10	12.0	"
1000	17.51	3.70	.700	6.81	.715	1.1	5.77	8.30	10.7	"
1010	17.62	4.40	.700	6.81	.718	0.8	5.67	8.41	9.9	"
1020	17.78	5.10	.700	6.81	.722	0.6	5.67	8.62	8.8	"
1030	17.83	5.80	.700	6.81	.724	0.6	5.65	8.62	8.3	"
1040	17.95	6.50	.700	6.82	.721	0.6	5.62	8.61	8.1	"
1050	18.04	7.20	.700	6.81	.724	0.6	5.62	8.62	7.7	"
1100	18.09	7.90	.700	6.82	.724	0.6	5.61	8.60	7.6	"
1110	18.18	8.60	.700	6.82	.724	0.6	5.59	8.52	7.1	"
1120	18.29	9.30	.700	6.82	.721	0.5	5.59	8.52	6.9	"
1130	18.47	10.00	.700	6.83	.722	0.5	5.58	8.52	6.6	"
1140	18.64	10.70	.700	6.83	.722	0.5	5.58	8.52	6.5	"
										Stop purge

Water Quality Meter (S/N) 98605084A
Control Box Type (S/N) NA
Turbidity Meter (S/N) 4531 3303

Pump Intake Depth 23.98'

SIGNATURE(S): [illegible]

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW0503
Sample Location: 01-05
Sampled By: Goerdt
C.O.C. No.: 4398 & 4400
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Sainity	ORP
Date: 1-27-04	Visual	Standard	mS/cm	°C	NTU	mg/l	%	mV
Time: ~~Pass~~ 0910								
Method: Peristaltic	Clear	6.96	1.535	8.64	5.0	0.01	<	-14.4

PURGE DATA:

Date: 1-26-04	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Method: Peristaltic								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 33.6	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 14.4								
One Casing Volume(gal/L): 11.85								
Start Purge (hrs): 1133								
End Purge (hrs): 1337								
Total Purge Time (min): 124								
Total Vol. Purged (gal/L): 25.2								

SAMPLE COLLECTION INFORMATION:

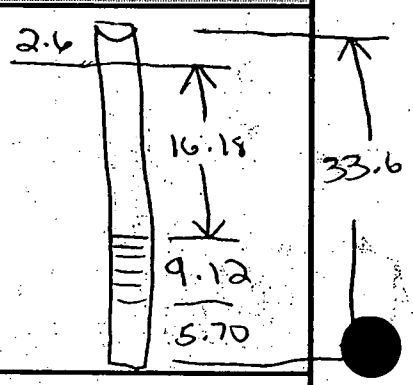
Analysis	Preservative	Container Requirements	Dup	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4°C	(1) HDPE	No	~~No~~ Yes
Chloride & Sulfate (EPA 300.0)	4°C	(1) HDPE		
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4°C	(1) HDPE		
Light Hydrocarbon & Hydrogen (Air Striped)	4°C	(1) 22cc Evacuated Vial		
Light Hydrocarbon & Hydrogen (Aqueous)	4°C	(1) 40ml Amber Vial		
Total Organic Carbon (SW-846 9069)	H_2SO_4/ 4°C	(1) 250ml HDPE		
Total Inorganic Carbon	4°C	(2) 40ml Clear Vial		
Volatile Fatty Acids w/Benzalkonium Chloride	4°C	(2) 40ml Amber Vial		

OBSERVATIONS / NOTES:

Depth of pump intake ~~25.68~~ 23.34

1/27/04 - samples
WL = 15.05
Turb = 5.0

33.6
14.4
19.2 (.163) = 3.13 gal
= 11.85 L



Circle if Applicable:

MS/MSD	Duplicate ID No.:	Signature(s):
Yes	01FD01~~26~~27 0401	

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ 0845
PROJECT SITE NAME: Swmu 01

WELL ID.: 01-05
DATE: 1-26-04
WEATHER: Cloudy 30°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1133	14.40	—	—	—	—	—	—	—	—	Start purge
1143	16.22	1.5	150	6.96	1.605	2.7	0.04	10.19	-10.7	Clear
1153	~~1158~~ 17.80	3.0	150	6.96	1.615	2.4	0.02	10.49	-11.8	"
1203	17.98	3.8	80	6.95	1.549	2.2	0.02	8.89	-12.7	reduced flowrate
1213	18.20	4.6	80	6.96	1.538	2.0	0.02	8.73	-13.1	Clear
1223	18.33	5.4	80	6.95	1.534	3.3	0.01	8.68	-13.9	"
1233	18.50	6.2	80	6.96	1.534	2.7	0.01	8.67	-14.2	
1243	18.70	7.0	80	6.96	1.535	2.0	0.01	8.64	-14.4	Lowering intake
			~~Stop purge~~							to bottom screen to
										pump dry
1252	18.70	10.3	330	—	—	—	—	—	—	
1303	21.40	13.6	"	—	—	—	—	—	—	
1313	22.80	16.9	"	—	—	—	—	—	—	* will sample
1323	25.90	20.2	"	—	—	—	—	—	—	on 1-27-04
1333	27.40	23.5	"	—	—	—	—	—	—	
1337	28.00	25.2	"	—	—	—	—	—	—	
			Stop purge							
			Sampling							
0910	15.05	—	—	—	—		—	—	—	

Water Quality Meter (S/N) 9860508 A2
Control Box Type (S/N) NA
Turbidity Meter (S/N) 4531 3303

Pump Intake Depth 23.34

* Bottom of screen = 27.9

SIGNATURE(S):

18.78

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name:	NSWC CRANE	Sample ID No.:	01GW0503
Project No.:	N0845	Sample Location:	01-05
Sampled By:	Gordt	Duplicate:	☐
Field Analyst:	Gordt	Blank:	☐
Field Form Checked as per QA/QC Checklist (initials):	DS		

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Salinity	ORP (Eh)
Date: 1-27-04								
Time: 0910	(Visual)	(S.U.)	(mS/cm)	(°C)	(NTU)	(mg/l)	(%)	(+/- mv)
Method: Peristaltic	Clear	6.96	1.535	8.64	5.0	0.01	—	-14.4

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)

Electrode Make & Model: YSI

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Concentration: 3.0 ppm

Range Used:	Range	Method	Concentration ppm
☐	0 to 1 ppm	K-7510	
☑	1 to 12 ppm	K-7512	3.0

Analysis Time: 1023

Notes:

Alkalinity:

Equipment: Chemetrics Test Kit

Concentration: 250 ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-9810	
☑	50 to 500 ppm	K-9815	250
☐	100 to 1000 ppm	K-9820	

Analysis Time: 1027

Filtered: ☐

Notes:

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Concentration: 40 ppm

Range Used:	Range	Method	Concentration ppm
☑	10 to 100 ppm	K-1910	40
☐	100 to 1000 ppm	K-1920	
☐	250 to 2500 ppm	K-1925	

Analysis Time: 1031

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-850 DR-8 __ Range: 0 - 3.00 mg/L

Program/Module: 500nm 33

Concentration: 2.20 ppm

Analysis Time: 1040

Filtered: ☐

Notes:

Hydrogen Sulfide (H_2S): Range: 0 - 5 mg/L

Equipment: HS-C Other:

Exceeded 5.0 mg/L range on color chart: ☐

Concentration: 0.0 ppm

Analysis Time: 1050

Notes:

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name:	NSWC CRANE	Sample ID No.:	01GW 0503
Project No.:	N0845	Sample Location:	01-05
Sampled By:	Gould	Duplicate:	☐
Field Analyst:	Gould	Blank:	☐

Sulfide (S^{2-}):

Equipment: DR-850 DR-8 __ Range: 0 - 0.70 mg/L Concentration: 0.0 ppm

Program/Module: 610nm 93 Analysis Time: 1145 Filtered: ☐

Notes:

Nitrite (NO_2^--N): Concentration: 0.006 ppm

Equipment: DR-850 DR-8 __ Range: 0 - 0.350 mg/L Analysis Time: 10.35 Filtered: ☐

Program/Module: 62

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Notes:

Manganese (Mn^{2+}): Concentration: 1.0 ppm

Equipment: DR-850 DR-8 __ Range: 0 - 20.0 mg/L Analysis Time: 1045 Filtered: ☐

Program/Module: 525nm 41

Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☑

Correct measurement units are cited in the SAMPLING DATA block: ☑

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☑

Mulitplication is correct for each *Multiplier* table: ☑

Final calulated concentration is within the appropriate *Range Used* block: ☑

Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☑

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☑

Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: NA

Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☑

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW 0603
Sample Location: 01-06
Sampled By: T. ROJAHN
C.O.C. No.: 4390
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Sainity	ORP
Date: 1-21-04	Visual	Standard	mS/cm	°C	NTU	mg/l	%	mV
Time: 1745								
Method: SAME	CLEAR	6.95	1.198	10.56	0.25	1.58	—	+24

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-21-04								
Method: Bladder								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 93.5	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 67.6								
One Casing Volume(gal/L): 16								
Start Purge (hrs): 1530								
End Purge (hrs): 1740								
Total Purge Time (min): 130								
Total Vol. Purged (gal/L): 16.5								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	NO
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4°C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 81.25

TOP OF SCREEN = 75.5'
BOTTOM OF SCREEN = 97.0'

93.5 - 67.60 = 25.9 x 0.163 = 4.2 gal or 16L

Circle if Applicable:

MS/MSD — Duplicate ID No.: —

Signature(s): Tey Rojahn

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ 0845
PROJECT SITE NAME: MGBG

WELL ID.: 01-06
DATE: 1-21-04
WEATHER: Partly Cloudy 30°S

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1530	67.60	—	—	—	—	—	—	—	—	START PURGE
1540	67.91	1.0	100	7.03	1.094	17	4.77	9.67	+111	CLEAR
1550	67.93	2.0	100	7.02	1.132	7.6	2.47	10.20	+61	"
1600	67.95	3.5	150	7.02	1.143	5.5	1.77	9.90	+40	"
1610	67.95	4.8	130	7.00	1.140	3.4	1.87	10.46	+33	"
1620	67.95	6.1	130	6.99	1.153	3.0	1.64	10.46	+33	"
1630	67.95	7.4	130	6.98	1.165	2.5	1.62	10.47	+32	"
1640	68.00	8.7	130	6.96	1.173	2.1	1.62	10.46	+30	"
1650	68.00	10.0	130	6.96	1.180	1.7	1.63	10.45	+29	"
1700	68.03	11.3	130	6.96	1.187	1.5	1.57	10.45	+27	"
1710	68.03	12.6	130	6.96	1.188	1.1	1.63	10.46	+28	"
1720	68.05	13.9	130	6.96	1.193	1.00	1.57	10.54	+28	"
1730	68.05	15.2	130	6.95	1.198	0.70	1.61	10.55	+25	"
1740	68.05	16.5	130	6.95	1.198	0.25	1.58	10.56	+24	"
1745	—	—	—	—	—	—	—	—	—	SAMPLE TIME

Water Quality Meter (S/N) 01M0616 AA
Control Box Type (S/N) NA
Turbidity Meter (S/N) 0918-4298

Pump Intake Depth 81.25'

SIGNATURE(S): [signature]

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW 0702
Sample Location: 01-07
Sampled By: T. ROJAHN
C.O.C. No.: 4386
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-18-03								
Time: 1130								
Method: SAME	CLEAR	6.72	0.823	8.90	0.10	0.76	–	-49

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-18-03								
Method: PERISTALTIC								
Monitor Reading (ppm): –								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 28.5	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 15.91								
One Casing Volume(gal/L) 7.8								
Start Purge (hrs): 0935								
End Purge (hrs): 1125								
Total Purge Time (min): 110								
Total Vol. Purged (gal/L) 8.6								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	NO
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

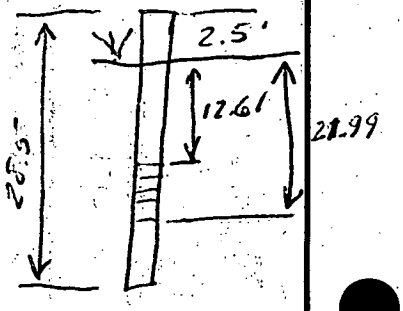
OBSERVATIONS / NOTES:

Depth of pump intake 20.20

28.5 - 15.91 = 12.59 x 0.163 = 2.1 gal or 7.8 L

Bottom of screen = 24.49
- 15.91 WL
8.58
4.29
Water col. above bottom of screen
12.87

15.91 + 4.29 = 20.20



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s): Terry Rojahn

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ 0845
PROJECT SITE NAME: MGBG

WELL ID.: WES-1-07-02 (01-07)
DATE: 1-19-04
WEATHER: Mostly Cloudy (overcast) 20°s

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
0935	15.91	–	–	–	–	–	–	–	–	START PURGE
0945	16.08	0.8	80	6.76	0.801	3.09	2.25	8.90	-70	CLEAR
0955	16.28	1.9	110	7.27	0.744	0.65	0.99	10.11	-104	CLEAR
1005	16.64	2.8	90	7.18	0.726	0.10	1.26	9.49	-93	CLEAR
1015	16.85	3.6	80	7.09	0.741	0.25	1.22	9.43	-82	CLEAR
1025	17.03	4.4	80	6.98	0.759	0.10	1.18	9.34	-71	CLEAR
1035	17.20	5.2	80	6.94	0.775	0.10	1.15	9.18	-64	CLEAR
1045	17.29	6.0	80	6.83	0.793	0.00	1.05	8.82	-58	CLEAR
1055	17.41	6.65	65	6.80	0.805	0.10	0.96	8.85	-54	CLEAR
1105	17.45	7.3	65	6.76	0.814	0.25	0.84	8.97	-52	CLEAR
1115	17.41	7.95	65	6.73	0.813	0.10	0.79	8.85	-50	CLEAR
1125	17.45	8.6	65	6.72	0.823	0.10	0.76	8.80	-49	CLEAR
1130	–	–	–	–	–	–	–	–	–	SAMPLE TIME

Water Quality Meter (S/N) 01M0616 AA
Control Box Type (S/N) NA
Turbidity Meter (S/N) 4650-4303

Pump Intake Depth 20.20

SIGNATURE(S): Terry Rigel

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW0803
Sample Location: WES-1-8-02
Sampled By: T. ROSAHN
C.O.C. No.: 4386
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-17-04								
Time: 1505								
Method: SAME	CLEAR	6.96	0.417	11.48	1.86	0.48	–	-62

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-17-04								
Method: Peristaltic								
Monitor Reading (ppm): –								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 31.20	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 12.37								
One Casing Volume(gal/L): 1.16								
Start Purge (hrs): 1314								
End Purge (hrs): 1504								
Total Purge Time (min): 110								
Total Vol. Purged (gal/L): 12.4								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	NO
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 20.76

31.20 - 12.37 = 18.83' x 0.163 = 3.06 gal or 11.6 L

Circle if Applicable:

MS/MSD	Duplicate ID No.:
–	–

Signature(s): Terry Royal

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N0060~~ 0845
PROJECT SITE NAME: MGBG

WELL ID.: WES-1-8-82
DATE: 1-17-04
WEATHER: RAIN 40°s

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1314	12.37	—	—	—	—	—	—	—	—	Start Purge w/ Orange Precip.
1324	12.38	1.3	130	6.96	0.442	20	1.23	11.02	-60	CLEAR
1334	12.38	2.5	120	7.04	0.435	19	0.95	11.09	-72	"
1344	12.38	3.6	110	7.04	0.427	15	0.75	11.35	-69	"
1354	12.38	4.7	110	7.04	0.427	11	0.81	11.29	-68	"
1404	12.38	5.8	110	7.04	0.425	9.3	0.73	11.40	-66	"
1414	12.38	6.9	110	7.03	0.424	8.2	0.72	11.54	-64	"
1424	12.38	8.0	110	7.01	0.421	5.5	0.63	11.40	-64	"
1434	12.38	9.1	110	7.00	0.421	3.3	0.59	11.54	-63	"
1444	12.38	10.2	110	6.98	0.418	2.1	0.55	11.49	-62	"
1454	12.38	11.3	110	6.97	0.417	1.93	0.50	11.47	-62	"
1504	12.38	12.4	110	6.96	0.417	1.86	0.48	11.48	-62	"
1505	—	—	—	—	—	—	—	—	—	Start Sampling

Water Quality Meter (S/N) 01M0616 AA
Control Box Type (S/N) NA
Turbidity Meter (S/N) 4650-4303

Pump Intake Depth 20.76

SIGNATURE(S): Terry Rogers

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW 0903
Sample Location: WES-1-9-82
Sampled By: T. ROJAHN
C.O.C. No.: 4386
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

Date: 1-17-04	Color	pH	S.C.	Temp.	Turbidity	DO	Sainity	ORP
Time: 1220	Visual	Standard	mS/cm	°C	NTU	mg/l	%	mV
Method: SAME	CLEAR	5.39	0.083	10.74	2.7	2.67	—	313

PURGE DATA:

Date: 1-17-04	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Method: Peristaltic								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 35.00	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 12.10								
One Casing Volume(gal/L): 14.1								
Start Purge (hrs): 0958								
End Purge (hrs): 1220								
Total Purge Time (min): 142								
Total Vol. Purged (gal/L): 14.2								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	NO
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4°C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 24.50

35.00 - 12.10 = 22.9 x 0.163 = 3.7 gal or 14.1 L MIN. VOL.

Circle if Applicable:

MS/MSD	Duplicate ID No.:	Signature(s):
—	—	Terry Rojahn

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT: NSWC CRANE
PROJECT NUMBER: ~~N9080~~ 0845
PROJECT SITE NAME: MGBG

WELL ID.: WES-1-9-82
DATE: 1-17-03
WEATHER: RAIN (H) 40°S / 30°S (L)

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
0958	12.10	—	—	—	—	—	—	—	—	START PURGE
1008	12.60	1,000	100	5.35	0.083	0.60	3.90	9.68	257	CLEAR NO ODOR
1018	12.73	2,000	100	5.23	0.081	0.80	3.49	9.74	272	"
1028	12.84	3,000	100	5.38	0.081	0.85	3.34	9.87	279	"
1038	12.94	4000	100	5.37	0.081	1.30	3.19	10.08	285	"
1048	13.01	5,000	100	5.36	0.082	1.2	3.01	10.11	290	"
1058	13.07	6,000	100	5.38	0.081	0.95	2.89	10.19	295	"
1108	13.12	7,000	100	5.38	0.081	1.0	2.84	10.26	299	"
1118	13.18	8,000	100	5.39	0.082	0.80	2.82	10.47	302	"
1128	13.22	9,000	100	5.36	0.082	0.75	2.77	10.41	305	"
1138	13.26	10,000	100	5.39	0.082	0.70	2.71	10.52	307	"
1148	13.30	11,000	100	5.39	0.082	0.60	2.71	10.51	308	"
1158	13.33	12,000	100	5.39	0.082	2.0	2.71	10.62	311	"
1208	13.36	13000	100	5.39	0.083	2.3	2.69	10.79	313	"
1218	13.39	14.000	100	5.39	0.083	2.7	2.67	10.74	313	"
1220	—	14.2	100	—	—	—	—	—	—	SAMPLE TIME

Water Quality Meter (S/N) 01M0616 AA
Control Box Type (S/N) NA
Turbidity Meter (S/N) 4650-4303

Pump Intake Depth 24.50

SIGNATURE(S): Terry Rogahn

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW 1003
Sample Location: 01-10-[illegible]
Sampled By: J. Gearhart
C.O.C. No.: 4389 & 4390
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-22-04								
Time: 1330								
Method: Bladder	Clear	7.02	.474	6.97	7.96	1.56	—	49.3

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-22-04								
Method: Bladder								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 43'	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 21.68								
One Casing Volume(gal/L): 11.92								
Start Purge (hrs): 0955								
End Purge (hrs): 1325								
Total Purge Time (min): 210								
Total Vol. Purged (gal/L) 12.0								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	Yes
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	Yes
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	Yes
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	Yes
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	Yes
Total Organic Carbon (SW-846 9069)	H2SO4/4° C	~~H2SO4~~ (1) 250ml HDPE	Yes
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	Yes
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	Yes

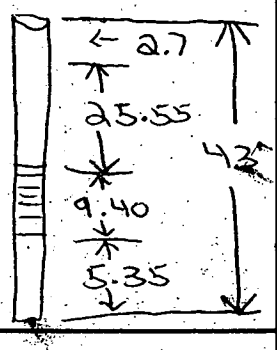
OBSERVATIONS / NOTES:

Depth of pump intake 33'

Initially no water reaching flow thru cell. Found ice to be blocking inlet nipple.

41.00
- 21.68
19.32 (.163) = 3.15 gal
= 11.92 L

WL = 21.68



Circle if Applicable:

MS/MSD	Duplicate ID No.:
✓	—

Signature(s): [illegible]

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ N0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 01-10
DATE: 1-22-04
WEATHER: Sunny 20's

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
0955	21.68	—	—	—	—	—	—	—	—	rust colored start purge
1005	22.41	1.0	100	7.03	.560	72.3	3.59	7.24	-8.5	"
1015	23.24	2.0	100	7.00	.544	60.9	3.34	7.00	-2.0	lighter
1025	24.32	3.0	100	6.98	.528	46.5	3.88	6.99	-5.6	cloudy
1035	24.56	3.5	50	6.99	.524	33.9	3.69	6.47	-4.7	clear
1045	24.83	4.0	50	7.00	.517	28.7	3.14	6.18	-5.6	"
1055	25.18	4.5	50	7.00	.517	21.5	2.99	6.23	-5.3	"
1105	25.44	5.0	50	7.00	.520	16.6	2.56	6.54	-5.1	"
1115	25.64	5.5	50	7.00	.522	14.8	2.38	7.08	-6.1	"
1125	25.92	6.0	50	7.01	.526	13.5	2.00	7.20	-6.8	"
1135	26.22	6.5	50	7.00	.515	11.5	1.75	6.63	-6.9	"
1145	26.38	7.0	50	7.02	.508	12.8	1.66	6.75	-7.6	"
1155	26.65	7.5	50	7.01	.503	14.4	1.58	6.71	-6.3	"
1205	26.74	8.0	50	7.01	.492	13.1	1.62	6.76	-6.4	"
1215	26.91	8.5	50	7.01	.486	13.8	1.57	6.77	-6.5	"
1225	27.06	9.0	50	7.02	.484	14.3	1.59	6.79	-7.0	"
1235	27.14	9.5	50	7.03	.478	12.6	1.66	6.81	-6.7	"
1245	27.26	10.0	50	7.02	.484	12.2	1.64	7.13	-6.4	"
1255	27.34	10.5	50	7.02	.492	11.8	1.63	7.54	-6.2	"
1305	27.45	11.0	50	7.02	.477	11.5	1.60	6.89	49.6	"
1315	27.53	11.5	50	7.02	.473	8.92	1.57	6.72	49.6	"
1325	27.64	12.0	50	7.02	.474	7.96	1.56	6.97	49.3	Stop purge

Water Quality Meter (S/N)
Control Box Type (S/N) 1054
Turbidity Meter (S/N) 4531-3303

Pump Intake Depth 33'

SIGNATURE(S): J. Doucet

Top of well screen 28.25

PAGE 2 OF 2

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: NSWC CRANE
Project No.: 085
Sampled By: J. Goerdt
Field Analyst: J. Goerdt
Field Form Checked as per QA/QC Checklist (initials): QP

Sample ID No.: 01GW1003
Sample Location: 01-10
Duplicate: ☐
Blank: ☐

SAMPLING DATA:

	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	ORP (Eh) (+/- mv)
Date: 1-22-04								
Time: 1330								
Method: Bladder	Clear	7.02	.474	6.97	7.96	1.56	—	49.3

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)

Electrode Make & Model: _____

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Concentration: 0.6 ppm

Range Used:	Range	Method	Concentration ppm
☑	0 to 1 ppm	K-7510	
☐	1 to 12 ppm	K-7512	

Analysis Time: 1520

Notes:

Alkalinity:

Equipment: Chemetrics Test Kit

Concentration: 250 ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-9810	
☑	50 to 500 ppm	K-9815	
☐	100 to 1000 ppm	K-9820	

Analysis Time: 1517

Filtered: ☐

Notes:

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Concentration: 25.0 ppm

Range Used:	Range	Method	Concentration ppm
☒	10 to 100 ppm	K-1910	
☐	100 to 1000 ppm	K-1920	
☐	250 to 2500 ppm	K-1925	

Analysis Time: 1530

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-850 DR-8 __ Range: 0 - 3.00 mg/L

Program/Module: 500nm 33

Concentration: 23.3 ppm

Analysis Time: 1534

Filtered: ☐

Notes:

Hydrogen Sulfide (H_2S): Range: 0 - 5 mg/L

Equipment: HS-C Other: _____

Exceeded 5.0 mg/L range on color chart: ☐

Concentration: 0.0 ppm

Analysis Time: 1528

Notes:

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: NSWC CRANE
Project No.: 0545
Sampled By: Goerlt
Field Analyst: Goerlt

Sample ID No.: 01GW1003
Sample Location: 01-10
Duplicate: ☐
Blank: ☐

Sulfide (S^{2-}):
Equipment: DR-850 DR-8 __ Range: 0 - 0.70 mg/L
Program/Module: 610nm 93
Concentration: 0.03 ppm
Analysis Time: 1542 Filtered: ☐
Notes:

Nitrite (NO_2^--N):
Equipment: DR-850 DR-8 __ Range: 0 - 0.350 mg/L
Program/Module: 62
Concentration: 0.17 ppm
Analysis Time: 1524 Filtered: ☐
Standard Solution: ☐ Results: _____
Reagent Blank Correction: ☐
Notes:

Manganese (Mn^{2+}):
Equipment: DR-850 DR-8 __ Range: 0 - 20.0 mg/L
Program/Module: 525nm 41
Concentration: 2.5 ppm
Analysis Time: 1550 Filtered: ☐
Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☑
Correct measurement units are cited in the SAMPLING DATA block: ☑
Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☑
Mulitplication is correct for each *Multiplier* table: ☑
Final calulated concentration is within the appropriate *Range Used* block: ☑
Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☑
QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☑
Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: ☑ A
Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☑

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW 1103
Sample Location: 01-11
Sampled By: Goerdt
C.O.C. No.: 4391 & 4393
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-24-04								
Time: 1110								
Method: Peristaltic	Clear	5.61	.054	7.02	7.3	5.09	—	5.4

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-24-04								
Method: Peristaltic								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 22.6'	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 5.71								
One Casing Volume(gal/L): 10.42								
Start Purge (hrs): 0911								
End Purge (hrs): ~~1052~~ 1101								
Total Purge Time (min): 110								
Total Vol. Purged (gal/L): 12.8								

SAMPLE COLLECTION INFORMATION:

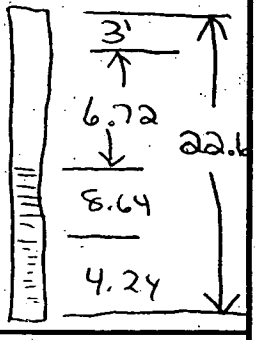
Analysis	Preservative	Container Requirements	Dup	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE		Yes
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE		Yes
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE		Yes
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial		Yes
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial		Yes
Total Organic Carbon (SW-846 9069)	H2SO4/ 4° C	(1) 250ml HDPE		Yes
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial		Yes
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial		Yes

OBSERVATIONS / NOTES:

Depth of pump intake 14.04'

▲ 5.71

22.60
5.71
16.89(.163) = 2.75 gal
= 10.42L



14

Circle if Applicable:

MS/MSD	Duplicate ID No.:	Signature(s):
—	01FD0124040 1	J. Goerdt

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ N0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 01-11
DATE: 1-24-04
WEATHER: Cloudy 30°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
0911	5.71	–	–	–	–	–	–	–	–	Start purge
0921	5.90	1.0	100	5.83	.072	>1100	5.97	7.27	11.7	rust colored
0931	5.95	2.0	100	5.60	.056	120	5.66	6.80	12.0	cloudy
0941	5.97	3.2	120	5.57	.055	55	5.49	6.80	11.6	clear
0951	6.00	4.4	120	5.56	.054	48	5.55	6.69	10.1	"
1001	6.03	5.6	120	5.56	.053	32	5.13	6.65	10.5	"
1011	6.04	6.8	120	5.58	.054	24	5.13	6.78	12.4	"
1021	6.07	8.0	120	5.59	.054	22	5.08	6.86	9.6	"
1031	6.08	9.2	120	5.58	.054	22	5.07	6.92	8.7	"
1041	6.09	10.4	120	5.60	.054	20	5.04	6.98	6.3	"
1051 ~~1048~~	6.10	11.6	120	5.60	.054	12	5.04	7.03	4.0	"
1101 ~~1052~~	6.08	12.8	120	5.61	.054	7.3	5.09	7.02	5.4	Stop purge
										"

Water Quality Meter (S/N) 98G0508 AA
Control Box Type (S/N) N/A
Turbidity Meter (S/N) 4531-3303

Pump Intake Depth 14.04'

SIGNATURE(S): [signature]

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name: NSWC CRANE
Project No.: N0845
Sampled By: Goerdt
Field Analyst: Goerdt
Field Form Checked as per QA/QC Checklist (initials): JD

Sample ID No.: 01GW 1103
Sample Location: 01-11
Duplicate: ☐
Blank: ☐

SAMPLING DATA:

	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	ORP (Eh) (+/- mv)
Date: 1/24/04								
Time: 1110								
Method: Peristaltic	Clear	5.61	.054	7.02	7.3	5.09	—	5.4

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)

Electrode Make & Model: _____

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Concentration: 3.0/3.0 ppm

Range Used:	Range	Method	Concentration ppm
☐	0 to 1 ppm	K-7510	
☑	1 to 12 ppm	K-7512	3.0/3.0

Analysis Time: 1307/1309

Notes:

Alkalinity:

Equipment: Chemetrics Test Kit

Concentration: >1000/>1000 ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-9810	
☐	50 to 500 ppm	K-9815	
☑	100 to 1000 ppm	K-9820	>1000/>1000

Analysis Time: 1320/1323

Filtered: ☐

Notes:

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Concentration: 37/42 ppm

Range Used:	Range	Method	Concentration ppm
☑	10 to 100 ppm	K-1910	37/42
☐	100 to 1000 ppm	K-1920	
☐	250 to 2500 ppm	K-1925	

Analysis Time: 1325/1327

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-850 DR-8 __ Range: 0 - 3.00 mg/L

Program/Module: 500nm 33

Concentration: 0.0/0.0 ppm

Analysis Time: 1340/1344

Filtered: ☐

Notes:

Hydrogen Sulfide (H_2S): Range: 0 - 5 mg/L

Equipment: HS-C Other: _____

Exceeded 5.0 mg/L range on color chart: ☐

Concentration: 0.0/0.0 ppm

Analysis Time: 1348/1354

Notes:

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name:	NSWC CRANE	Sample ID No.:	01GW~~07~~ 1103
Project No.:	N0845	Sample Location:	01-11
Sampled By:	Goerdt	Duplicate:	☐
Field Analyst:	Goerdt	Blank:	☐

Sulfide (S^{2-}):

Equipment: DR-850 DR-8 __ Range: 0 - 0.70 mg/L Concentration: 0.02 / 0.01 ppm

Program/Module: 610nm 93 Analysis Time: 1358 / 1405 Filtered: ☐

Notes:

Nitrite (NO_2^--N):

Concentration: 0.001 ppm / 0.005

Equipment: DR-850 DR-8 __ Range: 0 - 0.350 mg/L Analysis Time: ~~1318~~ 1318 / 1335 Filtered: ☐

Program/Module: 62

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Notes:

Manganese (Mn^{2+}):

Concentration: 0.3 / 0.3 ppm

Equipment: DR-850 DR-8 __ Range: 0 - 20.0 mg/L Analysis Time: 1409 / 1413 Filtered: ☐

Program/Module: 525nm 41

Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☑

Correct measurement units are cited in the SAMPLING DATA block: ☑

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☑

Mulitplication is correct for each *Multiplier* table: ☑

Final calulated concentration is within the appropriate *Range Used* block: ☑

Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☑

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☑

Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: NA

Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☑

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW 1202
Sample Location: 01-12
Sampled By: S. Goebel
C.O.C. No.: 4390
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-22-04								
Time: 1030								
Method: Bladder	Clear	6.86	.412	8.74	24	0.53	—	-11.9

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-22-04								
Method: Bladder								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 41'	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 23.36								
One Casing Volume(gal/L): 10.88								
1/22/04 Start Purge (hrs): 1710								
1/23/04 End Purge (hrs): 1025								
Total Purge Time (min): 240								
Total Vol. Purged (gal/L): 26.0								

SAMPLE COLLECTION INFORMATION:

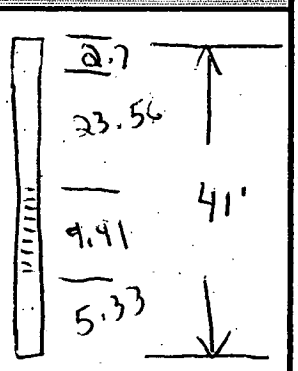
Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	NO
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 31'

Majority of purging completed 1-22-04. Remaining purging & sampling completed 1-23-04.

41.00
23.36
17.64 (.163) = 2.88 gal
= 10.88 L



Circle if Applicable:

MS/MSD —
Duplicate ID No.: —

Signature(s):

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N0060~~ N0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 01-12
DATE: 1-22-04 / 1-23-04
WEATHER: P. Sunny 15°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1710	23.36	—	—	—	—	—	—	—	—	Start pump
1720	23.97	1.0	100	8.01	.471	280	0.92	8.70	65.2	Cloudy
1730	24.63	2.0	100	7.45	.460	212	0.91	8.87	56.3	"
1740	24.91	3.0	100	7.40	.453	185	0.87	8.91	52.8	"
1750	25.42	4.0	100	7.32	.447	156	0.85	9.06	48.6	"
1800	26.08	5.0	100	7.21	.447	102	0.85	9.18	45.8	"
1810	26.35	6.0	100	7.15	.444	75	0.72	8.86	46.0	"
1820	26.42	7.0	100	7.13	.439	72	0.70	8.78	46.8	"
1830	26.49	8.0	100	7.12	.437	65	0.67	8.54	46.8	"
1840	26.53	9.0	100	7.11	.438	55	0.62	8.72	46.8	"
1850	26.72	10.0	100	7.10	.439	43	0.62	8.64	46.7	"
1900	26.83	11.0	100	7.13	.439	48	0.64	8.59	46.8	Air tank empty
1910	—	—	—	—	—	—	—	—	—	Replaced tank
1920	25.86	12.0	100	7.08	.422	230	0.65	6.79	47.3	Cloudy
1930	26.69	13.0	100	7.08	.422	80	0.65	6.79	47.3	"
1940		~~14.0~~	~~100~~							Stopped pump
~~1950~~		~~14.0~~	~~100~~							due to frozen
~~2000~~										lines
~~2010~~										
1/23/04 0855	24.94	-	-	-	-	-	-	-	—	Begin Purge
0905	24.63	14.0	100	7.04	.442	330	0.99	8.89	-10.3	Cloudy
0915	25.28	15.0	100	7.03	.450	207	0.67	9.07	-10.3	"

Water Quality Meter (S/N) 9860508AA
Control Box Type (S/N) 1054
Turbidity Meter (S/N) 4531-3303

Pump Intake Depth 31'

SIGNATURE(S): [illegible]

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ N0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 01-12
DATE: 1-22-04 / 1-23-04
WEATHER: P.Sunny 15°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
0925	25.91	20	100	7.03	0.455	110	0.53	8.96	-10.1	cloudy
0935	26.13	21	100	6.98	.447	82	0.51	8.96	-10.1	"
0945	26.35	22	100	6.95	.442	45	0.53	9.17	-9.7	Sl. cloudy
0955	26.41	23	100	6.90	.435	34	0.54	9.38	-10.3	"
1005	26.49	24	100	6.88	.423	29	0.55	9.14	-10.9	"
1015	26.57	25	100	6.87	.418	27	0.51	8.97	-11.6	"
1025	26.65	26	100	6.86	.412	24	0.53	8.74	-11.9	Stop Purge

Water Quality Meter (S/N) 98G0568AA
Control Box Type (S/N) 1054
Turbidity Meter (S/N) 4531-3303

Pump Intake Depth 31'

SIGNATURE(S): [illegible]

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW1302
Sample Location: WES-1-13-83
Sampled By: RWR
C.O.C. No.: 4390
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Sainity	ORP
Date: 1-22-04	Visual	Standard	mS/cm	°C	NTU	mg/l	%	mV
Time: 1320								
Method: PERISTALTIC PUMP	CLEAR	7.27	0.458	9.44	0.00	0.64	—	159.6

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-22-04								
Method: PERISTALTIC PUMP								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 38.8'	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 20.19								
One Casing Volume(gal/L): 11.2 l								
Start Purge (hrs): 1125								
End Purge (hrs): 1320								
Total Purge Time (min): 115								
Total Vol. Purged (gal/L): 11.7 l								

SAMPLE COLLECTION INFORMATION:

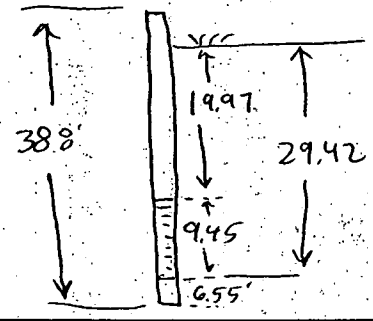
Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	No
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 28.9' BTOC 18.61 STANDING H2O ⇒ 11.2 l

TD = 38.8' TOP OF SCREEN = 22.80
BTM OF " = 32.25

32.25 - 20.19 = 12.06 ⇒ 9.45 SAT SCREEN



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s): [signature]

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ 0845
PROJECT SITE NAME: SWMU 1

WELL ID.: WES-1-13-83
DATE: 1-22-04
WEATHER: SUNNY 25°F (-3°C)

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1130	20.38	0.725	145	7.30	0.508	0.38	1.81	9.68	217.7	
1140	20.40	1.725	100	7.22	0.496	0.36	1.38	8.84	219.3	
1150	20.50	2.725	100	7.20	0.501	0.35	1.06	8.91	217.1	
1200	20.55	3.725	100	7.21	0.509	0.00	0.78	9.39	215.2	
1210	20.60	4.725	100	7.22	0.494	0.00	0.77	9.08	211.5	
1220	20.68	5.725	100	7.23	0.490	0.00	0.72	9.37	203.6	
1230	20.75	6.725	100	7.24	0.478	0.00	0.70	9.05	192.6	
1240	20.77	7.725	100	7.25	0.476	0.00	0.69	9.41	184.8	
1250	20.80	8.725	100	7.25	0.468	0.00	0.69	9.03	177.3	
1300	20.83	9.725	100	7.26	0.465	0.00	0.67	9.41	168.5	
1310	20.86	10.725	100	7.26	0.459	0.00	0.66	9.38	163.6	
1320	20.89	11.725	100	7.27	0.458	0.00	0.64	9.44	159.6	COMPLETED PURGE BEGIN TO FILL CONT.

Water Quality Meter (S/N) YSI 02F0628 AC
Control Box Type (S/N) —
Turbidity Meter (S/N) LAMOTTE

Pump Intake Depth ~~27.8~~ 28.4' BTC PVC CASING

SIGNATURE(S): Fred M Ramsey

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW 1403
Sample Location: 01-14
Sampled By: T. ROJAHN
C.O.C. No.: 4389 & 4390
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-23-04								
Time: 1250								
Method: SAME	CLEAR	6.43	1.015	8.70	6.7	0.47	–	-47

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-23-04								
Method: Peristaltic								
Monitor Reading (ppm): –								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 39.0	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 13.93								
One Casing Volume(gal/L): 15.5								
Start Purge (hrs): 1005								
End Purge (hrs): 1245								
Total Purge Time (min): 160								
Total Vol. Purged (gal/L): 15.9								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 26.5

Top of Screen 24.1'

39.0 - 13.93 = 25.07 x 0.163 = 4.1 gal or 15.5 L

Circle if Applicable:

MS/MSD —

Duplicate ID No.: —

Signature(s): Terry Rojahn

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

WES-1-14-83

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9000~~ N0845
PROJECT SITE NAME: MGBG

WELL ID.: 01-14
DATE: 1-23-04
WEATHER: Mostly Sunny & TEMP +TEENS 14°F

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1005	13.93	—	—	—	—	—	—	—	—	Start PURGE
1015	15.69	1.50	150	6.27	0.873	75	5.83	8.38	+ 43	Orangish tint
1025	16.22	2.50	100	6.27	0.899	68	4.01	7.97	+ 11	V. Sl. Cloudy
1035	16.38	3.50	100	6.19	0.917	53	3.10	7.55	+ 5	CLEAR
1045	16.72	4.50	100	6.08	0.932	45	2.01	7.10	+ 1	"
1055	17.09	5.50	100	6.29	0.939	45	1.86	7.45	- 9	"
1105	17.31	6.50	100	6.25	0.963	41	1.68	8.02	-15	"
1115	17.54	7.50	100	6.22	0.983	36	1.52	8.36	-24	"
1125	17.72	8.50	100	6.41	0.992	30	1.33	8.64	-27	"
1135	17.93	9.50	100	6.42	1.003	28	1.20	8.75	-32	"
1145	18.10	10.50	100	6.44	1.014	25	1.09	9.12	-36	"
1155	18.27	11.50	100	6.44	1.016	23	1.01	9.22	-38	"
1205	18.43	12.50	100	6.44	1.017	20	0.90	9.31	-40	"
1215	18.61	13.50	100	6.44	1.012	15	0.85	9.12	-42	"
1225	18.65	14.30	80	6.42	1.024	11	0.69	8.86	-43	"
1235	18.66	15.10	80	6.43	1.020	8.1	0.51	8.86	-46	"
1245	18.67	15.90	80	6.43	1.015	6.7	0.47	8.70	-47	"
1250	—	—	—	—	—	—	—	—	—	Start Sampling

Water Quality Meter (S/N) 01M0616 AA
Control Box Type (S/N) NA
Turbidity Meter (S/N) 0918-4298

Pump Intake Depth 26.5

SIGNATURE(S): Terry Rogers

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name: NSWC CRANE
Project No.: N0845
Sampled By: T. Rojahn
Field Analyst: T.R.
Field Form Checked as per QA/QC Checklist (initials): JD

Sample ID No.: 01GW 1403
Sample Location: 01-14
Duplicate: ☐
Blank: ☐

SAMPLING DATA:

	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	ORP (Eh) (+/- mv)
Date: 1-23-04 Time: 1250 Method: Peristaltic	CLEAR	6.43	1.015	8.70	6.7	0.47	–	-47

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)

Electrode Make & Model: YSI

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Concentration: 0.05 ppm

Range Used:	Range	Method	Concentration ppm
☑	0 to 1 ppm	K-7510	0.05
☐	1 to 12 ppm	K-7512	

Analysis Time: 1415

Notes:

Alkalinity:

Equipment: Chemetrics Test Kit

Concentration: 240 ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-9810	
☑	50 to 500 ppm	K-9815	240
☑	100 to 1000 ppm	K-9820	230

Analysis Time: 1422

Filtered: ☐

Notes:

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Concentration: 140 ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-1910	
☑	100 to 1000 ppm	K-1920	140
☐	250 to 2500 ppm	K-1925	

Analysis Time: 1431

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-850 DR-8 __ Range: 0 - 3.00 mg/L

Program/Module: 500nm 33

Concentration: 2.80 ppm

Analysis Time: 1439

Filtered: ☐

Notes:

Hydrogen Sulfide (H_2S): Range: 0 - 5 mg/L

Equipment: HS-C Other: _____

Exceeded 5.0 mg/L range on color chart: ☐

Concentration: 0.0 ppm

Analysis Time: 1442

Notes:

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name:	NSWC CRANE	Sample ID No.:	01GW1403
Project No.:	N0845	Sample Location:	01-14
Sampled By:	T. ROSAHN	Duplicate:	☐
Field Analyst:	T.R.	Blank:	☐

Sulfide (S^{2-}):

Equipment: (DR-850) DR-8 __ Range: 0 - 0.70 mg/L Concentration: 0.05 ppm

Program/Module: 610nm 93 Analysis Time: 1448 Filtered: ☐

Notes:

Nitrite (NO_2^--N):

Concentration: 0.000 ppm

Equipment: (DR-850) DR-8 __ Range: 0 - 0.350 mg/L Analysis Time: 1424 Filtered: ☐

Program/Module: 62

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Notes:

Manganese (Mn^{2+}):

Concentration: >22.0 ppm

Equipment: (DR-850) DR-8 __ Range: 0 - 20.0 mg/L Analysis Time: 1556 Filtered: ☐

Program/Module: 525nm 41

Notes: HIGH Limit

QA/QC Checklist:

All data fields have been completed as necessary: ☑

Correct measurement units are cited in the SAMPLING DATA block: ☑

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☑

Mulitplication is correct for each *Multiplier* table: ☑

Final calulated concentration is within the appropriate *Range Used* block: ☑

Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☑

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☑

Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: NA

Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☑

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW 1503
Sample Location: 01-15
Sampled By: Goerdt
C.O.C. No.: 4391 & 4392 & 4393
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-25-04/1-26-04								
Time: 1020 / 0940								
Method: Peristaltic	Clear	6.79	1.411	5.69	2.4	-0.01	—	-7.7

PURGE DATA:

Date: 1-25-04	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Method: Peristaltic								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 40'	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 27.83								
One Casing Volume(gal/L): 7.5								
Start Purge (hrs): 0857								
End Purge (hrs): 1017								
Total Purge Time (min): 80								
Total Vol. Purged (gal/L): 7.4								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected	
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes	Y25
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	Yes	Y25
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE		Y25
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE		Y26
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial		Y26
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial		Y25
Total Organic Carbon (SW-846 9069)	H2SO4/4° C	(1) 250ml HDPE		Y25
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial		Y25
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial		Y25

OBSERVATIONS / NOTES:

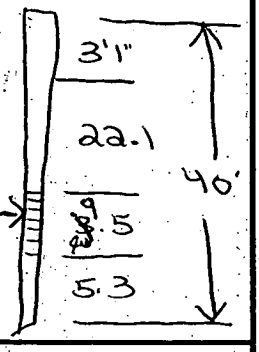
Depth of pump intake 31.27

10:55 - Stopped sampling due to well dry. Pulling up black liquid. Not able to air strip, collect hardness or NA at this time.

27.83

40.00
- 27.83
12.17 (.163) = 1.98 gal
= 7.51 L

1/26/04 Resumed sampling & MNA.



Circle if Applicable:

MS/MSD	Duplicate ID No.:	Signature(s):
—	—	

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N00602~~ 0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 0115
DATE: 1-25-04
WEATHER: Cloudy 15°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
0857	27.83	—	—	—	—	—	—	—	—	Start purge
0907	28.10	1.0	100	6.84	1.264	6.1	0.27	7.55	-18.0	Clear
0917	28.30	2.0	100	6.84	1.223	3.8	0.27	6.46	-14.3	"
0927	28.37	2.9	.90	6.81	1.193	3.1	-0.07	5.68	-9.7	"
0937	28.49	3.8	.90	6.79	1.168	2.5	-0.04	5.41	-8.0	"
0947	28.52	4.7	.90	6.77	1.152	2.6	-0.04	5.46	-7.6	"
0957	28.63	5.6	.90	6.78	1.142	2.3	-0.02	5.60	-7.2	"
1007	28.73	6.5	.90	6.77	1.141	2.2	-0.02	5.68	-7.6	"
1017	28.87	7.4	.90	6.79	1.141	2.4	-0.01	5.69	-7.7	Stop purge

Water Quality Meter (S/N) 98G0508 AA
Control Box Type (S/N) NA
Turbidity Meter (S/N) 4531-3303

Pump Intake Depth 31.27

SIGNATURE(S): [illegible]

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name: NSWC CRANE
Project No.: N0845
Sampled By: Goerdt
Field Analyst: Goerdt
Field Form Checked as per QA/QC Checklist (initials): LS

Sample ID No.: 01GW 1503
Sample Location: 01-15
Duplicate: ☐
Blank: ☐

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Salinity	ORP (Eh)
Date: 1-25-04								
Time: 1020	(Visual)	(S.U.)	(mS/cm)	(°C)	(NTU)	(mg/l)	(%)	(+/- mv)
Method: Peristaltic	Clear	6.79	1.141	5.69	2.4	-0.01	—	-7.7

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)

Electrode Make & Model: YSI

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Concentration: 0.2 ppm

Range Used:	Range	Method	Concentration ppm
☑	0 to 1 ppm	K-7510	0.2
☐	1 to 12 ppm	K-7512	

Analysis Time: 1032

Notes:

Alkalinity:

Equipment: Chemetrics Test Kit

Concentration: 325 ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-9810	
☑	50 to 500 ppm	K-9815	325
☐	100 to 1000 ppm	K-9820	

Analysis Time: 1037

Filtered: ☐

Notes:

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Concentration: 35 ppm

Range Used:	Range	Method	Concentration ppm
☑	10 to 100 ppm	K-1910	35
☐	100 to 1000 ppm	K-1920	
☐	250 to 2500 ppm	K-1925	

Analysis Time: 1042

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-850 DR-8 __ Range: 0 - 3.00 mg/L

Program/Module: 500nm 33

Concentration: 3.30 ppm

Analysis Time: 1048

Filtered: ☐

Notes:

Hydrogen Sulfide (H_2S): Range: 0 - 5 mg/L

Equipment: HS-C Other: _____

Concentration: 0.0 ppm

Exceeded 5.0 mg/L range on color chart: ☐

Analysis Time: 1050

Notes:

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name:	NSWC CRANE	Sample ID No.:	01GW 1503
Project No.:	N0845	Sample Location:	01-15
Sampled By:	Goerdt	Duplicate:	☐
Field Analyst:	Goerdt	Blank:	☐

Sulfide (S^{2-}):

Equipment: DR-850 DR-8 _ _ Range: 0 - 0.70 mg/L Concentration: 0.00 ppm

Program/Module: 610nm 93 Analysis Time: 1055 Filtered: ☐

Notes:

Nitrite (NO_2^--N):

Concentration: 0.007 ppm

Equipment: DR-850 DR-8 _ _ Range: 0 - 0.350 mg/L Analysis Time: 1039 Filtered: ☐

Program/Module: 62

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Notes:

Manganese (Mn^{2+}):

Concentration: 4.2 ppm

Equipment: DR-850 DR-8 _ _ Range: 0 - 20.0 mg/L Analysis Time: 1101 Filtered: ☐

Program/Module: 525nm 41

Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☑

Correct measurement units are cited in the SAMPLING DATA block: ☑

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☑

Mulitplication is correct for each *Multiplier* table: ☑

Final calulated concentration is within the appropriate *Range Used* block: ☑

Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☑

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☑

Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: NA

Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☑

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW 17-02 2 ms
Sample Location: 01-17
Sampled By: J. Cosgrove
C.O.C. No.: 4387
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-20-04								
Time: 1540								
Method: Peristaltic	Clear	6.23	~~661~~ .661	11.51	0.4	2.50	—	55.9

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-20-04								
Method: Peristaltic	13.0	6.23	661	11.51	0.4	2.50	—	55.9
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 41.0'	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 20.72								
One Casing Volume(gal/L): 12.51								
Start Purge (hrs): 1254								
End Purge (hrs): 1534								
Total Purge Time (min): 160								
Total Vol. Purged (gal/L): 13.0								

SAMPLE COLLECTION INFORMATION:

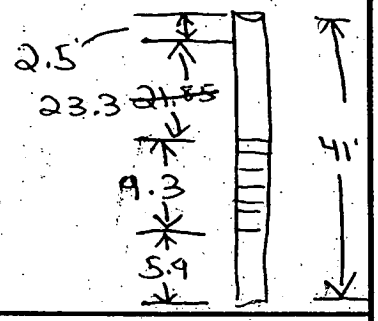
Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 30.45'

41.00
- 20.72
20.28 (.163) = 3.31 gal = 12.51 L

20.72



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ N0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 01-17
DATE: 1-20-04
WEATHER: P. Sunny 25°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1254	20.72	–	–	–	–	–	–	–	–	Start purge
1304	21.10	1000	1000	6.36	.653	2.8	3.78	11.19	56.4	Clear
1314	21.12	1.8	800	6.32	.649	1.8	3.27	10.51	56.4	"
1324	21.15	2.6	800	6.26	.647	1.6	3.05	10.89	56.6	"
1334	21.15	3.4	800	6.23	.655	1.3	2.95	11.39	56.2	"
1344	21.16	4.2	800	6.21	.657	0.8	2.96	11.36	56.0	"
1354	21.16	5.0	800	6.23	.650	0.6	2.91	10.84	56.7	"
1404	21.19	5.8	800	6.24	.644	0.6	2.82	10.61	56.8	"
1414	21.22	6.6	800	6.25	.645	0.6	2.79	10.80	56.7	"
1424	21.24	7.4	800	6.24	.648	0.6	2.75	10.82	56.5	"
1434	21.24	8.2	800	6.25	.647	0.6	2.76	10.84	56.6	"
1444	21.25	9.0	800	6.23	.650	0.6	2.74	10.92	56.6	"
1454	21.25	9.8	800	6.23	.649	0.8	2.75	10.96	56.0	"
1504	21.25	10.6	800	6.24	.651	0.9	2.68	10.98	56.6	"
1514	21.28	11.4	800	6.23	.663	0.8	2.59	11.63	56.5	"
1524	21.37	12.2	800	6.23	.665	0.5	2.52	11.71	56.2	"
1534	21.49	13.0	800	6.23	.661	0.4	2.50	11.51	55.9	"
										Stop purge

Water Quality Meter (S/N) 98605084A
Control Box Type (S/N) NA
Turbidity Meter (S/N) 4531 3303

Pump Intake Depth: 30.45'

SIGNATURE(S):

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW 1802
Sample Location: WES-1-18-83
Sampled By: RWR / JK
C.O.C. No.: 4390
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA: *

	Color	pH	S.C.	Temp.	Turbidity	DO	Sainity	ORP
Date: 1-23-04	Visual	Standard	mS/cm	°C	NTU	mg/l	%	mV
Time: 0915								
Method: SAME	Clear	7.24	0.509	8.62	105	1.20	—	-53.1

PURGE DATA:

Date: 1-22-04	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Method: PERISTALTIC PUMP								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 32	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 14.30								
One Casing Volume(gal/L): 10.5								
Start Purge (hrs): 1355								
End Purge (hrs): 1730								
Total Purge Time (min): 185								
Total Vol. Purged (gal/L): 53 l								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

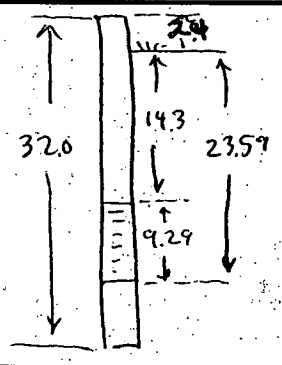
OBSERVATIONS / NOTES:

Depth of pump intake ~22.05

TOP OF SCREEN = 16.70
BTM OF SCREEN = 25.99

32 - 14.30 = 17.7' ⇒ 2.89 GAL ~ 10.5 l

* parameters taken 1/22/04 during purging well dry.



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s): Terry Rigal

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ 0845
PROJECT SITE NAME: SWMU 1

WELL ID.: WES-1-18-83
DATE: 1-22-04
WEATHER: SUNNY -5°C (23°F)

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1400		0.5l	~~80~~ 100	7.23	0.473	199	1.85	6.28	88.5	
1410	1570	~~1.5~~ 1.3l	80	7.24	0.475	165	1.50	6.16	66.6	
1420	1578	2.1	80	7.15	0.469	112	2.22	5.55	42.6	
1430	1580	2.9	80	8.11	0.265	89	1.97	8.62	2.2	CLEAN OUT FLOW THRU CELL
1440	16.46	3.7	80	8.72	0.518	85	1.19	8.77	-10.5	
1450	1682	4.5	80	8.54	0.519	80	0.92	8.58	-30.1	STOP PUMP
										ALLOW TO REC.
1600	15.37	—	—	—	—	—	—	—	—	TURN PUMP ON
1605	15.71	4.9	80	7.88	0.497	87	3.28	7.78	-8.2	
1615	15.98	5.7	80	7.24	0.509	105	1.20	8.62	-53.1	DECIDED TO
1625										PUMP DRY
1630	16.25		800	—	—	—	—	—	—	AND WILL SPL
1645	19.22		800	—	—	—	—	—	—	TOMORROW.
1655	23.5		800	—	—	—	—	—	—	
1730	30.2	53l	800	—	—	—	—	—	—	
1/23→ 0911	15.62	—	—	—	—	—	—	—	—	W.L. MCB
0915	—	—	—	—	—	—	—	—	—	Start Sampling

Water Quality Meter (S/N) YSI 02F0628 AC
Control Box Type (S/N) NA
Turbidity Meter (S/N) LAMOTTE

Pump Intake Depth -22.05

SIGNATURE(S): Terry Rogers for F. RANSER

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW1902
Sample Location: 01-19
Sampled By: T. ROJAHN
C.O.C. No.: 4392 & 4393
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Sainity	ORP
Date: 1-25-04	Visual	Standard	mS/cm	°C	NTU	mg/l	%	mV
Time: 1545								
Method: SAME	CLEAR	7.01	0.866	8.35	1.4	1.46	-	+346

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-25-04								
Method: PERISTALTIC								
Monitor Reading (ppm): -								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 32.7	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 21.5								
One Casing Volume(gal/L): 7								
Start Purge (hrs): 1323								
End Purge (hrs): 1543								
Total Purge Time (min): 140								
Total Vol. Purged (gal/L): 9								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	3 x (3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	MS MSD (1) HDPE	
Chloride & Sulfate (EPA 300.0)	4° C	" (1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	" (1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	H_2SO_4/4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	3 x (2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

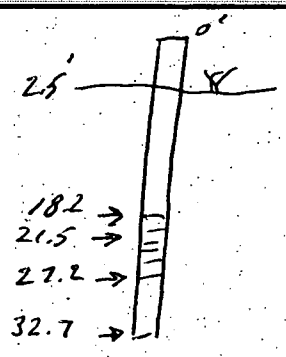
Depth of pump intake ~24.5'

18.2 Top of SCREEN
27.2 Bottom of SCREEN

32.7 - 21.5 = 11.2 x 0.163 = 1.8 gal OR 7L

27.2
-18.2
9' SCREEN

27.2
21.5
5.7' H_2O ABOVE SCREEN



Circle if Applicable:
MS/MSD YES
Duplicate ID No.:

Signature(s):

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N0000~~ 0845
PROJECT SITE NAME: MGBG

WELL ID.: 01-19
DATE: 1-25-04
WEATHER: Freezing Rain
* due to weather moved meters inside car. Temp fluk w/ car heater

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	* Temp. (Celsius)	ORP (mV)	Comments
1323	21.50	–	–	–	–	–	–	–	–	Start Purge
1333	21.66	0.3	30	6.85	0.873	11	6.49	8.82	192	Clear
1343	21.90	1.0	70	6.91	0.907	7.3	3.51	10.14	203	"
1353	22.13	1.7	70	6.91	0.920	2.4	2.82	10.07	226	"
1403	22.35	2.4	70	6.91	0.894	2.1	2.30	9.13	243	"
1413	22.52	3.1	70	6.99	0.880	1.8	2.01	8.74	248	"
1423	22.69	3.8	70	7.00	0.876	1.5	1.88	8.76	251	"
1433	22.83	4.5	70	6.98	0.903	1.2	1.76	9.75	267	"
1443	22.96	5.2	70	6.97	0.929	0.8	1.65	10.76	288	"
1453	23.09	5.9	70	6.95	0.910	0.8	1.60	10.59	325	"
1503	23.21	6.6	70	6.95	0.902	0.9	1.55	10.45	354	"
1513	23.36	7.2	60	6.99	0.889	1.0	1.57	9.06	360	"
1523	23.47	7.8	60	6.99	0.876	1.2	1.52	8.43	356	"
1533	23.55	8.4	60	7.00	0.870	1.1	1.48	8.40	350	"
1543	23.59	9.0	60	7.01	0.866	1.4	1.46	8.35	346	"
1545	—	—	—	—	—	—	—	—	—	Start Sampling

Water Quality Meter (S/N) 01M0616 AA
Control Box Type (S/N) NA
Turbidity Meter (S/N) 0918-4298

Pump Intake Depth 24.5

SIGNATURE(S): [signature]

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: NSWC CRANE
Project No.: N0845
Sampled By: T. Rosahn
Field Analyst: TR
Field Form Checked as per QA/QC Checklist (initials): QD

Sample ID No.: 01GW 1902
Sample Location: 01-19
Duplicate: ☐
Blank: ☐

SAMPLING DATA:

	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	ORP (Eh) (+/- mv)
Date: 1-25-04								
Time: 1545								
Method: Peristaltic	CLEAR	7.01	0.866	8.35	1.4	1.46	—	+346

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)
Electrode Make & Model: YSI
Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:
Equipment: Chemetrics Test Kit
Concentration: 3.0 ppm
Analysis Time: 1637

Range Used:	Range	Method	Concentration ppm
☑	0 to 1 ppm	K-7510	—
☑	1 to 12 ppm	K-7512	3

Notes: —

Alkalinity:
Equipment: Chemetrics Test Kit
Concentration: 260 ppm
Analysis Time: 1641
Filtered: ☐

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-9810	
☑	50 to 500 ppm	K-9815	260
☑	100 to 1000 ppm	K-9820	260

Notes: — —

Carbon Dioxide:
Equipment: Chemetrics Test Kit
Concentration: 18 ppm
Analysis Time: 1648

Range Used:	Range	Method	Concentration ppm
☑	10 to 100 ppm	K-1910	18
☑	100 to 1000 ppm	K-1920	—
☐	250 to 2500 ppm	K-1925	

Notes: — —

Ferrous Iron (Fe^{2+}):
Equipment: DR-850 DR-8 __ Range: 0 - 3.00 mg/L
Program/Module: 500nm 33
Concentration: 0.01 ppm
Analysis Time: 1743
Filtered: ☐
Notes:

Hydrogen Sulfide (H_2S): Range: 0 - 5 mg/L
Equipment: HS-C Other: _____
Exceeded 5.0 mg/L range on color chart: ☐
Concentration: 0.0 ppm
Analysis Time: 1740
Notes:

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name:	NSWC CRANE	Sample ID No.:	01GW1902
Project No.:	N0845	Sample Location:	01-19
Sampled By:	T. ROJAHN	Duplicate:	☐
Field Analyst:	TK	Blank:	☐

Sulfide (S^{2-}):

Equipment: DR-850 DR-8 __ Range: 0 - 0.70 mg/L Concentration: 0.03 ppm

Program/Module: 610nm 93 Analysis Time: 1751 Filtered: ☐

Notes:

Nitrite (NO_2^--N):

Concentration: 0.000 ppm

Equipment: DR-850 DR-8 __ Range: 0 - 0.350 mg/L Analysis Time: 1650 Filtered: ☐

Program/Module: 62

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Notes:

Manganese (Mn^{2+}):

Concentration: 0.0 ppm

Equipment: DR-850 DR-8 __ Range: 0 - 20.0 mg/L Analysis Time: 1001 Filtered: ☐

Program/Module: 525nm 41

Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☑

Correct measurement units are cited in the SAMPLING DATA block: ☑

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☑

Mulitplication is correct for each *Multiplier* table: ☑

Final calulated concentration is within the appropriate *Range Used* block: ☑

Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☑

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☑

Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: NA

Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☑

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW2002
Sample Location: 01-20
Sampled By: J. Goerdt
C.O.C. No.: 4387
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-21-04								
Time: 1110								
Method: Bladder	Clear	6.02	~~1.292~~ 1.297	9.51	0.73	2.10	–	8.4

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-21-04								
Method: ~~Peri~~ Bladder	~~8.5~~ gal							
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 39.04	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 27.48								
One Casing Volume(gal/L): 7.17								
Start Purge (hrs): 0930								
End Purge (hrs): 1100								
Total Purge Time (min): 90								
Total Vol. Purged (gal/L): 8.5								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

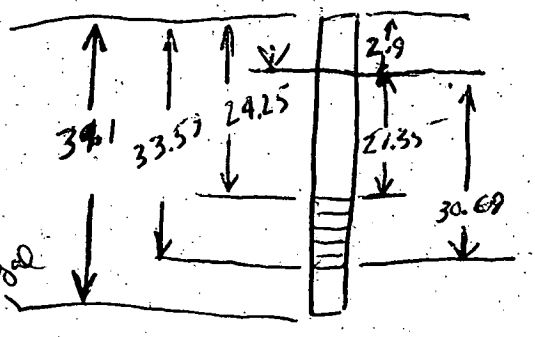
OBSERVATIONS / NOTES:

Depth of pump intake 30.53

33.69 - Bottom of screen
- 27.48 - WL
6.11 ÷ 2 = 3.05 + 27.48 = 30.53

34 - 27.49 =

39.10
27.48
11.62 (.163) = 1.89 gal
= 7.17



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	01FD012104 01

Signature(s):

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N0060~~ N0845
PROJECT SITE NAME: Swmu 01

WELL ID.: 01-20
DATE: 1-21-04
WEATHER: Cloudy 25°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
0930	27.48	1.0	1000			–	–	–	–	Start purge
0940	27.63	2.0	1000	6.34	1,355	1.70	2.73	10.30	13.8	Clear
0950	27.62	3.0	1000	6.19	1,359	1.05	2.35	10.61	13.4	"
1000	27.66	4.0	1000	6.12	1,358	0.55	2.26	10.69	11.8	"
1010	27.54	5.0	1000	6.06	1347	0.43	2.19	10.17	10.6	"
1020	27.58	5.7	700	6.03	1,308	0.40	2.28	9.09	10.9	"
1030	27.60	6.4	700	6.02	1,272	0.35	2.38	8.96	11.3	"
1040	27.61	7.1	700	6.03	1295	0.38	2.23	9.30	9.9	"
1050	27.63	7.8	700	6.03	1,297	0.42	2.15	9.53	8.5	"
1100	27.63	8.5	700	6.02	1,297	0.73	2.10	9.51	8.4	Stop purge

Water Quality Meter (S/N) 98G0508 AA
Control Box Type (S/N) 1054
Turbidity Meter (S/N) 4531 3303

Pump Intake Depth 30.53

SIGNATURE(S): [illegible]

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW 2102
Sample Location: WSS-1-21-93(0121)
Sampled By: T. ROJAHN
C.O.C. No.: 4386
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-19-04								
Time: 1452								
Method: SAME	CLEAR	6.78	0.618	8.95	030	0.58	—	-62

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-19-04								
Method: PERISTALTIC								
Monitor Reading (ppm): –								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 40.50	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 15.24								
One Casing Volume(gal/L) 15.6								
Start Purge (hrs): 1210								
End Purge (hrs): 1450								
Total Purge Time (min): 160								
Total Vol. Purged (gal/L) 16.3								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	NO
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 30.74

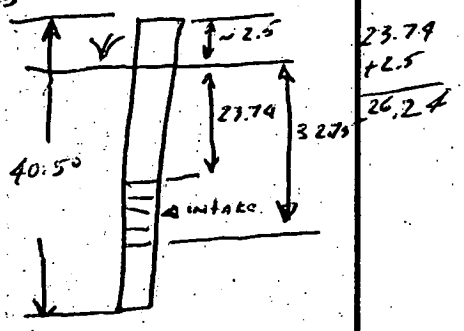
40.50
- 15.24
25.26 x 4.1 gal
or 15.6

2.5
23.74
4.5
Intake = 30.74

Top of Screen = 23.74 + 2.5
Bottom of Screen = 32.75
TD = 40.5

32.75
+2.5
35.25

32.75
- 23.74
9.01



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s): Ted Rojahn

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N0060~~ 0045
PROJECT SITE NAME: MGBG

WELL ID.: WES-1-21-83 (01-21)
DATE: 1-18-04
WEATHER: Mostly Cloudy & Cold 20°s

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1210	15.24	—	—	—	—	—	—	—	—	START PURGE
1220	16.32	1.3	130	7.97	0.172	6.32	7.32	10.40	-61	CLEAR
1230	16.48	2.3	100	8.20	0.159	5.87	6.85	10.17	-28	"
1240	16.60	3.3	100	8.38	0.154	4.93	6.75	9.87	+11	"
1250	16.70	4.3	100	8.45	0.155	2.50	6.64	10.01	+34	"
1300	16.73	5.3	100	8.41	0.164	1.35	6.33	9.60	+57	"
1310	16.75	6.3	100	7.53	0.430	1.42	3.22	9.70	-74	"
1320	16.79	7.3	100	7.21	0.522	1.30	2.13	9.71	-80	"
1330	16.82	8.3	100	7.00	0.597	1.10	1.10	9.70	-81	"
1340	16.83	9.3	100	6.95	0.598	0.90	0.89	9.73	-76	"
1350	16.85	10.3	100	6.90	0.602	0.85	0.76	9.75	-70	"
1400	16.85	11.3	100	6.93	0.608	0.55	0.65	9.50	-67	"
1410	16.85	12.3	100	6.83	0.611	0.35	0.61	9.26	-67	"
1420	16.85	13.3	100	6.95	0.611	0.30	0.59	9.07	-66	"
1430	16.85	14.3	100	6.83	0.618	0.35	0.59	9.29	-65	"
1440	16.85	15.3	100	6.81	0.619	0.32	0.58	9.10	-63	"
1450	16.85	16.3	100	6.78	0.618	0.30	0.58	8.95	-62	"
1452	—	—	—	—	—	—	—	—	—	SAMPLE TIME

Water Quality Meter (S/N) 01M0616AA
Control Box Type (S/N) NA
Turbidity Meter (S/N) 4650-4303

Pump Intake Depth 30.74

SIGNATURE(S): Ty Rogel

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW2202
Sample Location: 01-22
Sampled By: T. ROJAHN
C.O.C. No.: 4391
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-24-04								
Time: 1632								
Method: SAME	CLEAR	6.96	0.915	9.48	3.5	0.79	—	76

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-24-04								
Method: PERISTALTIC								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 38.0	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 18.93								
One Casing Volume(gal/L):								
Start Purge (hrs): 1430								
End Purge (hrs): 1630								
Total Purge Time (min): 120								
Total Vol. Purged (gal/L): 12.1								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	NO
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 27.62'

23.05 Top of Screen
32.20 Bottom of Screen

38 - 18.93 = 19.07 x 0.163 = 3.1 gal or 11.8L

Circle if Applicable:

MS/MSD —

Duplicate ID No.: —

Signature(s): Tony Rojahn

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9069~~ 0845
PROJECT SITE NAME: MGBG

WELL ID.: 01-22
DATE: 01-24-04
WEATHER: Mostly Sunny 30°s

MIN VOL 11.8

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal.)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1430	18.93	—	—	—	—	—	—	—	—	Start Purge
1440	19.71	1.1	110	7.02	0.965	65	1.42	10.42	+110	V. Sl. Cloudy
1450	19.80	2.1	100	7.00	0.963	58	1.21	10.50	102	" " "
1500	19.89	3.1	100	7.00	0.961	47	1.03	10.62	95	CLEAR
1510	19.97	4.1	100	6.95	0.961	35	0.92	10.66	88	"
1520	20.01	5.1	100	6.95	0.952	27	0.81	10.31	92	"
1530	20.06	6.1	100	6.95	0.940	17	0.78	10.07	95	"
1540	20.08	7.1	100	6.96	0.934	12	0.80	9.85	90	"
1550	20.10	8.1	100	6.96	0.929	9.5	0.79	9.78	85	"
1600	20.08	9.1	100	6.96	0.924	6.2	0.80	9.70	81	"
1610	20.10	10.1	100	6.96	0.920	7.5	0.80	9.55	78	"
1620	20.09	11.1	100	6.96	0.918	7.3	0.81	9.50	76	"
1630	20.09	12.1	100	6.96	0.915	3.5	0.79	9.48	76	"
1632 ~~1630~~	—	—	—	—	—	—	—	—	—	Sample Time

Water Quality Meter (S/N) 01M0616 AA
Control Box Type (S/N) NA
Turbidity Meter (S/N) 0918-4298

Pump Intake Depth 27.6'

SIGNATURE(S): Tony Rigal

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW2303
Sample Location: 01-23
Sampled By: T. ROJAHN
C.O.C. No.: 4387
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-20-04								
Time: 1510								
Method: SAME	CLEAR	7.60	1.305	7.72	9.5	1.31	—	-149

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-20-04								
Method: Bladder								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 48.00	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 38.95								
One Casing Volume(gal/L): 5.6								
Start Purge (hrs): 1210								
End Purge (hrs): 1420								
Total Purge Time (min): 130								
Total Vol. Purged (gal/L) 5.8								

SAMPLE COLLECTION INFORMATION:

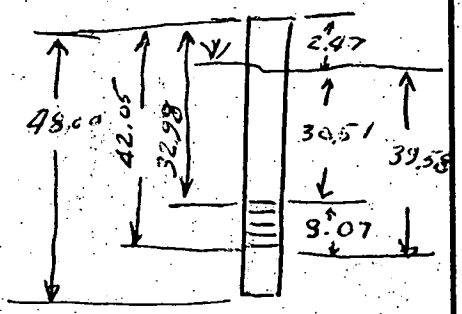
Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	NO
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 41.05'

Well Historically dries out will place pump intake ~1' above the bottom of SCREEN

49-38.95 = 9.05 x 0.163 = 1.48 gal or 5.6



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s): Tony Rojahn

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9068~~ 0845
PROJECT SITE NAME: MGBG

WELL ID.: WES-1-23-83 01-23
DATE: 1-20-04
WEATHER: Mostly sunny & 20's

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1210	38.95	—	—	—	—	—	—	—	—	Start Purge
1220	39.28	500	50	6.77	1.559	40	2.09	10.25	-61	CLEAR
1230	39.20	1,200	70	7.06	1.521	35	1.52	9.51	-86	"
1240	39.29	1,700	50	7.08	1.470	20	1.40	8.93	-104	"
1250	39.33	2,150	45	7.23	1.455	16	1.34	8.79	-113	"
1300	39.41	2,550	40	7.26	1.405	14	1.49	8.28	-118	"
1310	39.47	2,950	40	7.29	1.364	13	1.63	7.24	-123	"
1320	39.55	3350	40	7.40	1.352	12	1.51	7.60	-131	"
1330	39.65	3750	40	7.49	1.346	13	1.37	7.69	-137	"
1340	39.65	4,150	40	7.44	1.344	14	1.46	8.01	-138	"
1350	39.65	4,550	40	7.58	1.322	10	1.36	7.62	-144	"
1400	39.71	4,950	40	7.65	1.311	9.8	1.25	7.70	-145	"
1410	39.71	5,350	40	7.62	1.301	9.4	1.33	7.68	-147	"
1420	39.71	5,750	40	7.60	1.305	9.5	1.31	7.72	-149	"
1510	—	—	—	—	—	—	—	—	—	Sample Time

Water Quality Meter (S/N) 01M0616 AA
Control Box Type (S/N) MP10-1335
Turbidity Meter (S/N) 0918-4298

Pump Intake Depth 41.05'

SIGNATURE(S): Terry Rogers

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW2402
Sample Location: 01-24
Sampled By: T. ROJAHN
C.O.C. No.: 4387 & 4389
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Sainity	ORP
Date: 1-21-04	Visual	Standard	mS/cm	°C	NTU	mg/l	%	mV
Time: 1255								
Method: SAME	CLEAR	7.10	0.313	9.75	3.2	2.18	—	-90

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-21-04								
Method: Peristaltic								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 33.4	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 11.51								
One Casing Volume(gal/L): 13.5								
Start Purge (hrs): 1010								
End Purge (hrs): 1250								
Total Purge Time (min): 160								
Total Vol. Purged (gal/L): 13.8								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	YES
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	YES
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	YES
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	YES
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	YES
Total Organic Carbon (SW-846 9069)	4° C / H2SO4	(1) 250ml HDPE	YES
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	YES
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	YES

OBSERVATIONS / NOTES:

Depth of pump intake 23.32

Top of Screen = 18.62
Bottom of Screen = 28.03

33.4 - 11.51 = 21.89' x 0.163 = 3.6 gal / or 13.5 L

Circle if Applicable:

MS/MSD —

Duplicate ID No.: —

Signature(s): Tey Rojahn

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

WES-1-24-83

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ 0845
PROJECT SITE NAME: MGBG

WELL ID.: 01-24
DATE: 1-21-04
WEATHER: Mostly Cloudy 20's

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1010	11.51	—	—	—	—	—	—	—	—	Start Purge
1020	13.50	1,400	140	7.03	0.239	60	6.92	9.72	+ 25	Orange Percip.
1030	14.21	2,400	100	6.96	0.232	25	5.54	9.51	16	" " (Clear)
1040	14.75	3,300	90	7.00	0.229	12	5.31	9.57	- 5	CLEAR.
1050	15.05	4,100	80	7.07	0.264	11	4.37	9.44	- 20	"
1100	15.36	4,950	85	7.09	0.271	10	4.02	9.52	- 48	"
1110	15.67	5,800	85	7.11	0.276	7.1	4.10	9.63	- 54	"
1120	15.91	6,600	80	7.12	0.282	5.3	4.18	9.71	-60	"
1130	16.06	7,400	80	7.12	0.293	4.5	3.52	9.76	-68	"
1140	16.15	8,200	80	7.12	0.301	3.7	3.13	9.81	-74	"
1150	16.23	9,000	80	7.12	0.301	3.0	3.20	9.46	-76	"
1200	16.31	9,800	80	7.12	0.301	2.7	3.58	9.03	-78	"
1210	16.41	10,600	80	7.14	0.310	2.3	2.35	9.71	-85	"
1220	16.51	11,400	80	7.10	0.309	2.2	2.37	9.68	-85	"
1230	16.57	12,200	80	7.11	0.312	2.1	2.22	9.65	-88	"
1240	16.63	13,000	80	7.12	0.306	2.1	2.30	9.70	-89	"
1250	16.65	13,800	80	7.10	0.313	3.2	2.18	9.75	- 90	"
1255	—	—	—	—	—	—	—	—	—	Start Sample

Water Quality Meter (S/N) 01M0616 AA
Control Box Type (S/N) NA
Turbidity Meter (S/N) 0918-4298

Pump Intake Depth 23.32

SIGNATURE(S): Terry Royal

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: NSWC CRANE
Project No.: N0845
Sampled By: T. ROJAHN
Field Analyst: T.R.
Field Form Checked as per QA/QC Checklist (initials): QS

Sample ID No.: 01GW2402
Sample Location: 01-24
Duplicate: ☐
Blank: ☐

SAMPLING DATA:

	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	ORP (Eh) (+/- mv)
Date: 1/21/04 Time: 1255 Method: Peristaltic	CLEAR	7.10	0.313	9.75	3.2	2.18	—	-90

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)

Electrode Make & Model: 01M0616

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Concentration: 0.2 ppm

Range Used:	Range	Method	Concentration ppm
☑	0 to 1 ppm	K-7510	0.2
☑	1 to 12 ppm	K-7512	

Analysis Time: 1400

Notes:

Alkalinity:

Equipment: Chemetrics Test Kit

Concentration: 180 ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-9810	
☐	50 to 500 ppm	K-9815	
☑	100 to 1000 ppm	K-9820	180

Analysis Time: 1408

Filtered: ☐

Notes: Turned Green

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Concentration: 12 ppm

Range Used:	Range	Method	Concentration ppm
☑	10 to 100 ppm	K-1910	12
☑	100 to 1000 ppm	K-1920	
☐	250 to 2500 ppm	K-1925	

Analysis Time: 1419

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-850 DR-8 __ Range: 0 - 3.00 mg/L

Program/Module: 500nm 33

High Limit

Concentration: >3.3 ppm

Analysis Time: 1425

Filtered: ☐

Notes:

Hydrogen Sulfide (H_2S): Range: 0 - 5 mg/L

Equipment: HS-C Other: _____

Exceeded 5.0 mg/L range on color chart: ☐

Concentration: 0.0 ppm

Analysis Time: ~~0.0~~ TN 1426

Notes:

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name:	NSWC CRANE	Sample ID No.:	01GW0402
Project No.:	N0845	Sample Location:	01-24
Sampled By:	T. ROJAHN	Duplicate:	☐
Field Analyst:	T.R	Blank:	☐

Sulfide (S^{2-}):

Equipment: DR-850 DR-8 __ Range: 0 - 0.70 mg/L Concentration: 0.01 ppm

Program/Module: 610nm 93 Analysis Time: 1438 Filtered: ☐

Notes:

Nitrite (NO_2^--N):

Concentration: 0.006 ppm

Equipment: DR-850 DR-8 __ Range: 0 - 0.350 mg/L Analysis Time: 1412 Filtered: ☐

Program/Module: 62

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Notes:

Manganese (Mn^{2+}):

Concentration: 1.5 ppm

Equipment: DR-850 DR-8 __ Range: 0 - 20.0 mg/L Analysis Time: 1446 Filtered: ☐

Program/Module: 525nm 41

Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☑

Correct measurement units are cited in the SAMPLING DATA block: ☑

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☑

Mulitplication is correct for each *Multiplier* table: ☑

Final calulated concentration is within the appropriate *Range Used* block: ☑

Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☑

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☑

Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: NA

Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☑

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW - 2503
Sample Location: 0125
Sampled By: J. Goerdt
C.O.C. No.: 4387 & 4389
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-21-04								
Time: 1640								
Method: Bladder	Clear	7.05	~~1032~~ 1.037	11.58	86.7	0.31	—	52.7

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-21-04								
Method: Bladder	20.7							
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 34.20	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 21.80								
One Casing Volume(gal/L): 7.65								
Start Purge (hrs): 1233								
End Purge (hrs): 1633								
Total Purge Time (min): 240								
Total Vol. Purged (gal/L): 20.7								

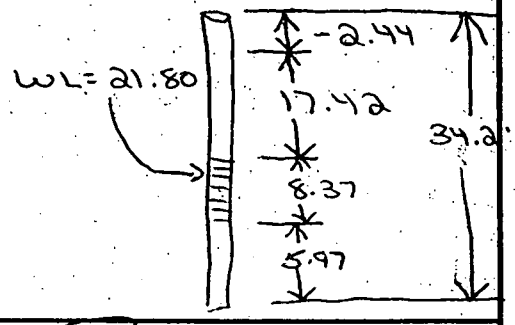
SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE ✓	Yes
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE ✓	Yes
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE ✓	Yes
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	Yes
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	Yes
Total Organic Carbon (SW-846 9069)	4° C / H2SO4	(1) 250ml HDPE ✓	Yes
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	Yes
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial ✓	Yes

OBSERVATIONS / NOTES:

Depth of pump intake 25.01

34.20
21.80
12.40 (.163) = 2.02 gal
= 7.65 L



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ N0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 0125
DATE: 1-21-04
WEATHER: Clear 25°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1233	21.80	—	—	—	—	—	—	—	—	Start purge
1243	22.19	.9	900	7.07	983	367	1.32	9.17	1.8	Cloudy
1253	22.28	1.4	500	7.06	994	305	1.14	10.17	54.3	"
1303	22.42	2.3	900	7.06	1012	275	0.96	10.34	53.7	"
1313	22.55	3.2	90.0	7.06	1011	240	0.88	10.26	53.6	"
1323	22.63	4.1	90	7.07	1007	214	0.82	10.09	53.2	"
1333	22.69	5.0	90	7.06	1010	210	0.79	10.30	53.2	"
1343	22.75	5.9	90	7.07	1012	185	0.72	10.43	52.9	"
1353	22.81	6.8	90	7.07	1009	107	0.67	10.28	52.8	"
1403	22.85	7.7	90	7.06	1011	95.2	0.68	10.42	52.7	"
1413	22.85	8.6	90	7.06	1013	91.0	0.50	10.40	52.7	"
1423	22.86	9.5	90	7.06	1011	80.6	0.49	10.38	52.8	"
1433	22.87	10.4	90	7.08	1015	72.1	0.53	10.47	52.3	"
1443	22.87	11.3	90	7.03	1022	48.3	0.55	10.93	52.5	Clear
1453	22.90	12.2	90	7.01	1021	26.3	0.53	10.78	52.0	"
1503	22.91	13.1	90	7.01	1015	22.8	0.50	10.57	52.4	"
1513	22.93	14.0	90	7.02	1007	18.0	0.47	10.47	52.3	"
1523	22.95	14.9	90	7.04	1014	30.5	0.43	10.70	52.3	"
1533	22.98	15.8	90	7.05	1013	51.3	0.38	10.66	52.3	"
1543	22.95	16.7	90	7.05	1013	50.2	0.40	9.81	52.4	"
1553	22.90	17.5	80	7.04	1007	97.7	0.41	10.41	52.6	"
1603	22.92	18.3	80	7.04	1010	104	0.42	10.40	52.4	"

Water Quality Meter (S/N) 98G0508 AA
Control Box Type (S/N) 1054
Turbidity Meter (S/N) 4531 3303

Pump Intake Depth 25.01

SIGNATURE(S): [signature]

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ N0845
PROJECT SITE NAME: Swmu 01

WELL ID.: 01-25
DATE: 1-21-04
WEATHER: Sun 30°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1613	22.91	19.1	80	7.04	1000	98.7	0.41	10.08	52.3	cloudy
1623	23.00	19.9	80	7.04	1023	93.8	0.31	11.42	52.3	"
1633	23.12	20.7	80	7.05	1032	86.7	0.31	11.58	52.7	stop purge

Water Quality Meter (S/N) 9860508 AA
Control Box Type (S/N) 1054
Turbidity Meter (S/N) 4531 3303

Pump Intake Depth 25.01

SIGNATURE(S): [illegible]

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: NSWC CRANE
Project No.: 0845
Sampled By: J. Goerdt
Field Analyst: Goerdt / Rojahn
Field Form Checked as per QA/QC Checklist (initials): QS

Sample ID No.: 01GW2503
Sample Location: 0125
Duplicate: ☐
Blank: ☐

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Salinity	ORP (Eh)
Date: 1-21-04								
Time: 1640	(Visual)	(S.U.)	(mS/cm)	(°C)	(NTU)	(mg/l)	(%)	(+/- mv)
Method: Bladder	Cloudy	7.05	1032	11.58	86.7	0.31	—	52.7

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)

Electrode Make & Model: YSI

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Concentration: .25 ppm

Range Used:	Range	Method	Concentration ppm
☑	0 to 1 ppm	K-7510	.25
☐	1 to 12 ppm	K-7512	

Analysis Time: 1808

Notes:

Alkalinity:

Equipment: Chemetrics Test Kit

Concentration: <10 ppm

Range Used:	Range	Method	Concentration ppm
☑	10 to 100 ppm	K-9810	<10
☐	50 to 500 ppm	K-9815	
☐	100 to 1000 ppm	K-9820	

Analysis Time: 1813

Filtered: ☐

Notes:

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Concentration: 25 ppm

Range Used:	Range	Method	Concentration ppm
☑	10 to 100 ppm	K-1910	25
☐	100 to 1000 ppm	K-1920	
☐	250 to 2500 ppm	K-1925	

Analysis Time: 1819

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-850 DR-8 __ Range: 0 - 3.00 mg/L

Program/Module: 500nm 33

Concentration: 0.03 ppm

Analysis Time: 1827

Filtered: ☐

Notes:

Hydrogen Sulfide (H_2S): Range: 0 - 5 mg/L

Equipment: HS-C Other: _____

Exceeded 5.0 mg/L range on color chart: ☐

Concentration: 0.0 ppm

Analysis Time: 1840

Notes:

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: NSWC CRANE
Project No.: 0845
Sampled By: Goerdt
Field Analyst: Goerdt / Rajan

Sample ID No.: 01GW2503
Sample Location: 0125
Duplicate: ☐
Blank: ☐

Sulfide (S^{2-}):

Equipment: DR-850 DR-8 __ Range: 0 - 0.70 mg/L
Program/Module: 610nm 93
Concentration: 0.23 ppm
Analysis Time: 1838
Filtered: ☐
Notes:

Nitrite (NO_2^--N):

Equipment: DR-850 DR-820 Range: 0 - 0.350 mg/L
Program/Module: 62
Concentration: 0.000 ppm
Analysis Time: 1834
Filtered: ☐
Standard Solution: ☐ Results: _____
Reagent Blank Correction: ☐
Notes:

Manganese (Mn^{2+}):

Equipment: DR-850 DR-8 __ Range: 0 - 20.0 mg/L
Program/Module: 525nm 41
Concentration: 0.0 ppm
Analysis Time: 1841
Filtered: ☐
Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☑
Correct measurement units are cited in the SAMPLING DATA block: ☑
Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☑
Mulitplication is correct for each *Multiplier* table: ☑
Final calulated concentration is within the appropriate *Range Used* block: ☑
Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☑
QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☑
Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: ☑ NA
Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☑

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW 2603
Sample Location: 01-26
Sampled By: Goerdt
C.O.C. No.: 4391
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-24-04								
Time: 1705								
Method: Bladder	Clear	6.82	1.111	10.51	8	-.04	—	34.4

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-24-04								
Method: Bladder								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 58.0'	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 36.20								
One Casing Volume(gal/L) 13.45								
Start Purge (hrs): 1439								
End Purge (hrs): 1659								
Total Purge Time (min): 150								
Total Vol. Purged (gal/L) 17.6								

SAMPLE COLLECTION INFORMATION:

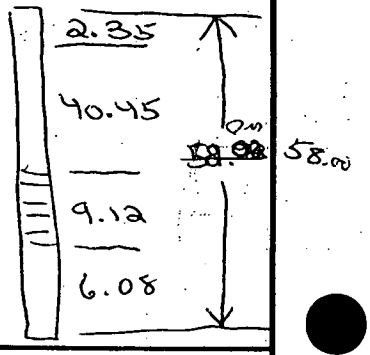
Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 47.36'

58.00
36.20
21.80 (.163) = 3.55 gal
= 13.45 L

▲ 36.20



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s): [signature]

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N0060~~ 0845
PROJECT SITE NAME: Summ 01

WELL ID.: 01-26
DATE: 1-24-04
WEATHER: P. Cloudy 30°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1439	36.20	—	—	—	—	-	-	-	-	start purge
1449	36.98	1.2	120	6.87	1.153	450	1.01	10.83	32.5	Cloudy
1459	37.64	2.7	150	6.87	1.166	200	0.00	11.26	30.5	"
1509	37.61	3.8	110	6.86	1.148	130	0.13	10.63	31.1	"
1519	37.78	4.9	110	6.87	1.150	98	-.02	10.68	31.3	"
1529	37.96	6.0	110	6.87	1.154	65	-.08	10.86	31.6	Sl. Cloudy
1539	38.03	7.1	110	6.86	1.149	52	-.01	10.74	32.2	"
1549	38.19	8.2	110	6.85	1.139	45	-.09	10.75	32.7	Clear
1559	38.18	9.4	120	6.84	1.138	29	-.08	10.82	33.3	"
1609	38.24	10.6	120	6.83	1.132	26	-.08	10.80	33.6	"
1619	38.32	11.8	120	6.82	1.126	20	-.07	10.80	34.0	"
1629	38.33	13.0	120	6.82	1.121	19	-.07	10.62	34.1	"
1639	38.29	14.2	120	6.81	1.112	14	-.04	10.53	34.6	"
1649	38.31	16.4	120	6.81	1.109	12	-.04	10.49	34.8	"
1659	38.33	17.0	60	6.81	1.109	11	-.05	10.52	34.4	"
1659	38.34	17.6	60	6.82	1.111	8	-.04	10.51	34.4	Stop purge

Water Quality Meter (S/N) 9860508 AA
Control Box Type (S/N) 1054
Turbidity Meter (S/N) 4531-3303

Pump Intake Depth 47' 36"

SIGNATURE(S): [illegible]

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW-~~0127~~ 2702
Sample Location: 01-27
Sampled By: Goerdt
C.O.C. No.: 4391
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-23-04								
Time: 1730								
Method: Bladder	Clear	7.14	.775	8.75	8.5	0.26	—	-25.7

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-23-04								
Method: Bladder								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 43'	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 24.8								
One Casing Volume(gal/L) 11.23								
Start Purge (hrs): 1510								
End Purge (hrs): 1720								
Total Purge Time (min): 130								
Total Vol. Purged (gal/L) 130								

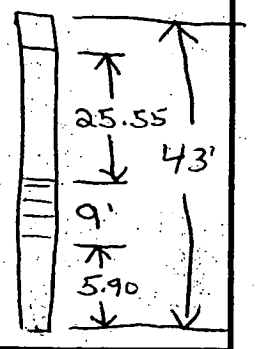
SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	No
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 32.6

43.00
24.80
18.20 (.163) = 2.97 gal
= 11.23 L



Circle if Applicable:

MS/MSD	Duplicate ID No.:	Signature(s):
—	—	[signature]

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ N0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 01-27
DATE: 1-23-04
WEATHER: Cloudy 28°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1510	24.80	—	—	—	—	—	—	—	—	Start purge
1520	26.02	1.0	100	7.09	.808	120	0.33	9.66	-21.7	sl. cloudy
1530	26.51	2.0	100	7.14	.799	92	0.40	9.80	-24.8	"
1540	26.98	3.0	100	7.15	.787	55	0.38	9.39	-25.8	"
1550	27.21	4.0	100	7.16	.782	36	0.38	9.21	-26.1	"
1600	27.42	5.0	100	7.15	.780	23	0.40	9.12	-26.6	clear
1610	27.68	6.0	100	7.16	.779	16	0.31	9.17	-26.2	"
1620	27.76	7.0	100	7.16	.775	15	0.30	9.04	-26.0	"
1630	27.95	8.0	100	7.15	.774	13	0.30	8.84	-26.9	"
1640	27.97	9.0	100	7.15	.773	12	0.31	8.84	-26.8	"
1650	27.99	10.0	100	7.14	.773	10	0.31	8.82	-25.7	"
1700	28.10	11.0	100	7.15	.775	10	0.29	8.79	-25.0	"
1710	28.13	12.0	100	7.14	.773	9.6	0.28	8.71	-25.5	"
1720	28.15	13.0	100	7.14	.775	8.5	0.26	8.75	-25.7	stop purge

Water Quality Meter (S/N) 98G0508 AA
Control Box Type (S/N) 1054
Turbidity Meter (S/N) 4531-3303

Pump Intake Depth 32.6

SIGNATURE(S): [illegible]

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW C0103
Sample Location: 01-C01
Sampled By: Goerdt
C.O.C. No.: 4398
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-26-04								
Time: 1805								
Method: Bladder	CLEAR	7.95	0.337	5.31	25	0.01	—	-10.8

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-26-04								
Method: Bladder								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 165.0	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 138.1								
One Casing Volume(gal/L): 16.6								
Start Purge (hrs): 1403								
End Purge (hrs): 1803								
Total Purge Time (min): 240								
Total Vol. Purged (gal/L) 35.9								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	No
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 156'

165.0
138.1
26.9(.163) = 4.38 gal
= 16.6 L

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ 0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 01-C01
DATE: 01/26/04
WEATHER: Cloudy/Foggy 30's

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1403	138.1	-	-	-	-	-	-	-	-	Start purge
1413	138.5	1.0	100	7.26	0.666	370	0.26	10.04	-7.0	cloudy
1423	137.8	2.0	100	7.35	0.600	330	0.21	10.33	-13.7	"
1433	137.9	3.0	170	7.54	0.489	160	0.12	11.23	-17.9	"
1443	137.9	5.4	170	7.59	0.451	110	0.08	11.22	-19.8	"
1453	137.9	7.1	170	7.62	0.426	80	0.05	11.36	28.4	clear
1503	138	8.8	170	7.64	0.412	68	0.04	11.43	28.4	"
1513	138	10.5	170	7.67	0.407	45	0.02	11.52	28.1	"
1523	138	12.2	170	8.92	0.389	47	0.02	10.61	-10.9	"
1533	138	13.9	170	7.66	0.378	48	0.02	9.43	-18.1	"
1543	138	15.6	170	7.66	0.379	50	0.02	9.38	-18.6	"
1553	138	17.3	170	7.67	0.380	48	0.03	9.32	-19.0	"
1603	138	19.0	170	7.71	0.383	45	0.03	9.30	-18.9	"
1613	138	20.7	170	7.75	0.387	42	0.01	9.38	-19.0	"
1623	138	22.4	170	7.79	0.386	39	0.01	9.30	-19.5	"
1633	138	24.1	170	7.81	0.382	37	0.01	9.06	-19.2	"
1643	138	25.8	170	7.85	0.381	33	0.01	8.99	-19.3	"
1653	138	27.5	170	7.90	0.377	30	0.01	8.91	-6.2	"
1703	138	29.2	170	7.93	0.366	27	0.01	7.64	-10.7	"
1713	138	30.9	170	7.93	0.352	27	0.00	6.86	-8.1	"
1723	138	31.9 ~~40.9~~	100	7.93	0.351	25	0.01	6.89	-7.1	"
1733	138	32.9 ~~50.9~~	100	7.96	0.348	25	0.01	5.66	-9.3	"

Water Quality Meter (S/N) 9860508 AA
Control Box Type (S/N) 1054
Turbidity Meter (S/N) 4531-3303

Pump Intake Depth 156'

SIGNATURE(S): [signature]

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9080~~ 0845
PROJECT SITE NAME: Summer 01

WELL ID.: 01-C01
DATE: 1-26-04
WEATHER: Cloudy / Fog 30's

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1743	138	33.9	100	7.96	0.339	27	.01	5.27	-12.3	Clear
1753	138	34.9	100	7.96	0.337	30	.00	5.28	-11.2	"
1803	138	35.9	100	7.95	0.337	25	.01	5.31	-10.8	Stop purge

Water Quality Meter (S/N) 9860508AA
Control Box Type (S/N) 1054
Turbidity Meter (S/N) 4531-3303

Pump Intake Depth 156'

SIGNATURE(S): [illegible]

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW T0204
Sample Location: 01T02
Sampled By: Goerdt
C.O.C. No.: 4391
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Sainity	ORP
Date: 1-24-04	Visual	Standard	mS/cm	°C	NTU	mg/l	%	mV
Time: 1900								
Method: Bladder	Clear	5.76	2.299	6.94	8.1	5.00	—	38.3

PURGE DATA:

Date: 1-24-04	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Method: Bladder								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 72.3"	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 65.32								
One Casing Volume(gal/L) 4.3								
Start Purge (hrs): 1735								
End Purge (hrs): 1855								
Total Purge Time (min): 80								
Total Vol. Purged (gal/L) 5.2								

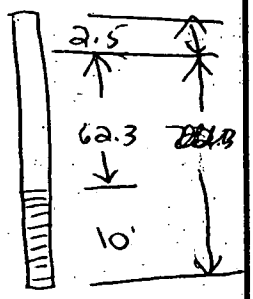
SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 68.8

72.30
65.32
6.98(.163) = 1.14 gal
= 4.3 L



72.3 +
=

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ 0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 01T02
DATE: 1-24-04
WEATHER: Cloudy 20's

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1735	65.32	—	—	—	—	—	—	—	—	Start purge
1745	66.19	.9	90	6.29	2.096	—	0.09	3.74	34.7	
1755	67.08	1.8	90	6.20	2.113	320	0.05	4.22	35.3	Cloudy
1805	68.30	2.7	90	6.08	2.218	210	0.10	5.94	36.2	"
1815	66.09	3.6	90	5.95	2.336	33	0.03	7.45	37.8	Clear
* 1825	66.23	4.5	90	5.92	2.335	26	0.02	7.36	38.0	"
1835	66.45	5.4	90	5.85	2.334	19	0.02	7.20	38.3	"
1845	66.79	6.3	90	5.79	2.300	14	0.05	7.15	38.7	"
1855	66.85	5.2	90	5.76	2.299	8.1	0.00	6.94	38.3	Stop purge

* well vol.

Water Quality Meter (S/N) 98G0508 AA
Control Box Type (S/N) 1054
Turbidity Meter (S/N) 4531-3303

Pump Intake Depth 68.6

SIGNATURE(S): [illegible]

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW T0302
Sample Location: 01-T03
Sampled By: Goerdt
C.O.C. No.: 4392
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Sainity	ORP
Date: 1-25-04	Visual	Standard	mS/cm	°C	NTU	mg/l	%	mV
Time: 1740								
Method: Bladder	Clear	7.29	.562	8.21	8.8	0.28	—	40.9

PURGE DATA:

Date: 1-25-04	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Method: Bladder								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 156.4	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 138.4								
One Casing Volume(gal/L): 11.11								
Start Purge (hrs): 1550								
End Purge (hrs): 1730								
Total Purge Time (min): 100								
Total Vol. Purged (gal/L): 12								

SAMPLE COLLECTION INFORMATION:

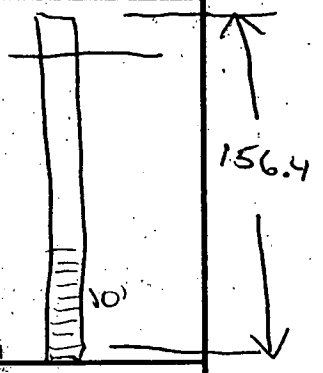
Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	No
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 151.4

~~156.4~~ 20
~~151.4~~

156.4
138.4
18.0 (.163) = 2.93 gal
= 11.11 L



Circle if Applicable:

MS/MSD | Duplicate ID No.:

Signature(s):

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N0060~~ 0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 01-T03
DATE: 1-25-04
WEATHER: Freezing rain - tears

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1550	138.4	–	–	–	–	–	–	–	–	Start purge
1600	138.8	1.0	100	–	–	75	–	–	–	YSI connection bad
1610	139.0	2.0	100	7.48	.543	60	0.73	7.56	-4.2	clear
1620	139.0	3.0	100	7.41	.550	38	0.51	7.63	-9.4	"
1630	139.0	4.0	100	7.36	.553	29	0.42	7.57	39.9	"
1640	139.0	5.0	100	7.32	.558	24	0.34	7.81	41.0	"
1650	139.0	6.0	100	7.31	.561	17	0.33	7.92	40.8	"
1700	139.0	7.5	150	7.31	.563	14	0.32	8.10	40.7	"
1710	139.0	9.0	150	7.30	.564	12	0.29	8.14	40.7	"
1720	139.0	10.5	150	7.30	.563	10	0.27	8.20	40.6	"
1730	139.0	12.0	150	7.29	.563	8.8	0.28	8.21	40.9	Stop purge

Water Quality Meter (S/N) 9860508 AA
Control Box Type (S/N) 1054
Turbidity Meter (S/N) 4531-3303

Pump Intake Depth 151.4

SIGNATURE(S): [illegible]

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW T0402
Sample Location: 01-T04
Sampled By: Goulet
C.O.C. No.: 4391
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-25-04								
Time: 1500								
Method: Bladder	Clear	7.80	.287	8.73	9.5	0.19	—	-6.4

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-25-04								
Method: Bladder								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 153.8	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 137.4								
One Casing Volume(gal/L): 10.12								
Start Purge (hrs): 1245								
End Purge (hrs): 1455								
Total Purge Time (min): 130								
Total Vol. Purged (gal/L): 19.5								

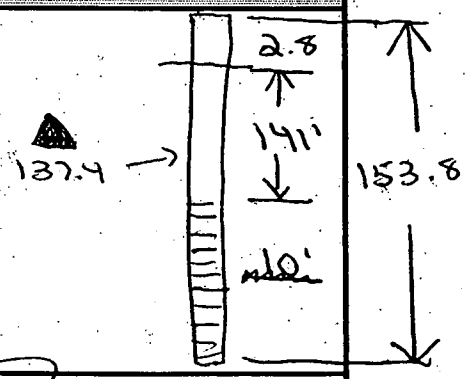
SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	NO
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 148.8

153.8
137.4
16.4 (.163) = 2.67 gal
= 10.12 L



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N9060~~ 0845
PROJECT SITE NAME: SWMU 01

WELL ID.: 01-T04
DATE: 1-25-04
WEATHER: 4 cars / freezing rain

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1245	137.4	—	—	—	—	—	—	—	—	Start purge
1255	137.8	1.5	150	7.79	.273	825	4.27	6.88	-8.5	Air tx
1305	137.3	3.0	150	7.82	.274	600	1.17	7.96	-7.2	"
1315	137.3	4.5	150	7.81	.275	310	1.01	7.81	-1.9	"
1325	137.3	6.0	150	7.81	.278	220	0.92	8.07	1.4	Cloudy
1335	137.3	7.5	150	7.82	.278	130	0.78	8.36	2.7	"
1345	137.4	9.0	150	7.81	.297	50	0.70	8.57	-7.0	Clear
1355	137.3	10.5	150	7.82	.287	31	0.62	8.92	-4.7	"
1400	137.3	~~0.8~~ 11.25	75	7.81	.286	21	0.53	8.76	-6.2	"
1405	137.3	12.0	75	7.81	.288	22	0.54	8.85	-5.7	"
1415	137.3	13.5	150	7.81	.289	19	0.53	8.90	-7.0	"
1425	137.6	15.0	150	7.85	.285	32	1.13	7.80	-6.2	Switched air tank
1435	137.3	16.5	150	7.83	.284	27	0.47	8.70	-6.2	Clear
1445	137.4	18.0	150	7.81	.283	14	0.50	8.68	-6.2	"
1455	137.3	19.5	150	7.80	.287	9.5	0.49	8.73	-6.4	Stop purge

Water Quality Meter (S/N) 9860508AA
Control Box Type (S/N) 1054
Turbidity Meter (S/N) 4531-3303

Pump Intake Depth 148.8

SIGNATURE(S): [signature]

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GWT0502
Sample Location: 01T05
Sampled By: T. ROJAHN
C.O.C. No.: 4389 & 4390
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Sainity	ORP
Date: 1-22-04	Visual	Standard	mS/cm	°C	NTU	mg/l	%	mV
Time: 1415								
Method: PERISTALTIC	CLEAR	5.73	1.044	6.55	8.2	1.38	—	+ 198

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-22-04								
Method: PERISTALTIC								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 33.25	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 17.83								
One Casing Volume(gal/L): 9.5								
Start Purge (hrs): 1200								
End Purge (hrs): 1410								
Total Purge Time (min): 130								
Total Vol. Purged (gal/L): 10								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4°C	(1) HDPE	
Chloride & Sulfate (EPA 300.0)	4°C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4°C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4°C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4°C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	H_2SO_4 / 4°C	(1) 250ml HDPE	
Total Inorganic Carbon	4°C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4°C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 28.25 Top of Screen = 23.25

33.25 - 17.83 = 15.42 x 0.163 = 2.5 gal or 9.5

Circle if Applicable:

MS/MSD —

Duplicate ID No.: —

Signature(s):

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N0060~~ 0845
PROJECT SITE NAME: MGBG

WELL ID.: 01T05
DATE: 1-22-04
WEATHER: Partly Sunny, 17°

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1200	17.83	–	–	–	–	–	–	–	–	START PURGE
1210	18.28	1.0	100	5.79	1.032	34	5.25	7.82	+230	CLEAR
1220	18.49	1.75	75	5.76	1.028	26	3.35	7.91	217	"
1230	18.66	2.50	75	5.70	1.035	25	2.89	7.68	217	"
1240	18.83	3.25	75	5.63	1.042	22	2.44	7.45	219	"
1250	18.89	4.00	75	5.61	1.046	20	2.21	7.45	219	"
1300	18.95	4.75	75	5.59	1.053	20	2.00	7.45	219	"
1310	19.03	5.50	75	5.60	1.065	17	1.75	7.50	215	"
1320	19.12	6.25	75	5.61	1.078	15	1.58	7.56	209	"
1330	19.17	7.00	75	5.67	1.072	14	1.55	7.34	206	"
1340	19.21	7.75	75	5.71	1.065	13	1.51	7.12	203	"
1350	19.21	8.50	75	5.72	1.060	12	1.50	6.65	203	"
1400	19.23	9.25	75	5.73	1.056	12	1.49	6.13	202	"
1410	19.24	10.00	75	5.73	1.044	8.2	1.38	6.55	198	"
1415	–	–	–	–	–	–	–	–	–	Start Sampling

Water Quality Meter (S/N) 01M0616 AA
Control Box Type (S/N) NA
Turbidity Meter (S/N) 0918-4298

Pump Intake Depth 28.25'

SIGNATURE(S): Terry Rogers

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name:	NSWC CRANE	Sample ID No.:	01GW T0502
Project No.:	N0845	Sample Location:	01T05
Sampled By:	T. ROJAHN	Duplicate:	☐
Field Analyst:	T.R	Blank:	☐
Field Form Checked as per QA/QC Checklist (initials):	TR		

SAMPLING DATA:

	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	ORP (Eh) (+/- mv)
Date: 1/22/04								
Time: 1415								
Method: Peristaltic	CLEAR	5.73	1.044	6.55	8.2	1.38	—	+198

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)

Electrode Make & Model: _____

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Concentration: 0.5 ppm

Range Used:	Range	Method	Concentration ppm
☑	0 to 1 ppm	K-7510	
☐	1 to 12 ppm	K-7512	

Analysis Time: 1645

Notes:

Alkalinity:

Equipment: Chemetrics Test Kit

Concentration: 40 ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-9810	
☐	50 to 500 ppm	K-9815	
☐	100 to 1000 ppm	K-9820	

Analysis Time: 1650

Filtered: ☐

Notes:

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Concentration: 35 ppm

Range Used:	Range	Method	Concentration ppm
☑	10 to 100 ppm	K-1910	35
☑	100 to 1000 ppm	K-1920	/
☑	250 to 2500 ppm	K-1925	/

Analysis Time: 1658

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-850 DR-8 __ Range: 0 - 3.00 mg/L

Program/Module: 500nm 33

Concentration: 0.35 ppm

Analysis Time: 1715

Filtered: ☐

Notes:

Hydrogen Sulfide (H_2S): Range: 0 - 5 mg/L

Equipment: HS-C Other: _____

Exceeded 5.0 mg/L range on color chart: ☐

Concentration: 0.0 ppm

Analysis Time: 1720

Notes:

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name:	NSWC CRANE	Sample ID No.:	01GW 070502
Project No.:	N0845	Sample Location:	
Sampled By:	T. ROJAHN	Duplicate:	☐
Field Analyst:	T.R.	Blank:	☐

Sulfide (S^{2-}):

Equipment: DR-850 (circled) DR-8 __ Range: 0 - 0.70 mg/L Concentration: 0.00 ppm

Program/Module: 610nm 93 Analysis Time: 1727 Filtered: ☐

Notes:

Nitrite (NO_2^--N):

Concentration: 0.004 ppm

Equipment: DR-850 (circled) DR-8 __ Range: 0 - 0.350 mg/L Analysis Time: 1707 Filtered: ☐

Program/Module: 62

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Notes:

Manganese (Mn^{2+}):

Concentration: 9.5 ppm

Equipment: DR-850 (circled) DR-8 __ Range: 0 - 20.0 mg/L Analysis Time: 1733 Filtered: ☐

Program/Module: 525nm 41

Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☑

Correct measurement units are cited in the SAMPLING DATA block: ☑

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☑

Mulitplication is correct for each *Multiplier* table: ☑

Final calulated concentration is within the appropriate *Range Used* block: ☑

Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☑

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☑

Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: NA

Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☑

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GW J06
Sample Location: 01J06
Sampled By: Goerdt
C.O.C. No.: 4391
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-23-04								
Time: 1715								
Method: Bladder	Clear	6.18	1.178	8.16	9.8	6.75	—	196

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-23-04								
Method: Peristaltic								
Monitor Reading (ppm): —								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 31.4	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 20.04								
One Casing Volume(gal/L): 7								
Start Purge (hrs): 1520								
End Purge (hrs): 1710								
Total Purge Time (min): 110								
Total Vol. Purged (gal/L): 8.6								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	NO
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 26.4'

31.4 - 20.04 = 11.36 x 0.163 = 1.9941 or 7L

Circle if Applicable:

MS/MSD —

Duplicate ID No.: —

Signature(s): [illegible]

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N0060~~ 0845
PROJECT SITE NAME: MGBG

WELL ID.: 01T06
DATE: 1-23-04
WEATHER: Mostly Cloudy, +60's

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1520	20.04	—	—	—	—	—	—	—	—	START PURGE
1530	21.80	1.0	100	6.25	1.176	22	8.61	10.22	+144	CLEAR
1540	22.28	2.0	100	6.22	1.143	40	8.45	9.04	154	"
1550	22.66	2.8	80	6.25	1.190	45	8.13	7.97	166	"
1600	23.31	3.0	80	6.22	1.188	36	7.44	8.23	176	"
1610	23.51	3.8	80	6.20	1.195	32.7	7.26	8.30	178	"
1620	23.87	4.6	80	6.20	1.187	25.0	7.18	8.17	183	"
1630	24.03	5.4	80	6.19	1.184	19.5	7.09	8.10	187	"
1640	24.45	6.2	80	6.21	1.172	16.3	6.99	8.08	189	"
1650	24.68	7.0	80	6.22	1.176	12.0	6.77	8.20	190	"
1700	24.87	7.8	80	6.19	1.180	10.0	6.63	8.19	192	"
1710	25.34	8.6	80	6.18	1.178	9.8	6.75	8.16	196	Stop purge

Water Quality Meter (S/N) 01M0616 AA
Control Box Type (S/N) NA
Turbidity Meter (S/N) 0918-4298

Pump Intake Depth 26.4'

SIGNATURE(S):

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 01GWT0701
Sample Location: 01T07
Sampled By: T. ROJAHN
C.O.C. No.: 4391
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Sainity %	ORP mV
Date: 1-24-04								
Time: 2010								
Method: PERISTALTIC	CLEAR	6.25	1.238	7.82	10	1.33	–	+185

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Date: 1-24-04								
Method: PERISTALTIC								
Monitor Reading (ppm): –								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD): 30.24	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL): 18.20								
One Casing Volume(gal/L): 7.4								
Start Purge (hrs): 1657								
End Purge (hrs): 2007								
Total Purge Time (min): 190								
Total Vol. Purged (gal/L): 12.9								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	NO
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	
Total Organic Carbon (SW-846 9069)	4° C	(1) 250ml HDPE	
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	

OBSERVATIONS / NOTES:

Depth of pump intake 25.24

30.24 - 18.20 = 12.04 x 0.163 = 1.9 gal or 7.4L

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s): Terry Rojahn

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : NSWC CRANE
PROJECT NUMBER: ~~N0060~~ 0845
PROJECT SITE NAME: MGBG

WELL ID.: 01T07
DATE: 1-24-04
WEATHER: Partly Cloudy (30°s)

MIN VOL = 7.4L

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1657	18.20	—	—	—	—	—	—	—	—	Start Purge
1707	18.90	0.8	80	6.82	1.357	220	2.98	11.61	195	CLOUDY
1717	19.18	1.4	60	6.22	1.248	130	1.59	11.00	191	"
1727	19.50	2.3	90	6.23	1.214	95	1.26	9.83	184	Sl Cloudy
1737	19.67	3.1	80	6.25	1.215	85	1.37	9.23	181	" "
1747	19.82	3.9	80	6.26	1.213	80	1.45	9.14	179	V. Sl. Cloudy
1757	19.95	4.7	80	6.25	1.219	70	1.40	9.29	179	" " "
1807	20.04	5.5	80	6.26	1.217	65	1.38	9.05	179	" " "
1817	20.11	6.3	80	6.26	1.214	60	1.39	8.93	179	" " "
1827	20.16	7.1	80	6.26	1.203	38	1.39	8.66	179	CLEAR
1837	20.23	7.9	80	6.26	1.220	30	1.44	9.01	180	CLEAR
1847	20.22	8.5	60	6.26	1.216	28	1.03	8.08	182	CLEAR
1857	20.19	9.1	60	6.26	1.209	23	1.13	7.91	183	CLEAR
1907	20.15	9.7	60	6.26	1.197	22	0.97	7.52	183	CLEAR
1917	20.21	10.3	60	6.25	1.175	16	1.03	7.67	184	CLEAR
1927	20.19	10.9	60	6.26	1.176	18	1.17	7.60	185	CLEAR
1937	20.23	11.4	50	6.26	1.202	14	1.25	7.58	185	CLEAR
1947	20.19	11.9	50	6.26	1.217	12	1.30	7.75	185	CLEAR
1957	20.15	12.4	50	6.25	1.228	11	1.32	7.80	185	CLEAR
2007	20.20	12.9	50	6.25	1.238	10	1.33	7.82	185	CLEAR
2010	—	—	—	—	—	—	—	—	—	SAMPLE TIME

Water Quality Meter (S/N) 01M0616 AA
Control Box Type (S/N) NA
Turbidity Meter (S/N) 0918-4298

Pump Intake Depth 25.24

SIGNATURE(S): Terry Hogan

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: SB01220401 ~~01GW~~
Sample Location: DI Source Water
Sampled By: T. Rojahn
C.O.C. No.: 4389 & 4390
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Sainity	ORP
Date: 1-22-04	Visual	Standard	mS/cm	°C	NTU	mg/l	%	mV
Time: 1915								
Method: Direct Pour	NA							

PURGE DATA:

Date:	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Method:								
Monitor Reading (ppm):								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD):	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL):								
One Casing Volume(gal/L):								
Start Purge (hrs):								
End Purge (hrs):								
Total Purge Time (min):								
Total Vol. Purged (gal/L):								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	YES
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	YES
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	YES
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	NO
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	NO
Total Organic Carbon (SW-846 9069)	H2SO4/ 4° C	(1) 250ml HDPE	YES
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	YES
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	YES

OBSERVATIONS / NOTES:

Depth of pump intake NA

QC - DI WATER
NERL
Reagent Grade Water
Lot: 0807253
Exp Date: 8/04

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s): Tey Rojah

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: NSWC CRANE
Project No.: N0845CTO 0315

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: RB01220401 ~~01GW~~
Sample Location: RINSATE BLANK
Sampled By: T. ROJAHN
C.O.C. No.: 4389 & 4390
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Sainity	ORP
Date: 1-22-04	Visual	Standard	mS/cm	°C	NTU	mg/l	%	mV
Time: 1945								
Method: THROUGH BLADDER	NA							

PURGE DATA:

Date:	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	ORP
Method:								
Monitor Reading (ppm):								
Well Casing Diameter & Material								
Type: 2" Dia. PVC								
Total Well Depth (TD):	SEE LOW FLOW PURGE DATA SHEET							
Static Water Level (WL):								
One Casing Volume(gal/L):								
Start Purge (hrs):								
End Purge (hrs):								
Total Purge Time (min):								
Total Vol. Purged (gal/L):								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOCs (SW-846/8260B)	HCl / 4°C	(3) 40 mL Vials	Yes
Nitrate + Nitrite (EPA 353.2)	H2SO4/ 4° C	(1) HDPE	YES
Chloride & Sulfate (EPA 300.0)	4° C	(1) HDPE	YES
Total Hardness as CaCO3 (EPA130.2)	HNO3/ 4° C	(1) HDPE	YES
Light Hydrocarbon & Hydrogen (Air Striped)	4° C	(1) 22cc Evacuated Vial	NO
Light Hydrocarbon & Hydrogen (Aqueous)	4° C	(1) 40ml Amber Vial	NO
Total Organic Carbon (SW-846 9069)	H_2SO_4 / 4° C	(1) 250ml HDPE	YES
Total Inorganic Carbon	4° C	(2) 40ml Clear Vial	YES
Volatile Fatty Acids w/Benzalkonium Chloride	4° C	(2) 40ml Amber Vial	YES

OBSERVATIONS / NOTES:

Depth of pump intake NA

RINSATE BLANK - BLADDER PUMP

Circle if Applicable:

MS/MSD —

Duplicate ID No.: —

Signature(s): [signature]

B.2.3

SWMU 01 Chain-of-Custody Records

TETRA TECH NUS, INC. CHAIN OF CUSTODY NUMBER 4384 PAGE 1 OF

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
N0845	NSWC CRANE	TOM JOHNSTON	(412) 921-8615	PACE / RANDY STAGGS
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
Terry Rojahn		TERRY ROJAHN	(412) 921-8857	1700 WEST ALBANY
		CARRIER/WAYBILL NUMBER		CITY, STATE
		FED EX AB# 8412 2490 9511		BROKEN ARROW, OK 74012

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): P P
PRESERVATIVE USED: 4°C 4°C

DATE YEAR 2004	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	TYPE OF ANALYSIS: VOCS (8260B)	PERCENT MOISTURE							COMMENTS
1/14	1430	01TP020506	TP 02	5	6	SO	G	4	3	1							
1/14	1530	01TP010607	TP 01	6	7	SO	G	4	3	1							
1/14	1640	01TP040607	TP 04	6	7	SO	G	4	3	1							
1/14	0000	01FD01140401	QC	-	-	SO	G	4	3	1							FROM 01TP01
1/14	1400	TB01140401	QC	-	-	QC	G	3	3	-							TRIP BLANK

1. RELINQUISHED BY Terry Rojahn	DATE 1-14-04	TIME 1900	1. RECEIVED BY FEDERAL EXPRESS	DATE 1-14-04	TIME 1900
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

TETRA TECH NUS, INC.

CHAIN OF CUSTODY

NUMBER 4385

PAGE 1 OF 1

PROJECT NO: CTO N0845 315	FACILITY: NSWC CRANE	PROJECT MANAGER: TOM JOHNSTON	PHONE NUMBER: (412) 921-8615
		FIELD OPERATIONS LEADER: TERRY ROJAHN	PHONE NUMBER: (412) 921-8857
		CARRIER/WAYBILL NUMBER: FED. EX. AB# 8412 2491 0456	

LABORATORY NAME AND CONTACT: PACE / RANDY STAGGS

ADDRESS: 1700 WEST ALBANY

CITY, STATE: BROKEN ARROW OK 74012

SAMPLERS (SIGNATURE): Terry Rojahn

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): P/G P

PRESERVATIVE USED: 4°C 4°C

TYPE OF ANALYSIS: VOCs (8260B) / PERCENT MOISTURE

DATE YEAR 2004	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	VOCs (8260B)	PERCENT MOISTURE							COMMENTS
1/15	0730	TB01150401	QC	–	–	QC	G	3	3	–							TRIP BLANK
1/15	0915	01TP050607	TP 05	6	7	SO	G	4	3	1							
1/15	1050	01TP060506	TP 06	5	6	SO	G	4	3	1							
1/15	1420	01TP080506	TP 08	5	6	SO	G	10	9	1							DO MS/MSD

1. RELINQUISHED BY: Terry Rojahn	DATE 1/15/04	TIME 1730	1. RECEIVED BY: FEDERAL EXPRESS	DATE 1/15/04	TIME 1730
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

TETRA TECH NUS, INC. CHAIN OF CUSTODY NUMBER 4386 PAGE 1 OF

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
N0845 CTO 315	NSWC CRANE	TOM JOHNSTON	(412) 921-8615	PACE / RANDY STAGGS
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
Terry Rosahn		TERRY ROSAHN	(412) 921-8857	1700 WEST ALBANY
		CARRIER/WAYBILL NUMBER		CITY, STATE
		FED. EX AB II 8412 2490 9522		BROKEN ARROW, OK 74012

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): G
PRESERVATIVE USED: 4°C
TYPE OF ANALYSIS: VOCs (8260B)

DATE YEAR 2004	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	VOCs (8260B)	COMMENTS
1/17	0730	TB01170401	QC	–	–	QC	G	3	3	
1/17	1220	01GW0903	0109	–	–	GW	G	3	3	
1/17	1505	01GW0803	0108	–	–	GW	G	3	3	
1/18	1130	01GW0702	0107	–	–	GW	G	3	3	
1/18	1452	01GW2102	0121	–	–	GW	G	3	3	

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY Terry Rosahn	1-19-04	1900	1. RECEIVED BY FEDERAL EXPRESS	1-19-04	1900
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

TETRA TECH NUS, INC.

CHAIN OF CUSTODY | NUMBER 4387 | PAGE 1 OF 1

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
N0845 CTO 315	NSWC CRANE	TOM JOHNSTON	(412) 921-8615	PACE / RANDY STAGGS
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER: TERRY ROJAHN	PHONE NUMBER: (412) 921-8857	ADDRESS: 1700 WEST ALBANY
		CARRIER/WAYBILL NUMBER: FED. EX AB# 8412 2490 9603		CITY, STATE: BROKEN ARROW, OK 74012

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): G P P P

PRESERVATIVE USED: HCl/4°C 4°C H2SO4 4°C 4°C/HNO3

DATE YEAR 2004	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	VOCS (8260B)	Nitrate + Nitrite (EPA 353.2)	CHLORIDE & SULFATE (EPA 300.0)	Total Hardness as CaCO3 (EPA 130.2)				COMMENTS
1/19	1700	TB01190401	QC	-	-	QC	G	3	3							TRIP BLANK
1/19	1748	01GW0303	01-03	-	-	GW	G	3	3							
1/20	1150	01GW0403	01-04	-	-	GW	G	3	3							
1/20	1510	01GW2303	01-23	-	-	GW	G	3	3							
1/20	1540	01GW1702 38 9	01-17	-	-	GW	G	3	3							
1/21	1110	01GW2002	01-20	-	-	GW	G	3	3							
1/21	1255	01GW2402	01-24	-	-	GW	G	6	3	1	1	1				
1/21	1640	01GW2503	01-25	-	-	GW	G	6	3	1	1	1				
1/21	0000	01FD01210401	QC	-	-	GW	G	3	3							FROM 01GW2002

1. RELINQUISHED BY	DATE 1-21-04	TIME 1900	1. RECEIVED BY FED EX	DATE	TIME
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

TETRA TECH NUS, INC. CHAIN OF CUSTODY NUMBER 4389 PAGE 1 OF

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
N0845 CTO 315	NSWC CRANE	TOM JOHNSTON	(412) 921-8615	MICROSEEPS / DEBBIE HALLO
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
Terry Rojahn		TERRY ROJAHN	(412) 921-8857	220 WILLIAM PITT WAY
		CARRIER/WAYBILL NUMBER		CITY, STATE
		FED EX AB # 8412 2490 9614		PITTSBURGH, PA 15238

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR 2004	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	Lt. Hydrocarbons & Hydrogen (Gas Stripping)	Lt. Hydrocarbons & Hydrogen (MO)	Volatile Fatty Acids w/Benzoic Acid	Total Inorganic Chloride	Total Organic Carbon Sw 846 9060				COMMENTS
									CONTAINER TYPE PLASTIC (P) or GLASS (G)				G	G	G	G	
									PRESERVATIVE USED				4°C	4°C	4°C	4°C/H2SO4 pH<2	
1/21	1255	01GW2402	01-24	–	–	GW	G	7	1	1	2	2	1				
1/21	1640	01GW2503	01-25	–	–	GW	G	7	1	1	2	2	1				
1/22	1330	01GW1003	01-10	–	–	GW	G	7	1	1	2	2	1				
1/22	1415	01GWT0502	01T05	–	–	GW	G	7	1	1	2	2	1				
1/22	1915	SB01220401	QC	–	–	QC	G	5	–	–	2	2	1				
1/22	1945	RB01220401	QC	–	–	QC	G	5	–	–	2	2	1				
1/23	1250	01GW1403	01-14	–	–	GW	G	7	1	1	2	2	1				
1/23	1255	01GW0103	01-01	–	–	GW	G	7	1	1	2	2	1				

1. RELINQUISHED BY	DATE	TIME	1. RECEIVED BY	DATE	TIME
Terry Rojahn	1-23-04	1900	FED EX	1-23-04	1900
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

TETRA TECH NUS, INC. | CHAIN OF CUSTODY | NUMBER 4390 | PAGE 1 OF 1

PROJECT NO: N0845 CTO 315	FACILITY: NSWC CRANE	PROJECT MANAGER: TOM JOHNSTON	PHONE NUMBER: (412) 921-8615	LABORATORY NAME AND CONTACT: PACE / RANDY STAGGS
SAMPLERS (SIGNATURE): Terry Rojahn		FIELD OPERATIONS LEADER: TERRY ROJAHN	PHONE NUMBER: (412) 921-8857	ADDRESS: 1700 WEST ALBANY
		CARRIER/WAYBILL NUMBER: FED EX AB# 8412 2490 9555		CITY, STATE: BROKEN ARROW, OK 74012

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR 2004	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	VOCs (8260B)	Nitrate + Nitrite (EPA 353.2)	Chloride & Sulfate (EPA 300.0)	Total Hardness as CaCO3 (EPA 130.2)					COMMENTS
CONTAINER TYPE PLASTIC (P) or GLASS (G)									G	P	P	P					
PRESERVATIVE USED									4°C/HCl	4°C/H2SO4	4°C	4°C/HNO3					
1/21	1600	TB01210401	QC	-	-	QC	G	3	3								
1/21	1745	01GW0603	01-06	-	-	GW	G	3	3								
1/22	1320	01GW1302	01-13	-	-	GW	G	3	3								
1/22	1330	01GW1003	01-10	-	-	GW	G	6	3	1	1	1					
1/22	1415	01GWT0502	01T05	-	-	GW	G	6	3	1	1	1					
1/22	1915	SB01220401	QC	-	-	QC	G	6	3	1	1	1					
1/22	1945	RB01220401	QC	-	-	QC	G	6	3	1	1	1					
1/23	0915	01GW1802	01-18	-	-	GW	G	3	3								
1/23	1030	01GW1202	01-12	-	-	GW	G	3	3								
1/23	1250	01GW1403	01-14	-	-	GW	G	6	3	1	1	1					
1/23	1255	01GW0103	01-01	-	-	GW	G	6	3	1	1	1					
1/23	0000	01FD01230401	QC	-	-	QC	G	3	3								

1. RELINQUISHED BY: Terry Rojahn	DATE: 1-23-04	TIME: 1900	1. RECEIVED BY: FEDERAL EXPRESS	DATE: 1-23-04	TIME: 1900
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

TETRA TECH NUS, INC. CHAIN OF CUSTODY NUMBER 4391 PAGE 1 OF

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
N0845 CTO 315	NSWC CRANE	TOM JOHNSTON	(412) 921-8615	PACE / RANDY STAGGS
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
Terry Rojahn EJG		TERRY ROJAHN	(412) 921-8857	1700 WEST ALBANY
		CARRIER/WAYBILL NUMBER		CITY, STATE
		FED EX AB # 8412 2491 0982		BROKEN ARROW, OK 74012

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR 2004	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	VOCs (8260B)	Nitrate + Nitrite (EPA 353.2)	Chloride & Sulfate (EPA 300.0)	Total Hardness as CaCO3 (EPA 130.2)					COMMENTS
CONTAINER TYPE PLASTIC (P) or GLASS (G)									G	P	P	P					
PRESERVATIVE USED									4°C/HCl	4°C/H2SO4	4°C	4°C/HNO3					
1/23	1700	TB01230401	QC	-	-	QC	G	3	3								
1/23	1715	01GWT0601	01T06	-	-	GW	G	3	3								
1/23	1735	01GW2702	01-27	-	-	GW	G	3	3								
1/24	1110	01GW1103	01-11	-	-	GW	G	6	3	1	1	1					
1/24	1632	01GW2202	01-22	-	-	GW	G	3	3								
1/24	1705	01GW2603	01-26	-	-	GW	G	3	3								
1/24	1900	01GWT0204	01T02	-	-	GW	G	3	3								
1/24	2010	01GWT0701	01T07	-	-	GW	G	3	3								
1/24	0000	01FD01240401	QC	-	-	QC	G	6	3	1	1	1					
1/25	1020	01GW1503	01-15	-	-	GW	G	5	3	1	1						
1/25	1130	RB01250401	QC	-	-	QC	G	3	3								BLADDER PUMP
1/25	1136	RB01250402	QC	-	-	QC	G	3	3								PERISTALTIC TUBING
1/25	1500	01GWT0402	01T04	-	-	GW	G	3	3								

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY Terry Rojahn	1-26-04	1900	1. RECEIVED BY FEDERAL EXPRESS	1-26-04	1900
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

TETRA TECH NUS, INC.

CHAIN OF CUSTODY | NUMBER 4392 | PAGE 1 OF 1

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
N0845 CTO 315	NSWC CRANE	TOM JOHNSTON	(412) 921-8615	PACE / RANDY STAGGS
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
Terry Rojahn & JG		TERRY ROJAHN	(412) 921-8857	1700 WEST ALBANY
		CARRIER/WAYBILL NUMBER		CITY, STATE
		FED. EX AB# 8412 249 1982		BROKEN ARROW, OK 74012

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR 2004	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	VOCs (8260B)	Nitrate Nitrite (EPA 353.2)	Chloride & Sulfate (EPA 300.0)	Total Hardness as CaCO3 (EPA 130.2)				COMMENTS
CONTAINER TYPE PLASTIC (P) or GLASS (G)									G	P	P	P				
PRESERVATIVE USED									4°C/HCl	4°C/H2SO4	4°C	4°C/HNO3				
1/25	1545	01GW1902	01-19	-	-	GW	G	12	9	*1	*1	*1				DO MS/MSD
1/25	1735	01GWT0302	01T03	-	-	GW	G	3	3							
1/26	1240	01GW0203	01-02	-	-	GW	G	6	3	1	1	1				
1/26	0000	01FD01260401	QC	-	-	QC	G	3	3							
1/26	0940	01GW1503	01-15	-	-	GW	G	1	-	-	-	1				

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY Terry Rojahn	1/26/04	1900	1. RECEIVED BY FEDERAL EXPRESS	1/26/04	1900
2. RELINQUISHED BY			2. RECEIVED BY		
3. RELINQUISHED BY			3. RECEIVED BY		

COMMENTS * PROVIDED 1L HDPE FOR MS/MSD

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

FORM NO. TtNUS-001 4/02R

TtA TECH NUS, INC. CHAIN OF CUSTODY NUMBER 4393 PAGE 1 OF

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
N0845 CTO 315	NSWC CRANE	TOM JOHNSTON	(412) 921-8615	MICROSEEPS / DEBBIE HALLO
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
Terry Rojahn & JG		TERRY ROJAHN	(412) 921-8857	220 WILLIAM PITT WAY
		CARRIER/WAYBILL NUMBER		CITY, STATE
		FED. EX. AB# 8412 2491 0993		PITTSBURGH PA 15238

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR 2004	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	Lt. Hydrocarbons & Hydrogen (Gas Stripping)	Lt. Hydrocarbons & Hydrogen (AGA)	Volatile Fatty Acids w/ Benzol/Konium Salt	Total Inorganic Carbon	Total Organic Carbon (SW-846 9060)				COMMENTS
								CONTAINER TYPE PLASTIC (P) or GLASS (G)	G	G	G	G	G				
								PRESERVATIVE USED	4°C	4°C	4°C	4°C	4°C/H2SO4				
1/24	1110	01GW1103	01-11	–	–	GW	G	7	1	1	2	2	1				
1/24	0000	01FD01240401	QC	–	–	GW	G	7	1	1	2	2	1				
1/25	1020	01GW1503	01-15	–	–	GW	G	6	–	1	2	2	1				
1/25	1545	01GW1902	01-19	–	–	GW	G	11	1	1	*6	2	1				*DO MS/MSD
1/26	0940	01GW1503	01-15	–	–	GW	G	1	1	–	–	–	–				
1/26	1240	01GW0203	01-02	–	–	GW	G	7	1	1	2	2	1				

1. RELINQUISHED BY	DATE	TIME	1. RECEIVED BY	DATE	TIME
Terry Rojahn	1-26-04	1900	FEDERAL EXPRESS	1-26-04	1900
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

TETRA TECH NUS, INC. | CHAIN OF CUSTODY | NUMBER 4398 | PAGE 1 OF 1

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
CTO N0845 315	NSKIC CRANE	TOM JOHNSTON	(412) 921-8615	PACE / RANDY STAGGS
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER: TERRY ROJAHN	PHONE NUMBER: (412) 921-8857	ADDRESS: 1700 WEST ALBANY
		CARRIER/WAYBILL NUMBER: FED. EX AB# 8412 2490 9533		CITY, STATE: BROKEN ARROW, OK 74012

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): G P P P

PRESERVATIVE USED: 4°C/HCl, 4°C/H2SO4, 4°C, 4°C/HNO3

DATE YEAR 2004	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	VOCS (8260B)	Nitrate + Nitrite (EPA 353.2)	Chloride & Sulfate (EPA 300.0)	Total Hardness as CaCO3 (EPA 130.2)					COMMENTS
1/26	1800	TB01260401	QC	-	-	QC	G	3	3								
1/26	1805 ~~0916~~	01GWC0103	01 C01	-	-	GW	G	3	3								
1/27	0910	01GW0503	01-05	-	-	GW	G	12	*9	1	1	1					* DO MS/MSD ON VOCS Only
1/27	0000	01FD01270401	QC	-	-	GW	G	3	3								

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY [signature]	1-27-04	1900	1. RECEIVED BY FEDERAL EXPRESS	1-27-04	1900
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

TETRA TECH NUS, INC. CHAIN OF CUSTODY NUMBER 4400 PAGE 1 OF

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
N0845 CTO 315	NSWC CRANE	TOM JOHNSTON	(412) 921-8615	MICROSEEPS / DEBBIE HALLO
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
		TERRY ROJAHN	(412) 921-8857	220 WILLIAM PITT WAY
		CARRIER/WAYBILL NUMBER		CITY, STATE
		FED. EX AB# 8412 2490 9544		PITTSBURGH, PA 15238

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR 2004	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	Lt. Hydrocarbons & Hydrogen (Gas Stripping)	Lt Hydrocarbons & Hydrogen (AQ)	Volatile Fatty Acids w/ Benzoic Acid	Total Inorganic Carbon	Total Organic Carbon (SW-846 9060)				COMMENTS
CONTAINER TYPE PLASTIC (P) or GLASS (G)									G	G	G	G	P				
PRESERVATIVE USED									4°C	4°C	4°C	4°C	4°C/H2SO4				
1/27	0910	01GW0503	01-05	–	–	GW	G	7	1	1	2	2	1				

1. RELINQUISHED BY	DATE 1-27-04	TIME 1900	1. RECEIVED BY FEDERAL EXPRESS	DATE 1-27-04	TIME 1900
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

B.2.4

SWMU 01 Monitoring Well Inspection Sheets

MONITORING WELL INSPECTION SHEET

Well ID: 01-01

Time: 0814 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		painted on stenciled
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. S as of 7-14-01.
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			N/A
PVC Riser	Condition of riser & survey reference point	✓		

Comments:

WL = 28.30

Signature(s) [signature]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-02

Time: 0825 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on PVC riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		unable to inspect due to snow/ice. S as of 7-14-01.
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 11.63

Signature(s) [illegible]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-03

Time: 0929 **Date:** 1-28-04 **Inspector's Name:** Goeldt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on PVC riser
Well security	Condition protective case, cap, lock		✓	Needs new lock & plug
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. Sat of 7-14-01.
Well seal	Condition of...	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 5.49

Signature(s) [illegible]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-04

Time: 0818 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on PVC riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. Sat as of 7-14-01
Well seal	Condition of…			
Area Immediately around well pad	Record any evidence of/or standing water in area of well			
Dedicated sampling equipment	Condition of…			N/A
PVC Riser	Condition of riser & survey reference point			

Comments: WL = 16.80

Signature(s) [illegible]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-05

Time: 0820 **Date:** 1-28-04 **Inspector's Name:** Goerdt / Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. S as of 7-14-01
Well seal	Condition of...	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL= 15.52

Signature(s) [illegible]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-06

Time: 0848 **Date:** 1-28-04 **Inspector's Name:** Goerdt / Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		
Well security	Condition protective case, cap, lock	✓		Replaced well cap.
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. S as of 7-14-01.
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 69.05

Signature(s)

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-07

Time: 0855 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		painted well ID starting to fade on riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition		✓	unable to inspect due to snow/ice. Was ok 7-14-01.
Well seal	Condition of...		✓	as of 7-14-01.
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 15.78

Signature(s) [signature]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-08

Time: 0850 **Date:** 1-28-04 **Inspector's Name:** Gourdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on PVC riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		S as of 7-14-01 inspection. Unable to inspect due to snow/ice.
Well seal	Condition of...	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments:

WL = 12.80

Signature(s) [illegible]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-09

Time: 0840 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser.
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. S as of 7-14-01
Well seal	Condition of...	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments:

WL = 12.60

Signature(s) [signature]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-10

Time: 0838 **Date:** 1-28-04 **Inspector's Name:** Goerlitz/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser.
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. Was ok 7-14-01.
Well seal	Condition of...	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments:

WL = 22.19

Signature(s) [signature]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-11

Time: 0827 **Date:** 1-28-04 **Inspector's Name:** Goerlitz/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser.
Well security	Condition protective case, cap, lock		✓	Well cap in place, but no lock.
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. S as of 7-14-01.
Well seal	Condition of...	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 6.64

Signature(s) [signature]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-12

Time: 0834 **Date:** 1-28-04 **Inspector's Name:** Goeldt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. S as of 7-14-01
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL= 23.90

Signature(s) [signature]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-13

Time: 0833 **Date:** 1-28-04 **Inspector's Name:** Goerlt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser.
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice S as of 7-14-01
Well seal	Condition of...	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 20.65

Signature(s)

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-14

Time: 0919 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. S as of 7-14-01
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		pvc riser at slight angle.

Comments: WL = 14.01

Signature(s) [illegible]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-15

Time: 0914 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser.
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. S as of 7-14-01
Well seal	Condition of...	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL= 28.20

Signature(s) [signature]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-16

Time: 0905 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. S as of 7-14-01
Well seal	Condition of...	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL= 21.65

Signature(s)

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-17

Time: 0921 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. S as of 7-14-01.
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 20.70

Signature(s) [illegible]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-18

Time: 0942 **Date:** 1-28-04 **Inspector's Name:** Goeldt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. S as of 7-14-01
Well seal	Condition of...	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL= 14.62

Signature(s)

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-19

Time: 0908 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. S as of 7-14-01
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL= 21.65

Signature(s) [signature]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-20

Time: 0904 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. Saw 7-14-01 ~~although loose~~
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 27.24

Signature(s): [illegible]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-21

Time: 0857 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		painted on pvc riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. Sat as 7-14-01, although loose
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 15.43

Signature(s) [signature]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-22

Time: 0911 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. S as of 7-14-01
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL= 18.54

Signature(s) [illegible]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-23

Time: 0901 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on PVC riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice Same as 7-14-01
Well seal	Condition of...			Insp. on 7-14-01 indicated unknown
Area Immediately around well pad	Record any evidence of/or standing water in area of well		✓	7-14-01 insp indicated large hole on down side of slope & run off could enter.
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 38.73

Signature(s)

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-24

Time: 0859 **Date:** 1-28-04 **Inspector's Name:** Goerdt / Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice S as of 7-14-01
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 11.70

Signature(s) [signature]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-25

Time: 0912 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. S as of 7-14-01
Well seal	Condition of...	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 21.79

Signature(s) [signature]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-26

Time: 0938 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		marked on pvc riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. Sat by 7-14-01
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL= 36.45

Signature(s) [illegible]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-27

Time: 0940 **Date:** 1-28-04 **Inspector's Name:** Goerdt / Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		Painted on pvc riser
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice Saw as of 7-14-01
Well seal	Condition of...	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 24.98

Signature(s): [signature]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-C01

Time: 0945 **Date:** 1-28-04 **Inspector's Name:** Goeldt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		Unable to inspect due to snow/ice. Saw of 2-14-01
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 138.54

Signature(s)

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-T02

Time: 0811 **Date:** 1-28-04 **Inspector's Name:** Goerdt/ Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		
Well seal	Condition of...	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments: WL = 65.60

Signature(s)

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-T03

Time: 0823 **Date:** 1-28-04 **Inspector's Name:** Goeldt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments:

WL = 139.25

Signature(s)

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-T04

Time: 0916 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		
Well seal	Condition of...	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of...			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments:

WL = 138.09

Signature(s)

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-T05

Time: 0933 **Date:** 1-28-04 **Inspector's Name:** Goerdt / Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments:

WL = 17.92

Signature(s) [signature]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-T06

Time: 0927 **Date:** 1-28-04 **Inspector's Name:** Goerdt/Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments:

WL = 20.28

Signature(s)

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

MONITORING WELL INSPECTION SHEET

Well ID: 01-T07

Time: 0924 **Date:** 1-28-04 **Inspector's Name:** Goerdt / Rojahn

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible	✓		
Well security	Condition protective case, cap, lock	✓		
Well pad	Concrete or gravel & condition	✓		
Well seal	Condition of…	✓		
Area Immediately around well pad	Record any evidence of/or standing water in area of well	✓		
Dedicated sampling equipment	Condition of…			NA
PVC Riser	Condition of riser & survey reference point	✓		

Comments:

WL = 18.56

Signature(s) [illegible]

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

B.2.5

SWMU 01 Monitoring Well Development Records

Tetra Tech NUS, Inc.

MONITORING WELL DEVELOPMENT RECORD

Well: 01T07
Site: SWMU 1
Date Installed: 1-17-04
Date Developed: 1-21-04
Dev. Method: SURGE/BAILER
Pump Type: —

Depth to Bottom (ft.): 30.24 BTOC
Static Water Level Before (ft.): 18.15
Static Water Level After (ft.): 18.56
Screen Length (ft.): 10
Specific Capacity: —
Casing ID (in.): 2"

Responsible Personnel: FRED W. RAMSER
Drilling Co.: BOWSER MORNER
Project Name: CRANE NSWC SWMU1
Project Number: 0845

Time	Estimated Sediment Thickness (Ft.)	Cumulative Water Volume (Gal.)	Water Level Readings (Ft. below TOC)	Temperature (Degrees C)	pH	Specific Conductance (Units _____)	Turbidity (NTU)	Remarks (odor, color, etc.)
1600	—	—	—	—	—	—	—	SURGED WELL WITH
1630	—	5	—	—	—	—	—	BAILER, THEN BAILED
		SEE SAMPLING PURGED DATA FOR						WELL DRY AFTER
		GROUNDWATER PARAMETERS						WITHDRAWING
								~ 5 GALS.

Tetra Tech NUS, Inc.

MONITORING WELL DEVELOPMENT RECORD

Well: 01T06
Site: SWMU 1
Date Installed: 1-16-04
Date Developed: 1-21-04
Dev. Method: SURGE/BAILER
Pump Type: —

Depth to Bottom (ft.): 31.40 BTOC
Static Water Level Before (ft.): 20.20
Static Water Level After (ft.): 20.28
Screen Length (ft.): 10
Specific Capacity: —
Casing ID (in.): 2"

Responsible Personnel: FRED W. RAMSER
Drilling Co.: BOWSER MORNER
Project Name: CRANE NSWC SWMU 1
Project Number: 0845

Time	Estimated Sediment Thickness (Ft.)	Cumulative Water Volume (Gal.)	Water Level Readings (Ft. below TOC)	Temperature (Degrees C)	pH	Specific Conductance (Units _____)	Turbidity (NTU)	Remarks (odor, color, etc.)
1540	—	—	—	—	—	—	—	SURGED WELL WITH
1600	—	4.5	—	—	—	—	—	BAILER, THEN BAILED
	SEE	PURGE	DATA FOR	GROUNDWATER		PARAMETERS		WELL DRY AFTER
								WITHDRAWING ~4.5 GALS

B.2.6

SWMU 01 Water Level Measurement Sheets

Tetra Tech NUS, Inc.

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: NSWC CRANE **Project No.:** N0845
Location: MGBG/SWMU 1 **Personnel:** T. Rojahn/J. Goerdt
Weather Conditions: Clear & Cold (Temp. 5°F) **Measuring Device:** M-Scope
Tidally Influenced: Yes ____ No _X_ **Remarks:** Ground was snow covered

Well or Piezometer Number	Date	Time	Elevation of Reference Point (feet)*	Total Well Depth (feet)*	Water Level Indicator Reading (feet)*	Thickness of Free Product (feet)*	Groundwater Elevation (feet)*	Comments
01-01	1/28/2004	0814	685.22		28.3	NA	656.92	
01-02	1/28/2004	0825	666.03		11.63	NA	654.4	
01-03	1/28/2004	0929	669.55		5.49	NA	664.06	
01-04	1/28/2004	0818	671.99		16.8	NA	655.19	
01-05	1/28/2004	0820	667.79		15.52	NA	652.27	
01-06	1/28/2004	0848	598.41		69.05	NA	529.36	well repaired & resurveyed
01-07	1/28/2004	0855	605.81		15.78	NA	590.03	well repaired & resurveyed
01-08	1/28/2004	0850	604.09		12.8	NA	591.29	
01-09	1/28/2004	0840	612.23		12.6	NA	599.63	
01-10	1/28/2004	0838	638.92		22.19	NA	616.73	
01-11	1/28/2004	0827	658.36		6.64	NA	651.72	
01-12	1/28/2004	0834	636.12		23.9	NA	612.22	
01-13	1/28/2004	0833	637.06		20.65	NA	616.41	
01-14	1/28/2004	0919	658.09		14.01	NA	644.08	
01-15	1/28/2004	0914	665.64		28.2	NA	637.44	well repaired & resurveyed
01-16	1/28/2004	0905	644.05		35.71	NA	608.34	
01-17	1/28/2004	0921	664.61		20.7	NA	643.91	
01-18	1/28/2004	0942	660.55		14.62	NA	645.93	
01-19	1/28/2004	0908	658.92		21.65	NA	637.27	
01-20	1/28/2004	0904	633.45		27.24	NA	606.21	
01-21	1/28/2004	0857	606.01		15.43	NA	590.58	
01-22	1/28/2004	0911	655.85		18.54	NA	637.31	
01-23	1/28/2004	0901	627.88		38.73	NA	589.15	
01-24	1/28/2004	0859	602.66		11.7	NA	590.96	
01-25	1/28/2004	0912	656.33		21.79	NA	634.54	

* All measurements to the nearest 0.01 foot

Tetra Tech NUS, Inc.

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name:	NSWC CRANE	**Project No.:**	N0845
Location:	MGBG/SWMU 1	**Personnel:**	T. Rojahn/J. Goerdt
Weather Conditions:	Clear & Cold (Temp. 5°F)	**Measuring Device:**	M-Scope
Tidally Influenced:	Yes ____ No _X_	**Remarks:**	Ground was snow covered

Well or Piezometer Number	Date	Time	Elevation of Reference Point (feet)*	Total Well Depth (feet)*	Water Level Indicator Reading (feet)*	Thickness of Free Product (feet)*	Groundwater Elevation (feet)*	Comments
01-26	1/28/2004	0938	672.3		36.45	NA	635.85	
01-27	1/28/2004	0940	661.86		24.98	NA	636.88	
0C01	1/28/2004	0945	666.23		138.54	NA	527.69	
01T01	NA	NA	NA		NA	NA	NA	
01T02	1/28/2004	0811	698.89		65.6	NA	633.29	
01T03	1/28/2004	0823	667.12		139.25	NA	527.87	
01T04	1/28/2004	0916	665.81		138.09	NA	527.72	
01T05	1/28/2004	0933	641.85		17.92	NA	623.93	
01T06	1/28/2004	0927	677.06		20.28	NA	656.78	
01T07	1/28/2004	0924	673.47		18.56	NA	654.91	

* All measurements to the nearest 0.01 foot

B.2.7

SWMU 01 Field Task Modification Request Forms

ATTACHMENT A. RADIATION LOG SHEET 1

PAGE _____ OF _____

Analyst_____ Date_____

Source Check:
Radionuclide:_____S/N:_____
Activity (dpm):_____on _____ (Date)

β + γ Ratemeter Calibration:
Model:_____
S/N: _____
Cal. due date:_____

Probe (β + γ):
Model:_____
S/N: _____

~~α Ratemeter Calibration:~~
~~Model:_____~~
~~S/N:_____~~
~~Cal. due date:_____~~

~~Probe (α):~~
~~Model:_____~~
~~S/N:_____~~

Backgrounds Determined on: _____ (Date)

Background Readings (~~Beta +~~ Gamma)
#1 (β + γ):_____ cpm
#2 (β + γ):_____ cpm
#3 (β + γ):_____cpm

~~Background Readings (Alpha)~~
~~#1 (α):_____cpm~~
~~#2 (α):_____cpm~~
~~#3 (α):_____cpm~~

Average Background (β + γ) =_____cpm (=[#1 + #2 + #3)]/3)
~~Average Background (α) =_____cpm (=[#1 + #2 + #3)]/3)~~
~~Current Radioactivity Status Limit =_____cpm (from Sec. 7.1 or 7.2, as applicable)~~

β + γ Instrument Efficiency, Eff (cpm/dpm x 100%):_____Percent

~~α Instrument Efficiency, Eff (cpm/dpm x 100%):~~_____~~Percent~~

~~Average detector efficiency, Eff (cpm/dpm x 100%), [Eff$_{\alpha}$ + Eff$_{(\beta+\gamma)}$]/2:~~_____~~Percent~~

SOIL SAMPLE SCREENING FOR DETERMINING RADIOACTIVITY STATUS

A	B	C	D	E	F
SAMPLE ID	**Sample (β + γ), cpm**	**Net Sample (β + γ), cpm:** (Column B) – Background (β + γ)	**~~Sample (α), cpm~~**	**~~Net Sample (α), cpm:~~** ~~Column D – Background (α)~~	**Total Radiation, cpm:** Column C + Column E
			NA	NA	NA
			NA	NA	NA
			NA	NA	NA
			NA	NA	NA
			NA	NA	NA
			NA	NA	NA
			NA	NA	NA
			NA	NA	NA
			NA	NA	NA
			NA	NA	NA
			NA	NA	NA
			NA	NA	NA
			NA	NA	NA

Reviewed by:_____ **Title:**_____ **Date:**_____

TETRA TECH NUS
FIELD TASK MODIFICATION REQUEST FORM

NSWC CRANE
Project/Installation Name

315/0845
CTO & Project Number

MGBG #1
Task Mod. Number

SOPs
Modification To (e.g. Work Plan)

SWMU 1 MGBG
Site/Sample Location

1-13-04
Date

Activity Description: MODIFY Attachment A of SOP CTO 315-05

Reason for Change: To streamline "Radiation Log Sheet 1" FOR FIELD USE. All references to alfa & beta were dropped since gamma (only) was being screened.

Recommended Disposition: Will use streamlined form (see Attachment B).

Field Operations Leader (Signature)

3/4/04
Date

Approved Disposition:

Project/Task Order Manager (Signature)

3/4/04
Date

Distribution:

Program/Project File –
Project/Task Order Manager –
Field Operations Leader –

Other:

B.2.8

SWMU 01 Equipment Calibration Logs

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME : NSWC CRANE

SITE NAME: SWMUs 01

PROJECT No.: N0845, CTO 0315

INSTRUMENT NAME/MODEL: PID No. 2020

MANUFACTURER: PE-PHOTOVAC

SERIAL NUMBER: ED HE 381

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		
1-14-04	EDHE381	PUR	—	—	70.2	100	00210-03	
1-15-04	"	PUR	—	—	89.5	100	00210-03	
1-16-04	"	PUR	—	—	89.9	100	"	
1-18-04	"	PUR	—	—	93.2	100	"	
1-28-04	"	TR	—	—	94.4	100	"	

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME: NSWC CRANE

SITE NAME: SWMUs 01

PROJECT No.: N0845, CTO 0315

INSTRUMENT NAME/MODEL: PID No 2020

MANUFACTURER: PE - PHOTO VAC

SERIAL NUMBER: ED FM 309

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		
1-14-04	EDFM309	FUR	—	—	98.7	100	00210-03	
1-15-04	"	FUR	—	—	81.7	100.0	"	
1-16-04	"	FUR	—	—	103	100	"	
1-17-04	"	FUR	—	—	86	100	"	
1-18-04	"	FUR			110	100	00210-03	

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME: NSWC CRANE

SITE NAME: SWMUs 13 &16

PROJECT No.: N9060, CTO 0279

INSTRUMENT NAME/MODEL: COUNT RATEMETER ~~LU~~ MODEL 15

MANUFACTURER: LUDLUM

SERIAL NUMBER: 102818

Date/Time of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration HV	Post-calibration BKGROUND	Pre-calibration (READING SOURCE)	Post-calibration		
1/14/04 1000	102818	PVR	900VDC	5000cpm	~~350000~~			PERFORMANCE CHECK ONLY
1/14/04 1730	"	"	910VDC	50x10+2	35000			PROBE @ 6" FROM SOURCE.
					36000			
1-15-04 0730	102818	PVR	900VDC	50x10+2	350x10+2			
1-16-04	102818	PVR	900	50x10+2	380x10+2			
1-17-04	102818	PVR		50x10+2	380x10+2			

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME : NSWC CRANE

SITE NAME: SWMUs 01

PROJECT No.: N0845, CTO 0315

INSTRUMENT NAME/MODEL: LaMotte 2020

MANUFACTURER: LaMotte

SERIAL NUMBER: 4531-3303

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		
1-19-04	Same	[illegible]	–	–	0.000	0.000	Supplied	10.0 check 9.9 ok
1-20-04	"	[illegible]			0.0	0.0	by US Env	"
1-21-04	"	[illegible]			0.0	0.0		10.0 @ 10.5 ok
1-22-04	"	[illegible]			0.0	0.0		
1-23-04	"	[illegible]			0.0	0.0		
1-24-04	"	[illegible]			0.0	0.0		10.0 @ 10.0
1-25-04	"	[illegible]			0.0	0.0		
1-26-04	"	[illegible]			0.0	0.0		10 @ 9.9
1-27-04	"	[illegible]			0.0	0.0		10 @ 10

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME : NSWC CRANE

SITE NAME: SWMUs 13 &16

PROJECT No.: N9060, CTO 0279

INSTRUMENT NAME/MODEL: LaMotte 2020

MANUFACTURER: LaMotte

SERIAL NUMBER: 0918-4298

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		
1-20-04	same	[illegible]	—	—	0.0	0.0		10 check @ 11.0 ok
1-21-04	"	[illegible]			0.0	0.0		10 " " 10.0 ok
1-22-04	"	[illegible]	—	—	0.0	0.0		10 " " 10.1 ok
1-23-04	"	[illegible]	—	—	0.0	0.0		10 " " 10.0 ok
1-24-04	"	[illegible]	—	—	0.0	0.0		10 " @ 9.8 ok
1-25-04	"	[illegible]	—	—	0.0	0.0		10 @ 10
1-26-04	"	[illegible]	—	—	0.0	0.0		10 @ 10
1-27-04	"	[illegible]	—	—	0.0	0.0		10 @ 10

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME : NSWC CRANE

SITE NAME: SWMUs 01

PROJECT No.: N0845, CTO 0315

INSTRUMENT NAME/MODEL: LaMotte 2020

MANUFACTURER: LaMotte

SERIAL NUMBER: 4650 - 4303

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		
1-17-03	SAME	TR	—	—	0.00	0.00	supplied	10.0 Check - OK 9.9
1-18-03	SAME	TR	—	—	0.00	0.00	by USENV	" "

Tetra Tech NUS, Inc.

DOCUMENTATION OF FIELD CALIBRATION

PROJECT NAME : NSWC CRANE

SITE NAME: SWMUs 01

PROJECT No.: N0845, CTO 0315

INSTRUMENT NAME/MODEL: YSI

MANUFACTURER: YSI

SERIAL NUMBER: 01M0616 AA

Date of Calibration	Person Performing Calibration	INITIAL READINGS PH	COND	~~TURB~~ ORP	DO	TEMP		FINAL READINGS PH	COND	~~TURB~~ ORP	DO	TEMP	Calibration Standard (Lot No.)	Remarks and Comments
1/17/04 am	TR	7.15 3.94	924	236.8 ~~TTA~~	101.5% 10.13 mg/L	NA		7.00 4.00	1000	237.5	97.8% 9.76 mg/L	NA	ORP - 03J1385 7.0 - 3106	EXP - 10/05 4/04
—	—	—	-	—	—	—		—	—	—	—	—	4.0 - 3129 Cond - ~~3393~~ 4026	5/04 6/04
1/18/04 am	TR	7.00 4.04	1014	235	—	NA		—	—	—	-	—	CHECK W/ ALL ABOVE STANDARDS	
1/19/04	QD	7.01 4.09	994											Not used
1/20/04 am	QD	7.00 4.04	991	~~244.4~~ (QD) 236	—	—		—	—	~~236.7~~ (QD)	-	-		
1/20/04 pm	QD	7.08 4.06	1004	232	—	—		—	—	—	—	—		
1/22/04	QD	6.98 4.05	1055	234.2	—	—								
1/23/04	QD	6.99 4.05	1071	234 @15	—	—								
1/24/04	QD	7.03 4.04	1068	230.9 @16	—	—								
1/25/04	QD	7.05 4.07	1041	233.1 @12	—	—								
1/26/04	QD	6.99 4.01	1026	233.5	—	—								

Tetra Tech NUS, Inc.

DOCUMENTATION OF FIELD CALIBRATION

PROJECT NAME : NSWC CRANE

SITE NAME: SWMUs 01

PROJECT No.: N0845, CTO 0315

INSTRUMENT NAME/MODEL: YSI

MANUFACTURER: YSI

SERIAL NUMBER: 98G0508AA

Date of Calibration	Person Performing Calibration	INITIAL READINGS PH	COND	~~TURB~~ ORP	DO	TEMP		FINAL READINGS PH	COND	~~TURB~~ ORP	DO	TEMP	Calibration Standard (Lot No.)	Remarks and Comments
1/19/04	QN	7.39 3.78	909	235.1	86.5% 8.6 mg/L	N/A		6.99 3.98	1.0	235.7	98.7% 9.77 mg/L	N/A	ORP - 0321385 7.0 - 3106	Exp 10/05 4/04
—	—	—	—	—	—	—		—	—	—	—	—	4.0 - 3129 Cond - 4026	5/04 6/04
1/20/04 am	QN	6.96 4.06	1002	211.4	—	—		~~6.99~~ —	—	236.7	—	—		
1/20/04 pm	QN	6.97 4.07	1019	233.7										
1/22/04	QN	6.93 4.01	1028	235.4	—	—								
1/23/04	QN	6.99 4.04	1081	253.2 210	—	—								
1/24/04	QN	6.79 4.00	1120	251.8 216	—	—		7.00 4.00						
1/25/04	QN	6.97 4.14	1037	253.8 212	—	—								
1/26/04	QN	7.17 4.06	1033	247	—	—		7.00						

Tetra Tech NUS, Inc.

DOCUMENTATION OF FIELD CALIBRATION

PROJECT NAME : NSWC CRANE

SITE NAME: SWMUs 01

PROJECT No.: N0845, CTO 0315

INSTRUMENT NAME/MODEL: YSI

MANUFACTURER: YSI

SERIAL NUMBER: 02E0628 AC

Date of Calibration	Person Performing Calibration	INITIAL READINGS						FINAL READINGS					Calibration Standard (Lot No.)	Remarks and Comments
		PH	COND	TURB	DO	TEMP		PH	COND	TURB	DO	TEMP		
1/22/04	[illegible]	6.79 4.05	882	—	98.3% 10.26mg/L			7.01 4.00	1000	—	99.3% 10.62	—		232.7 / 234.9 ORP

B.3

Miscellaneous Field Records

B.3.1

SWMU 01 Site Logbook

Book No. 1340

START OF ROUND 2

OTHER NOTEBOOKS:

1) GEO Notebook 1347 - S. CONTI (Site Geologist)
2) SAMPLING NB 2493 - K. SIMPSON

TITLE NSWC CRANE

PROJECT NO. 3959

BOOK NO. 1340

TUES 5/28/02

Work continued from Page

TRAVEL DAY

1230 Hrs - Arrive @ Pass Gate - S. Conti & T. Rojahn
1248 Hrs - Arrive @ 3245 BLDG - Check in w/ C. Freeman
Check & organize Fed. Ex. Deliveries
1340 Hrs - Drillers set up Personnel Arrive
Kenny Boehmer & Adam Todd
1400 Hrs - Escort Drillers supplies through Crane
Gate - Global Drilling Supplies
1425 Hrs - Check w/ Donna on Dig Permits -
Need signed by (1) more party - should be able
to pick up permit for MGBG tomorrow
1505 Hrs - Escort Global Drilling supply truck out
Crane Gate
1510 Hrs Return to 3245 - Quick H&S tailgate &
Leave for MGBG
1540 Hrs - Arrive @ MGBG
Drillers set up Decon
S.C. & T.R. visted drilling locations
1605 Hrs - Left MGBG for BLDG 3245
1635 Hrs - Arrive @ BLDG 3245 - Paperwork
1700 Hrs - Left BLDG 3245

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DATE 5/28/02

DISCLOSED TO AND UNDERSTOOD BY **DATE** **WITNESS** **DATE**

WED.
5/29/02 DAILY SUMMARY

1) Picked up Dig Permits for MGBG & Jeep Trail see p 77 & 78
2) Escort Dozer Delivery to MGBG - to & From Crane Gate #4
3) Hot Work Permit For MGBG - see p. 76 Meet w/ Don Mills @ Site
4) H&S Site Specific Training For Drilling Crew & S. Conti
5) Escort/Recon MGBG w/ Drillers
6) Sampled & Shipped IDW Sample From PCB Capacitor/Pole Yard For PCBs

CREWS → FOR 1st SHIFT

TT NUS
S. Conti (Geologist)
T. Rojahn (FOL)

Bowser-Morner
M. Duncan (Drilling Crew Leader)
J. VanKirk (Driller)
J. Dunn (Driller Helper)
J. Berresford (Driller Helper)

FIRE INSPECTOR:

FIRE DEPARTMENT
NAVAL SURFACE WARFARE CENTER
CRANE DIVISION
CODE 0131, BUILDING 10
300 HIGHWAY 361
CRANE IN 47522-5001

DON MILLS

Fire Inspector
PHONE: DSN 482-6019, Commercial 812-854-6019
FAX: DSN 482-4269, Commercial 812-854-4269
Email: mills_d@crane.navy.mil

Also Hot Work Permit # 854-3343

Work continued from Page Weather - overcast, scattered showers & mid 70s

0700 Hrs - Arrive @ BLDG 3245
- Start organize NA test kits & Notebook
- Set up meeting w/ Fire Inspector for 1030 Hrs @ MGBG
- Call Public Works Digging Permits ready for OJT & MGBG picked up @ 0830 Hrs

1030 Hrs - Meet w Don Mills - Fire Inspector
All hot work to take place on gravel pad
Parking 75' from magazines

1100 Hrs - Left MGBG to meet National Rental @ Cran Gat

1128 Hrs - Arrive @ Crane Gate Escort National Rental w/ Dozer to MGBG - Drop off Dozer 1205 Hrs

1230 Hrs - Escort National Rental Driver off site (Crane Gate)

1245 Hrs - Return to BLDG 3245
Prep for H&S site Specific Training

1510 Hrs - H&S Training w/
S. Conti - TTNUS
M. Duncan
J. Bernstein
J. Dunn
J. VanKirk
} Bowser Morner

1625 Hrs - Left BLDG 3245 for MGBG
Show Drilling crew MGBG

1650 Hrs - Arrive @ MGBG
Show Drilling crew decon, gravel pad for steam Generator, & Well locations

1800 Hrs - Return to BLDG 3245

1815 Hrs - Check w/ Fire Dept. to see if they recharge Fire Ext. - No they do not but got info. on where to purchase same

1820 Hrs - Left Site

1850 Hrs - Drop off IDW sample @ Fed.Ex. in Bloomington

SIGNATURE
DATE 5/29/02
DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

Ty Royal 5/29/02

FLAME TOOL/HOT WORK PERMIT
NSWC CRANE 11320/19 (REV. 1-02)

ITEM	FROM	TO	ISSUED TO
EFFECTIVE DATES	5.29.02	6.22.02	☐ NSWC ☐ CAAA ☑ CONTRACTOR ☐ TENANT
TIME	0700	1800	NAME OF TRADE/CONTRACTOR/TENANT ACTIVITY: TETRA TSS

TYPE OF EQUIPMENT TO BE USED *(Cutting Torch, Arc Welder, etc.)*

STEAM GENNY, CUTTING TORCH, GRINDER (WELL LOCATIONS 01T03, 01T04)

PURPOSE OF USE

SAMPLE SOIL/SEDIMENT AT MUSTARD GAS AREA

WHERE USED *(Building/Structure/Other location)*

Hwy 251 OFF OF Hwy 161

☐ INSIDE ☑ OUTSIDE

INSTRUCTIONS OF THE FIRE SUPPRESSION/PREVENTION BRANCH, FIRE DEPARTMENT

☑ GENERAL FIRE PREVENTION INSTRUCTIONS ON REVERSE SIDE MUST BE COMPLIED WITH.

☑ IN ADDITION TO THE GENERAL FIRE PREVENTION INSTRUCTIONS ON REVERSE SIDE, YOU SHALL COMPLY WITH THE FOLLOWING:

☑ REMOVE ALL COMBUSTIBLES 35 FEET, ALL FLAMMABLE LIQUIDS 50 FEET, AND ALL EXPLOSIVES (UNLESS APPROVED TO STAY BY THE SAFETY DEPARTMENT (CAAA OR NAVY ESO) AND FIRE PREVENTION) 100 FEET FROM THE HOT WORK AREA.

1) FIRE WATCH REQUIRED WITH 30 MINUTES AFTER COMPLETION OF WORK EACH DAY

2) NO TORCH/GRINDER OR WELDER/SPARK PRODUCING TOOL WILL BE USED AT WELL SITE IF REQUIRED MUST CALL FIRE PROVENTION

3) CAMP AND INJECT AREA CAN BE USED IN BRAVO!

PERSON DESIGNATED AS FIRE WATCH *(NOT SAME PERSON AS PERMIT HOLDER)*

Ty Royal AS DIRECTED

REQUIRED FIRE EXTINGUISHER AT WORK SITE		OTHER FIRE PROTECTION STANDBY REQUIREMENT(S)
TYPE	SIZE	
☐ WATER ☐ CO_2 ☑ DRY CHEMICAL	20LB ABC / WATER SUPPORT TRUCK	

I have read, understand and will comply with the above "Instructions of the Fire Suppression/Prevention Branch, Fire Department"

SIGNATURE *(Permit Holder)*: Ty Royal — DATE: X 5/29/02

HAZARDOUS AREAS ONLY

I agree that the "Instructions of the Fire Suppression/Prevention Branch, Fire Department" stated above are adequate and area is safe to work in.

SIGNATURE *(Building Supervisor/Forman/Representative)* — DATE

Permission is hereby granted the Trade/Contractor/Tenant Activity named above to use specified equipment in accordance with the "Instructions of the Suppression/Prevention Branch, Fire Department as stated above.

SIGNATURE *(Fire Department/Representative)* — DATE: 5.29.02

DISTRIBUTION: Original *(Code 0631 File)*

Ty Hale

5/28/02

3791

GGING PERMIT
/SCC 11000/3 (REV. 12/89)

QUESTED BY: Terry Pate	DATE: 5/16/02
RK REQUEST OR E/S NO.: 38646	LOCATION: Summit Mustard Gas Burial Grd
RK WILL BE PERFORMED BY: Tetra Tech NUS, Inc.	DATE (Start - on or about): 5/23/02

RK DESCRIPTION
Installation of three (3) ground water monitoring wells, & some limited sediment sampling in the MGBG area drainage channels. See attached drawing.

UIPMENT TYPE

☐ HAND TOOLS ☐ CORE DRILL ☐ TRENCHER ☐ BACKHOE ☐ HEAVY EQUIPMENT

Faxed ZZ 5/16/02

UNDERGROUND UTILITIES LOCATED IN WORK SITE

UTILITY	PRESENT	MARKED	NOT LOCATED	REMARKS
MPRESSED AIR ZZ	N/A			BZ 5-28-02
CTRICAL	NA			5.7
E ALARM ZZ	NA			M 5-20-02
OUNDING ZZ	N/A			BZ 5-28-02
TURAL GAS	N/A			5/16/02 dy MAP
CURITY ALARM ZZ Haseman	N/A			5/16/02 JRC
VER	NA			5-16-02 Rich
AM	NA			5-20-02 RC
EPHONE Faxed 5/16/02	NA			5-21-02
TER	NA			5-16-02 Rich
Secondary Electrical	N/A			BZ 5-28-02

addition to the general precautions for excavating where underground utilities are present, comply with the following:

MIT HOLDER SIGNATURE: Ty Hale — DATE: 5/29/02

GING PERMIT APPROVED BY — DATE

STRIBUTION:

ORIGINAL - Code 0932 File

Terry Rogalski
5/29/02

DIGGING PERMIT
NWSCC 11000/3 (REV. 12/89)

3792

REQUESTED BY: Terry Pate
DATE: 5/16/02
WORK REQUEST OR E/S NO.: 38650
LOCATION: Sumu 3, JT-25, Old Burn Pit
WORK WILL BE PERFORMED BY: Tetra Tech NUS, Inc.
DATE (Start - on or about): 5/22/02
WORK DESCRIPTION: Environmental investigation studies which includes drilling of 2 soil borings to install ground water monitoring wells at Sumu3, Jeep Trail 25, Old Burn Pit, South of the Ammunition Burning Ground. Drawing attached, locations of the 2 soil borings are handwritten & highlighted.

EQUIPMENT TYPE:
☐ HAND TOOLS ☐ CORE DRILL ☐ TRENCHER ☐ BACKHOE ☐ HEAVY EQUIPMENT

Faxed 22 5/16/02

UNDERGROUND UTILITIES LOCATED IN WORK SITE

UTILITY	PRESENT	MARKED	NOT LOCATED	REMARKS
COMPRESSED AIR 22	N/A			5-28-02
ELECTRICAL	NA			S.P.
FIRE ALARM 22	NA			MB
CONDUIT 22	N/A			5/28/02
NATURAL GAS	N/A			5/16/02 by MMP
SECURITY ALARM 22	N/A			5/16/02 JRP
SEWER	NA			5-30-02
STEAM	N/A			5-30-02
TELEPHONE Faxed 5/16/02	NA			5-21-02
WATER	NA			5-20-02
22 Secondary Electrical	N/A			5-21-02

In addition to the general precautions for excavating where underground utilities are present, comply with the following:

PERMIT HOLDER SIGNATURE: Terry Rogalski
DATE: 5/29/02
DIGGING PERMIT APPROVED BY: [illegible]
DATE: 5/29/02

DISTRIBUTION:
ORIGINAL - Code 0932 File

THURS 5/30/02
Work continued from Page WEATHER - Partly Cloudy Low 80's

0700 Hrs - ARRIVE @ BLDG 3245
- PAPERWORK
- CALL FIRE INSPECTOR FOR SMOKING PERMIT - D. Mills said it would be ok to smoke in the CENTER OF GRAVEL Road - put butt in COFFEE CAN
- CHECK Bottles FROM SWLO & LAUCKS

0900 Hrs - LEFT CRANE FOR Bloomington to RECHARGE 2816 FIRE Extinguisher @ Fire Ext. Sales & Serv. - Bloomington

1110 Hrs - Return to CRANE & ARRIVE @ MGBG Check in w/ Stan & Drop off Fire Ext @ Hot work AREA ~~in~~ @ GRAVEL PAD

1215 Hrs - RETURN to BLDG #3245 - CHECK IN w/ T. JOHNSTON & Pick up LUNCH

1250 Hrs - ARRIVE @ MGBG check in w/ Stan drop off Lunch

1310 Hrs - Check out Site FOR 01T05 ; prep. to clear vegetation - M. DUNCAN DOZER OPERATOR

* 1330 Hrs - BEGIN DOZER Activity @ 01T05 Site
- NEED Large clearing to MANUVER LARGE top HEAVY rig - HAVE to (TR) ~~Cut~~ cut slope to PREVENT Rig FROM rolling over.

* 1548 Hrs - FINISH CLEARING @ 01T05

1555 Hrs - CHECK ON DRILLING CREW / S. Conti

1610 Hrs - Was going to check OST w/ M. DUNCAN - WHAT/How much clearing will be involved - M.D. WENT FOR H_2O

1623 Hrs - LEFT Site (MGBG) to Follow M.D. to make sure that he could get into BLDG 3245 to turn on H_2O VALUES

1645 Hrs - Arrive @ BLDG 3245 - M.D OIC C. Freeman still IN FRONT OFFICE

1718 Hrs - RETURN to MGBG - Driller ~~putting~~ installing CASING @ 01T03

1835 Hrs - LEFT Site

1910 Hrs - Stop FOR GAS

*: PAY Item Also, SEE NoteBook #1347 for drilling activities this date PAGE 59.

Work continued to Page

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

SIGNATURE [signature] DATE 5/30/02

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

FRI. 5/31/02 SUMMARY

- Get Drilling crews updated 8 hr REFRESHER Certificates
- TR & M. DUNCAN locate 2 drilling locations @ OJT
- C. FREEMAN type WEEKEND WORK LETTER
- Conference Call w/ PIT. OFFICE
- SEE ~~Drilling~~ SCS NB # 1347 pp 61-64 FOR Drilling details

END

FRI 5/31/02
Work continued from Page WEATHER - Mostly Sunny Hot & Humid Temp MID 80's

0700 Hrs - Arrive @ BLDG 3245
- PAPERWORK
- Call BOWSER MORNER FOR Drilling Crews up dated 8 hr REFRESHER TRAINING Certificates
- Prep FOR Groundwater Sampling
- Check IN w/ T. Johnston

0930 Hrs - RELAY T. JOHNSTON'S QUESTIONS to S. Conti Regarding Drilling status

1010 Hrs - Return to BLDG 3245
- RECEIVE 8 hr REFRESHER Training Cert. FROM BOWSER FOR DRILLERS
- TALKED to T. J. - WANTS to Keep INFORMED OVER WEEKEND
  E-mail address DENDRIMER@AOL.COM
  Home Phone (412) 854-1052
- CALI. YSI & TURBIDITY METER
- Complete set up OF MNA Kits & Analysis Notebook
- CALI. BEARINGS & Dist FOR 03T02 & 03T01 @ OJT

1227 Hrs - M. DUNCAN Arrived @ BLDG - Empty H_2O & go to OJT.

1335 Hrs - Arrive @ OJT
Locate APPROXIMATE Locations FOR 03T01 @ 03T02
T. Brents Locations SOMEWHAT DIFFERENT

1520 Hrs - Return to BLDG 3245 - Conference Call w R. Basinski, T. Johnston & A. BERNHARDT - Progress & PHOTOS
- ASK C. Freeman to type weekend Letter

1600 Hrs - Stan Conti Arrived @ BLDG # 3245 - Drilling Crew done FOR the day

1640 Hrs - LEFT SITE FOR Sams Club - NEED drinking H_2O

1730 Hrs - GAS Vehicle & PURCHASE Drinking H_2O on ride to Motel

END

SAT. 6-01-02 SUMMARY

- SAMPLED Monitoring WELLS 01-03 & 01-04
- SEE S.C.S NB #1347 PAGES 65 & 66 FOR drilling details.

END

Terry Nagel

TITLE NSWC CRANE

PROJECT NO. 3959

BOOK NO. 1340

SAT 6/01/02

Work continued from Page

WEATHER - Hot & Humid High 80's Mostly Sunny

0650Hrs - ARRIVE @ BLDG 3245
PREP. FOR GW SAMPLING

0730Hrs - ARRIVE @ WES-1-3-81
Start Purge @ 0802
END Purge @ 0922 WELL DRY With slow RECOVERY / sample later

0940Hrs - LEFT MGBG site to let Driller take on drilling H_2O @ BLDG 3245

1035 Hrs - Drillers LEFT BLDG 3245 FOR MGBG

1045 Hrs - Flat tire in RENTAL CAR

1115 Hrs - LEFT BLDG FOR MGBG

1135 Hrs - Arrive @ MGBG - take lunch w/ S.C. outside CRANE Gate

1310 Hrs - Return to MGBG - Check WL @ WES-1-3-81 RECOVERY less than 70% will sample later

1350 Hrs - Start PURGE @ WES-1-4-81

1750 Hrs - END PURGE @ WES-1-4-81
SAMPLE WES-1-4-81 @ 1755 Hrs (01GW0402)

1805 Hrs - SAMPLE WES-1-3-81 (01GW0302)

1835 Hrs - ARRIVE @ BLDG 3245
Drop of METERS & IDW
Refrigerate SAMPLES & SECURE

1900Hrs - LEFT MGBG

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DATE 6/1/02

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

SUN. 06-02-02 SUMMARY

- SAMPLED Monitoring WELLS 01-01 & 01-06
- Collected RINSATE BLANKS RB06020201 & RB06020202
- SEE SCs NB# 1347 pages 67 & 68 for drilling Activities

END

SUN 6/02/02

Work continued from Page

WEATHER - Hot & Humid Partly Cloudy Temp High 80

0715 Hrs - ARRIVE ON SITE
PREP to SAMPLE GW

0800 Hrs - ARRIVE @ MG86

0855 Hrs - BEGIN PURGE @ WES-1-1-81
END PURGE @ 1025 Hrs

1030 Hrs - SAMPLE TIME FOR (01GW0102)

Trouble getting to 01MW06 - ROADS BAD

1205 Hrs - Start purge @ 01MW06
END PURGE @ 1355 Hrs

1400 Hrs - SAMPLE 01GW0602
WELL CLEAN UP
CHECK IN W/ S. Conti - Finish Drilling @ 01T03

1430 Hrs - LEFT MG86

1500 Hrs - ARRIVE @ BLDG #3245
• PAPERWORK

1530 Hrs - Collect VOCs RINSATE OF PERISTALTIC TUBING
RB06020201

1550 Hrs - Collect VOCs RINSATE OF Bladder Pump
RB06020202
DECON both bladder pumps for tomorrow
CLEAN out SUV
Dump IDW ; CHECK CALI. ON YSI probes

1740 Hrs - LEFT SITE for Motel

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DATE 6/02/02

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

MON. 06-03-02 SUMMARY

- SAMPLED MONITORING WELLS 01-08 & 01-09
- COLLECTED SOURCE WATER BLANKS SB06030201 & SB06030202
- SHIPPED SAMPLES ON CoFC - MGBG060102 VIA FED EX ON AB# 8316 7333 0335
- SEE SCs NB# 1347 pages 69 & 70 FOR drilling details.

END

Tony Pogel

MON 6/03/02

Work continued from Page WEATHER : Hot & Humid Partly Cloudy Temp 80's(Hi

0705 HRS - Arrive @ BLDG # 3245
Prep to Sample GW
Check in w/ T. Brent
Check in w/ Ralph B. @ office
Call Sandy order another YSI for well dev.

0810 Hrs - Arrive @ MGBG
0850 HRS - Start Purging @ WES-1-8-82 (01GW0802)
1030 HRS - END PURGE
1035 HRS - SAMPLE TIME & Collected FD060302

1110 HRS - Start Purge @ WES-1-9-82 (01GW0902)
1310 Hrs - END PURGE
1315 Hrs - SAMPLE TIME

1400 Hrs - LEFT MGBG FOR BLDG #3245
1420 Hrs - Arrive @ BLDG # 3245
CHECK IN W/ T. Johnston & R. Basinski
1515 Hrs - TAKE Source Blank SB06030201 - DI Reagent Grab
1530 Hrs - TAKE " " SB06030202 - Tap H_2O @ BLDG 3245

PREP. SAMPLES FOR SHIPPING ON CoFC MGBG 060102
CALL SWLO spoke to S. Grovenstein to look for
SHIPMENT TUES - FED EX DELIVERY AB# 8316 7333 0335
CHECK YSI CALIBRATION - OK
MAKE UP VOC SETS

1805 Hrs - LEFT SITE FOR FED. EX w/ S. Conti
1830 Hrs - Drop OFF SAMPLES @ FED. EX.
AB# ABOVE

END

SIGNATURE Terry Rozalski
DATE 6/03/02
DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

TUES 06-04-02 SUMMARY

- COLLECT SAMPLES @ MONITORING WELLS 01-23 & 01-26.
- SEE SCs NB #1347 pages 71 & 72 FOR Drilling details.

END

TUES 6/4/02

Work continued from Page WEATHER: Hot & Humid, Partly Cloudy TEMP High 80°s

0700 Hrs - ARRIVE @ BLDG #3245
PREP. FOR GW SAMPLING
TALK to K. SIMPSON REGARDING OFFICE ASSISTANCE W/ORDERING ~~ordering~~ TPG SUPPLIES & PAPERWORK

0940 Hrs - Start Purge @ WES-1-23-83 (01GW2302)
1210 Hrs - END PURGE
1215 Hrs - Start SAMPLE collection

1305 Hrs - Check in w/ Drilling Crew - FINISHED 01T04 & mobing to 01T05

1355 Hrs - Start PURGE @ WES-1-26-83
1755 Hrs - END PURGE
1800 Hrs - Start Sample Collection (01GW2602)

1820 Hrs - LEFT MGDG
1844 Hrs - ARRIVE @ BLDG #3245
SECURE SAMPLES in Frig.
Drop off meters, etc.
1900 Hrs - LEFT SITE

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE Ted Nagel DATE 6/4/02

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

WED 06-05-02 SUMMARY

- COLLECT SAMPLE @ MONITORING WELL 01-14
- SHIPPED SAMPLES ON COPC #MGBG060402 VIA FED EX AB# 828074028087
- SEE SCS NB #1347 page 73 for drilling details

SHIFT SUMMARY FOR Drilling

- All three WELLS WERE COMPLETED (01T03, 01T04 & 01T05) by this date
- All pads & posts WERE completed on this date 6-5-02.
- Drillers (NAMES SEE p.74) TRAVEL DAY
- TTNUS will travel to Pittsburgh ON 6-6-02
- Drillers will return NEXT Shift FOR CLEAN-UP, Etc.

END

Ty Rogal

TITLE NSWC CRANE

PROJECT NO. 3959

BOOK NO. 1340

WED 6/05/02

Work continued from Page

WEATHER: AM Partly cloudy Temp 70's, PM Rain heavy @ times

0655 Hrs - ARRIVE @ BLDG #3245

PREP. to SAMPLE GW

Check in w/ T. Brent - 1) Low Boy available to MOB Dozer to ABG TUES or WED. of NEXT WEEK; he will check into

2) Status of ABG WELLS - to set up/prep for Drillers status

3) PCB Capacitor IOW - 120ug/K

K. Simpson Called - CAN come out NEXT shift in he will do some prep. work & EQ ordering for NEXT shift

0815 Hrs - ARRIVE @ MGBG

0850 Hrs - Start PURGE @ WES-1-14-83 (01GW1402)

1250 Hrs - END PURGE

1255 Hrs - SAMPLE Collection Time

1320 Hrs - Recon ABG w/ S. Conti - PLACE well location stakes

1400 Hrs - Arrive @ BLDG 3245

PAPERWORK & PACKAGE SAMPLES FOR SHIPPING

UNLOAD VEHICAL

Call Southwest Labs (S. Grovenstein) report shipment AB# 92807402 8087

Check in w/ T. Johnston - Progress REPORT

1700 Hrs - LEFT NSWC CRANE

1730 Hrs - Drop off SAMPLES @ FED. EX

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DATE 6/5/02

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

TTNUS CREW : S. Conti
For 2ND SHIFT K. Simpson
T. Rojahn

MON 06-10-02 SUMMARY

- NORMAL TRAVEL DAY - NO SAMPLING
- PREP. VEHICALS FOR GROUNDWATER SAMPLING
- CALIBRATE METERS
- 1500 Hrs DRILLERS ARRIVE, SAME NAMES ON PAGE 74
- DEVELOPE MONITORING WELL 01T04 (SC OVERSIGHT)
- SEE ALSO PAGE 77 OF SCs NB #1347

END

TITLE NSWC CRANE **PROJECT NO.** 3959 **BOOK NO.** 1340

ON 6/10/02 CREW S. Curti, K. Simpson & T. Rosahn

Work continued from Page

TRAVEL DAY

1300 Hrs - Arrive @ BLDG# 3245
Decon Bladder Pumps
Organize EQ.
Cali YSI
Check in w/ Home OFFICE - Discuss sluge tests @ SWMU 5 & 9
S.C. - Worked with M. Duncan DEV. WELL 01T04

1700 Hrs - Arrive @ MGBG
Install Pump @ 01C01-93, WGS-1-10-82 & 01T02 in prep for tomorrow's sampling
Check in w/ S.C. & WELL DEV.

1805 Hrs - LEFT NSWC CRANE
- Stop @ Lowes check on straw / Hay for Revegs @ MGBG - don't have straw said to check w/ Coop on SEC. street.

1900 Hrs - Stop @ COOP - close @ 1730 Hrs will come Back tomorrow @ 0730 Hrs to purchase straw, seed, Etc.

END

Work continued to Page

SIGNATURE

DATE 6/0

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

TUES 06-11-02 SUMMARY

- Drilling crew & S.C. DEVELOPE WELLS (01T05 & 01T03) SEE Notebook 1347 PAGES 79 & 80.
- Sample MONITORING WELLS 01C01, 01-10 & (TK) ~~Start~~ purge 01T02 (will collect sample tomorrow).

END

TUES 6/11/02

Work continued from Page

WEATHER: AM Hot & Humid 80°s PM scattered thunder storms 70°

0730 Hrs - Stop @ COOP to purchase straw, seed, etc.
No straw in stock - purchased seed

0835 Hrs - Arrive @ BLDG #3245
- CALL other supplier for straw / hay
- Check in with R. BASINSKI
- Prep. to sample GW (KS & TC)
- Arrange for B. MORNER to bring in truck to pick up unused supplies
- PREP. - TRIP Blank TB061102 @ 0945 Hrs

1025 Hrs - Arrive @ MGBG
1100 Hrs - Start PURGE @ 01C01
1310 Hrs - END PURGE @ 01C01
1315 Hrs - Collect 01GWC0102

1353 Hrs - Start PURGE @ 01T02
1545 Hrs - END PURGE (DRY OUT WELL)
1645 Hrs - Monitor RECOVERY FOR 60 min. - END RECOVERY monitoring. - will sample tomorrow (recovery to slow).
1715 Hrs - RETURN to BLDG #3245
- SECURE Samples in Frig
- Drop off meters
- CHECK MESSAGES - Survey crew coming tomorrow! SLUDGE testing CONFIRMED
- Start COC MGBG061102

1745 Hrs - LEFT BLDG #3245

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DATE 6/11/02

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

SUMMARY 06/12/02

- FINISHED SAMPLING 01T02; TEST KITS FOR MNA PARAMETERS
- STARTED W.Ls @ OST, ABG & DBG
- SEE NB 1347 FOR DRILLING DETAILED INFO. page 81
  DRILLING CREW DEMOB this date
- K.S. did recon w/ SURVEYORS (Ben Bledsoe Crew Boss)

END

WED. 06/12/02

Work continued from Page

Weather - OVERCAST, Hot & Humid

0700 Hrs - Arrive @ BLDG # 3245

- Arrange for pass for Dozer Pick up w/ T. Breit
- Prep. for GW & NA sampling @ 01T02
- Check in w/ R. Basiaski

0900 Hrs - Start sampling @ 01T02
K.S. taking NA parameters

0930 Hrs - End sampling & clean up @ 01T02

1052 Hrs - Arrive @ Dye Burial Ground for water levels

1153 Hrs - Stop WLs Head to Cafe. to meet S.C. & K.S.

1210 Hrs - Arrive @ Cafe.

1300 Hrs - Return to DBG to take W.L.

1340 Hrs - Finish W.L. @ DBG - Head for ABG to meet w/ SC & K.S.

1555 Hrs - Arrive @ ABG check in w/ K.S.
Take water levels @ OJT until 1800 Hrs

1812 Hrs - Arrive @ S.C. & K.S. vehicle - waited until 1840 Hrs to meet with them - then left for BLDG # 3245

1850 Hrs - Arrive @ BLDG # 3245
to wait for SC & K.S.; Paperwork; Decon M-Scope & Boots - Poison Ivy thick @ Both OJT & DBG.
Decon Pumps - will assemble tomorrow

2010 Hrs - Left BLDG for Gas Sta. & Motel
K.S & S.C. didn't come to BLDG 3245 - Called cell Phone several times No response

END

SUMMARY 6/13/02

- FINISH W.L.s @ OJT (~11 WELLS)
- RAN NA Nitrate/Nitrite FOR 01T02
- DOZER FROM NATIONS RENT - ESCORT PICKUP ON & OFF SITE
- ~80% OF REVEGETATION ACTIVITIES COMPLETED @ NEW WELL SITES MGBG
- S.C. WORKED ON CTO 10 SLUGE TEST PREP 1/2 day SWMUS 5 & 9. (SEE NB #1347 page 83)

END

TITLE NSWC CRANE

PROJECT NO. 3959 / 3960

BOOK NO. 1340

THURS 6/13/02

Work continued from Page

WEATHER : Hot & Humid Low 80°s (Rain 0830 Hrs - 1030 SUNNY AFTERNOON)

0700 Hrs - ARRIVE ON SITE (BLDG 3245)

- K.S. going through W.L. taken yesterday to SEE WHAT REMAINS (11 wells remain)
- T.R. Assembled bladder pumps (3)
- T.R. RAN Nitrate / Nitrite tests on 01T02
- K.S. & S.C. (0810 Hrs) Left to take WLs

0840 Hrs - RECEIVED CALL FROM M. DUNCAN that Nations Rent WAS @ CRANE gate to PICK UP DOZER

0900 Hrs - Arrive @ Gate to Escort DOZER pick up person

0930 Hrs - Arrive @ MGBG w/ Nations RENT

1015 Hrs - Escort Nations RENT OFF NSWC CRANE

1035 Hrs - Talk w/ T. JOHNSTON - up date

1100 Hrs - LEFT FOR OJT - FOR Water LEVELS

1200 Hrs - LUNCH

1245 Hrs - Return to OJT FOR WATER LEVELS

1400 Hrs - LEFT OJT FOR MGBG

REVEGETATE Disturbed AREA (01T05)

1630 Hrs - Stop Revegetation to RETURN to BLDG #3245

1655 Hrs - ARRIVE @ BLDG #3245

PAPERWORK & PACKAGE SAMPLES FOR SHIPMENT

COC # MGBG 061102 on FED EX. AB # 828074028043

1730 Hrs - LEFT NSWC CRANE FOR FED EX.

1800 Hrs - Drop of SAMPLES @ FED. EX.

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 - MADE IN USA

Work continued to Page

SIGNATURE

DATE 6/13/02

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

Summary 6/14/02

- SC, SLUG TESTING @ SWMUs 5 & 9 (SEE NB 1347 page 85)
- TR/KS - SAMPLE @ WELLS 01-11, 01-25
- Collect Rinsate Blank RB061402

END

TITLE NSWC CRANE

PROJECT NO. 3959

BOOK NO. 1340

FRI 6/14/02

Work continued from Page

WEATHER - Partly Cloudy Mid 70°s

0700 Hrs - ARRIVE @ BLDG #3245

- PREP. FOR GW SAMPLING Collect TB 06/14/02 @ 0800 Hrs
- CALL IN HRS
- SPOKE W/ M. FRANCIS - couldn't get T.J. discussed QA QC, etc.
- CALLED LAB REPORT SHIPMENT C.o.C MGBG 061102 SHIPPED 6/13/02
- PAPERWORK
- K.S. showed S.C. SWMUs 5 & 9 so he could start slug tests

0955 Hrs - Arrive @ MGBG
dropped bladder pumps in WES-1-15-83 & 01T04

1100 Hrs - Start purging @ WES-1-11-82

1300 Hrs - END PURGE @ WES-1-11-82

1305 Hrs - Start Collection of 01GW1102

1400 Hrs - Arrive @ WES-1-25-83 to assist K.S. with MNA

1515 Hrs - Finish MNA @ WES-1-25-83

1520 Hrs - Arrive @ / Return to WES-1-11-82 to do MNA with K.S. assisting.

1554 Hrs - Finish MNA @ WES-1-11-82
CLEAN UP @ WELL

1620 Hrs - Return to BLDG #3245
PAPERWORK
Collect Rinsate of Bladder RB061402 @ 1745
K.S. MNA = Nitrate & Nitrite from 01GW2502 & 01GW1102
DECON Bladder Pump

1820 Hrs - LEFT BLDG #3245 / S.C. ALREADY OFF SITE

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE Terry Rogers

DATE 6/14/02

DISCLOSED TO AND UNDERSTOOD BY **DATE** **WITNESS** **DATE**

Summary 6/15/02

- S.C. SLUG Testing @ SWMUS 5 & 9 (SEE NB 1347 page 87)
- K.S. & T.R. Sample 01, T04, 01T05, WES-1-5-81 & WES-1-15-83

END

TITLE NSWC CRANE

PROJECT NO. 3959

BOOK NO. 1340

Sat 6/15/02

Work continued from Page

WEATHER - Partly Cloudy TEMP MID 70°S

0700 Hrs - Arrive @ BLDG #3245

PREP. FOR GW SAMPLING w/ K. SIMPSON

~~CALL T. JOHN~~ (TC)

CALL T. JOHNSTON @ HOME SUMMARIES Daily Activities

0830 Hrs - Arrive @ MGBG

INSTALL BLADDER PUMP IN 01T03

0925 Hrs - Start Purge @ WES-1-5-81

END Purge @ 1110 Hrs

Pumped W.L. BELOW Bottom OF Screen

Monitored Recharge FOR 20 MIN

will sample tonight or tomorrow morning

1208 Hrs - Start Purge @ WES-1-15-83

END Purge @ 1400 Hrs

1410 Hrs - Collect sample 01GW1502 & RUN MNA

1615 Hrs - Finish up CLEAN up @ WES-1-15-83

1620 Hrs - Arrive @ 01T05 to ASSIST K.S.

- SPREAD out straw - FINISH COVERING grass SEED
- will return to BLDG to RUN Nitrate/Nitrites & Sulfate

1705 Hrs - Arrive @ BLDG 3245

RUN ABOVE NA TESTS FOR WELLS 01T04 & WES-1-15-83

1852 Hrs - LEFT 3245 FOR MGBG

1915 Hrs - Arrive @ MGBG Assist K.S. w/ MNA

2010 Hrs - SAMPLE 01GW0502 - Purged Early in the day

2034 Hrs - RETURN to BLDG 3245

Drop OFF EQ; SECURE SAMPLES

2045 Hrs - LEFT BLDG 3245

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DATE 6/15/02

DISCLOSED TO AND UNDERSTOOD BY **DATE** **WITNESS** **DATE**

SUMMARY 6/16/02

- S.C. FINISH UP SLUG TEST @ SWMUS 5 & 9 & PACKAGE SLUG TEST EQ FOR SHIPPING (SEE NB 1347 p. 89)
- COLLECT RINSATE BLANKS RB061602 & RB061602-B
- K.S. & TK - TAKE PHOTOS @ ABG & OJT HABITAT, SEDI, LOCATIONS W/ LEAD CONT., SEEP, SPRINGS, ETC.

END

TITLE NSWC CRANE

PROJECT NO. 3959 / 3960

BOOK NO. 1340

SUN 6/16/02

Work continued from Page

WEATHER: Partly Cloudy Temp MID 70's

0700 Hrs - Arrive @ BLDG 3245

PAPERWORK; CLEAN-UP

NA TESTS RUN ON OIT05 Nitrate/Nitrite & SULFATE

DECON Bladder Pumps & NA GLASSWARE

Collect Rinsate BLANK RB061602 & AB061602-F

PREP. FOR TAKING PHOTOS @ OJT

1025 Hrs - LEFT BLDG #3245 FOR OJT

PHOTOS OF ABG

1200 Hrs - LUNCH BRAKE

1245 Hrs - Continue taking PHOTOS - Habitate, SEEPS, springs stream deposition, etc.

1600 Hrs - FINISH PHOTOGRAPHING OJT

Work on MGBG - PAPERWORK, shipping Labels, etc.

1700 Hrs - LEFT NSWC CRANE

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DATE 6/16/02

DISCLOSED TO AND UNDERSTOOD BY **DATE** **WITNESS** **DATE**

SUMMARY 6-17-02

K.S. & SC - W.L. @ MGBG
3 SW SAMPLES collected
6 SD SAMPLES collected

T.R. - W.L. @ MGBG
SAMPLED 01T03 & WES-1-2-81

PACKAGED & SHIPPED SAMPLES ON
CoPCs MGBG 061402 (GWs)
MGBG061702 (SD)

SHIP 8 SLUG TEST EQ to U.S. ENVIRONMENTAL & Pittsburgh WAREHOUSE
U.S. ENV. AB# 828074028054
WAREHOUSE AB# 828074028926

SEE NB#1347 FOR Additional INFORMATION p. 91 -
END

TITLE NSWC CRANE

PROJECT NO. 3959

BOOK NO. 1340

MON 6-17-02

Work continued from Page

WEATHER: Partly Cloudy TEMP MID 70's

0700 Hrs - Arrive @ BLDG # 3245
PREP. to SAMPLE GW

0816 Hrs - Begin W.L. MEAS. @ MGBG w/ K.S. & S.C.
0845 Hrs - END W.L. MEAS. @ MGBG (KS & S.C will continue)
Start set up @ 01T03
0847 Hrs - Start PURGE @ 01T03
END PURGE @ 10.40 Hrs
1045 Hrs - BEGIN Sampling GW 01T0301 Along w/ MNA

1215 Hrs - Start PURGE @ 01GW0202 or WES-1-2-81
1355 Hrs - END PURGE
1400 Hrs - BEGIN Sampling Along w/ MNA

1526 Hrs - LEFT MGBG for BLDG 3245
1546 Hrs - Arrive @ BLDG 3245
- RUN Nitrite & Nitrate FOR WELLS 01T03 & WES-1-2-81
- PACKAGE SAMPLES ON CoFCs MGBG061402 & 061702
FOR Drop off @ FED. EX (AB# 828074028801)

1900 Hrs - Drop of Samples @ FED EX (T.K & K.S); SC @ BLDG 3245

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE Terry Rogers

DATE 6-17-02

DISCLOSED TO AND UNDERSTOOD BY **DATE** **WITNESS** **DATE**

SUMMARY 6-18-02

- S.C. TRAVEL DAY
- Collect SW SAMPLE @ 01SW04
- FINISH REVEGETATION @ 01T05 & 01T04
- PACKAGE SAMPLES & EQ FOR SHIPMENT
- K.S. & T.R. will RETURN to Pittsburgh 06-19-02

END OF SHIFT

END OF ROUND 2 FIELD EFFORT

Page 109

TITLE NSWC CRANE

PROJECT NO. 3959

BOOK NO. 1340

TUES. 6-18-02

Work continued from Page

WEATHER: Partly Cloudy Temp MID 70's

0700 Hrs - Arrive @ BLDG #3245

- Run Sulfate FROM 01T03 & WES-1-2-81
- Process SW & SDs collected 6-17-02
- PAPERWORK & Prep. to collect sample @ 01SW04

1000 Hrs - Collected 01SW0402 @ MGBG
Finish Revegetation Activities @ NEWY installed monitoring wells

1200 Hrs - Lunch

1235 Hrs - Return to BLDG #3245

- PACKAGE - EQ (RENTAL) to return to U.S. ENVIRONMENTAL AB # 828074028904
- PACKAGE - Files, Paperwork, NA EQ. for Return to Pittsburgh - AB # 828074028812
- PACKAGE - SAMPLES FOR SHIPMENT to SWLO AB # 828074028823
- CLEAN OFFICE & WORK SPACE @ BLDG #3245

1535 Hrs - Drop of PACKAGES @ FED. EX. Bloomington

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DATE 6/18/02

DISCLOSED TO AND UNDERSTOOD BY **DATE** **WITNESS** **DATE**

DIGGING PERMIT
NSWC CRANE 11000/3 (REV. 8/02)

4343

REQUESTED BY: Tetra Tech NVS, Inc. Tom Brent 6160	DATE: 10/16/03
W[illegible] REQUEST ON E/S NO.: 08127	SWMU 01 Mustard Gas Burial Ground
WORK WILL BE PERFORMED BY: Tetra Tech NVS, Inc. / Dr. Tom Johnston	DATE (Start - on or about): 10/23/03

WORK DESCRIPTION
Soil Borings to obtain surface & subsurface samples at SWMU 01 Mustard Gas Burial Ground

EQUIPMENT TYPE
☐ HAND TOOLS ☐ CORE DRILL ☐ TRENCHER ☐ BACKHOE ☐ HEAVY EQUIPMENT

UNDERGROUND UTILITIES LOCATED IN WORK SITE

UTILITY	PRESENT	MARKED	NOT LOCATED	REMARKS
COMPRESSED AIR	N/A			10/16/03 dg
HIGH VOLTAGE ELECTRICAL	N/A			10/16/03 RAT
FIRE ALARM	N/A			10/16/03 SL
[illegible]NDING	N/A			10/16/03 SL
NATURAL GAS	N/A			10/16/03 dg
SECURITY ALARM	N/A			10/16/03 SL
SEWER	N/A			10/16/03 SL
STEAM	N/A			10/16/03 SL
TELEPHONE	N/A			10/16/03 SL
WATER	N/A			10/16/03 SL
SECOND ELECTRICAL	N/A			10/16/03 RAT
GENERAL DYNAMICS/NMCI	N/A			10/16/03 dg

In addition to the general precautions for excavating where underground utilites are present, comply with the following:

[illegible]MIT HOLDER SIGNATURE: [signature]	DATE: 10/20/03
DIGGING PERMIT APPROVED BY: Donna L. Zollman	DATE: ~~10/20/03~~ 1/12/04

DISTRIBUTION:
ORIGINAL - Code 09Z5 File
YELLOW - Supv. At work site
PINK - Permit requestor

TITLE NSWC CRANE

PROJECT NO. 0845

BOOK NO. 1340

TUES 1-13-04

Work continued from Page

TRAVEL DAY

1420 Hrs - ARRIVE @ BLDG #3245

- ORGANIZE SOME EQ & CONTAINERS
- PUT PIDs ON CHARGE
- PREP to do layout work @ MGBG
- CALL ERG FOR CAL INFO ON LUDLUM 12 & 44-10 PROBE

EFFICIENCY INFO NOT W/ METER - TALKED to ERG TECH (CHUCK FARR) EFFICIENCY NOT NECESSARY/NA FOR GAMMA (to MUCH INTERFERENCES FROM the ENVIRONMENT) - other INSTRUMENT checks are OF MUCH greater VALUE - i.e. VOLTAGE - Recommended Operation voltage 400 & Daily Function checks ON the Cs-137 SOURCE.

1530 Hrs - LEFT FOR MGBG

Lay out Test Pit Location 01TP01 - 05 & Proposed Monitoring Wells 01T06 & 01T07

1730 Hrs - RETURN to BLDG #3245

- Continue to organize FIELD OFFICE
- Called ERG - obtain more INFO ON Ludlum RAD Meter
- MADE SHOPPING List OF EQ & SUPPLIES NEEDED

1845 Hrs - LEFT BLDG FOR LOWES

1948 Hrs - FINISHED EQ. PURCHASES @ LOWES HARDWARE

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DATE 1-13-04

DISCLOSED TO AND UNDERSTOOD BY **DATE** **WITNESS** **DATE**

0854 - 1235 Fire Dispatch

TT Crew - F. Ramser & T. Rojahn
Bowser Morner - M. Lahti, J. McCloud, S. Whiddon & D. Smith

TLD BADGES	SN#	Participant #
~~FRED~~ Ramser	34482 6E8	99001
Terry Rojahn	3448 25E4	99005
Joe McCloud	3444823E	99003
Maynard Lahti	3444826E	99006
Scott Whiddon	3444824E5	99004
Don Smith	3444827E2	99007

Drilling - Start Test Pitting @ SWMU 1
SEE Note Book (NB) #1347

TITLE NSWC CRANE

PROJECT NO. 0845

BOOK NO. 1340

WED. 1-14-04

Work continued from Page

WEATHER - PM Low 40's & Partly cloudy

0700 Hrs - Arrive @ BLDG # 3245

0715 Hrs - Drillers Arrive Begin H&S Training

MAYNARD LAHTI

Joe McCloud

Scott WHIDDON

Don Smith

0900 Hrs - T.R. & M.L Arrive @ Crane Gate to Escort Hertz w/ Dozer & Backhoe to MGBG

0930 Hrs - Arriv @ MGBG

Drop off EQ

1015 Hrs - Escort Hertz delivery Truck off Base

1035 Hrs - Return to BLDG.

CHECK IN W/FRED

1100 Hrs - Picked up Dig Permits for SWMUS 01 & 16

1115 Hrs - CHECKED IN W/ FIRE Inspector

MADE AN Appointment ~~for~~ W/ Don Mills to inspect the MGBG @ 1300 Hrs

1130 Hrs - Return to BLDG Prep to Dig Test Pits

1230 Hrs - Arrive @ MGBG - to wait on Fire Hot Permit Inspector & drilling / test pit crew

- Establish Background locations for Rad Survey

1300 Hrs - Don Mills ARRIVED FOR FIRE INSPECTION & ISSUED Hot WORK PERMIT.

SEE PAGES 114 & 115.

SAMPLE ID	TIME	COMMENTS
TB01140401	1400	TRIP BLANK
01TP020506	1430	
01TP010607	1530	01FD01140401
01TP040607	1640	

1720 Hrs - Return to BLDG #3245 - Prep. Samples for Shipment

1745-1810 Hrs - Conversation w/ T. Johnston

1820 Hrs - Left Site for Fed Ex.

1855 Hrs - Drop of Samples @ Fed. Ex AB# 8412 2490 9511

Samples on CoC #4384 shipped to Pace Analytical.

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DISCLOSED TO AND UNDERSTOOD BY

DATE

WITNESS

DATE 1/14/04

DATE

B 100 P ©

FLAME TOOL/HOT WORK PERMIT
NSWC CRANE 11320/19 (REV. 1-02)

ITEM	FROM	TO	ISSUED TO
EFFECTIVE DATES	1-14-09	1-23-09	☐ NSWC ☐ CAAA ☑ CONTRACTOR ☐ TENANT
TI			NAME OF TRADE/CONTRACTOR/TENANT ACTIVITY: TETRA-TEC

TYPE OF EQUIPMENT TO BE USED *(Cutting Torch, Arc Welder, etc.)*

Gasoline Motor, Torch, Distillation

PURPOSE OF USE

Test Fuel Mixture by Distillation

WHERE USED *(Building/Structure/Other location)*

Bldg 851 Maintenance Area

☐ INSIDE
☑ OUTSIDE

INSTRUCTIONS OF THE FIRE SUPPRESSION/PREVENTION BRANCH, FIRE DEPARTMENT

☑ GENERAL FIRE PREVENTION INSTRUCTIONS ON REVERSE SIDE MUST BE COMPLIED WITH.

☑ IN ADDITION TO THE GENERAL FIRE PREVENTION INSTRUCTIONS ON REVERSE SIDE, YOU SHALL COMPLY WITH THE FOLLOWING:

☐ REMOVE ALL COMBUSTIBLES 35 FEET, ALL FLAMMABLE LIQUIDS 50 FEET, AND ALL EXPLOSIVES (UNLESS APPROVED TO STAY BY THE SAFETY DEPARTMENT (CAAA OR NAVY ESO) AND FIRE PREVENTION) 100 FEET FROM THE HOT WORK AREA.

1) Fire watch required
2) No refueling of vehicles in Grass - must be on pond
3) No Hot work (Torch) in grass - must be on road
4) No smoking

PERSON DESIGNATED AS FIRE WATCH *(NOT SAME PERSON AS PERMIT HOLDER)*

Eric McCormick

REQUIRED FIRE EXTINGUISHER AT WORK SITE		OTHER FIRE PROTECTION STANDBY REQUIREMENT(S)
TYPE	SIZE	
☐ WATER ☐ CO_2 ☑ DRY CHEMICAL	20 LB ABC	

I have read, understand and will comply with the above "Instructions of the Fire Suppression/Prevention Branch, Fire Department"

SIGNATURE *(Permit Holder)*	DATE
Tony [illegible]	1-14-09

HAZARDOUS AREAS ONLY

I agree that the "Instructions of the Fire Suppression/Prevention Branch, Fire Department" stated above are adequate and area is safe to work in.

SIGNATURE *(Building Supervisor/Forman/Representative)*	DATE

Permission is hereby granted the Trade/Contractor/Tenant Activity named above to use specified equipment in accordance with the "Instructions of the Suppression/Prevention Branch, Fire Department as stated above.

SIGNATURE *(Fire Department/Representative)*	DATE
[illegible]	[illegible]

DISTRIBUTION: Original *(Code 0631 File)*

Work continued from Page

GENERAL FIRE PREVENTION INSTRUCTIONS

1. All combustibles, flammable liquids, and explosives must be out of the hot work area. (Minimum of 35 feet for combustibles, 50 feet for flammable liquids, 100 feet for explosives if in a building, railcar, or vehicle containing explosives or ammunition unless approved by the Safety Department (CAAA or Navy) and the Fire Prevention Branch.)
2. Building and/or Area Supervisor/Foreman/Representative will be contacted before work begins each day (hazardous locations especially).
3. All work shall be performed by competent, well trained, carefully supervised personnel.
4. All work shall be performed in a manner equal or superior to normal trade practices.
5. During the performance of his/her duties a worker realizes he/she does not fully understand the work to be done; or the planned work has changed; hazards of the job have changed; the work must stop and advice from their supervisor and Fire Prevention must be obtained.
6. Welding or other hot work is not permitted within 100 feet of a building, railcar, or vehicle containing explosives or ammunition unless approved by the Safety Department (CAAA or Navy) and the Fire Prevention Branch. Flame permits for this type of work must be issued by the Fire Prevention Branch before such work is started.
7. Drilling is not permitted in a room containing explosives, ammunition, or pyrotechnics, unless otherwise specified by the Safety Department (CAAA or Navy) and the Fire Prevention Branch. Drilling permits for this type of work must be issued by the Fire Prevention Branch before such work is started.
8. Steel tools are not permitted in a room containing explosives or propellants. Steel tools shall be used as little as possible in other rooms adjacent to rooms containing explosives or ammunition.
9. On completion of work, the work area shall be cleaned so that the work areas is returned to as good or better condition than when the work began.
10. Equipment that may have been contaminated with explosives shall be carefully cleaned by an explosive operator and certified clean by the job supervisor before an employee may work on it.
11. Contractors not in compliance with the above instructions and other requirements of this permit resulting in injury to person(s) and/or damage to property, may be liable for injury and/or damages incurred.
12. Government employees not in compliance with the above instructions and other conditions of this permit, resulting in injury to person(s) and/or damage to property, may be subject to disciplinary action.
13. Report all fires to the Fire Department (extension 911- Center Phones, and 854-1333/1100 - Cell Phones).
14. If at any time during the progress of work explosive contamination is discovered, the building supervisor and Fire Prevention must be notified, work shall be stopped and the contamination/hazard shall be removed by qualified personnel.
15. The permit holder may be held responsible for condition(s) in and around the work area. The permit holder must take positive action to inform his/her supervisor of any suspected hazardous condition(s) encountered or observed.
16. All Flame Tool/Hot Work Permits issued for work in or on an explosive/pyrotechnics structure must be signed by the building supervisor or his designated representative.
17. A minimum of one person will be designated as a fire watch with the specified fire extinguisher in hand, during all hot work. The fire watch will be required to stay in the immediate hot tool work area for a minimum of 30 minutes to insure no fire starts after the fact.
18. This permit may be revoked at any time that the permit holder is found to be in on-complicance with the above instructions or other conditions of this permit.

DISPATCH # 854-1235

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE Ley

DATE 1-14-04

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

CREWS SAME AS ON P. 112

Test Pit ID	Sample ID	SAMPLE TIME	Start Excavation	END →	Comments
NA	TB01150401	0730	NA	NA	TRIP BLANK
01TP05	01TP050607	0915	0846	0920	
01TP03	NA	NA	0935	1015	
01TP06	01TP060506	1050	1030	1055	
01TP07	NA	NA	1115	1200	
01TP08	01TP080506	1420	1345	1420	

Drillers - Start Installation of 01T06
Finish Test Pitting
SEE NB 1347

THURS 1-15-04

Work continued from Page

WEATHER - AM Cold high 20's PM - Mostly Sunny High 30's Low

0655 Hrs - Arrive @ Gate
- Fax C of C #4384 to E. Sedlmyer
- Make copies of Hot Work Permit for Fred to have on site
- Prep to collect TP samples

0830 Hrs - Arrive @ MGBG
- Prep to Test Pit
- Excavate test pits 01TP03, 05, 06 & 07
- T. Brent & C. Freeman arrived @ MGBG to discuss excavation @ installed vents - only one vent could be located will excavate after lunch

1200 Hrs - Drillers break for lunch

1215 Hrs - TR & FR left MGBG for BLDG #3245 to pick up Flute (arrived Fed. Ex. today) & have lunch

1320 Hrs - Return to MGBG
Excavate & sample 01TP08 - Excavate vent contact filter (sand & gravel, as well as a white neutralizing substance)

1420 Hrs - Test Pitting complete
- F.R. remained on site to over see drilling @ 01TO6
- TR left site for BLDG #3245

1455 Hrs - Arrive @ BLDG #3245
- Call in ... talked to T. Johnston & R. Basinski
- Prep. samples for shipment to PACE

1630 Hrs - Left Crane for Fed. Ex. & to find seed to spread @ MGBG excavated areas.

1700 Hrs - Drop of samples @ Fed Ex (AB # 8912 2491 0456) on C of C # 4385

1730 Hrs - Purchase winter seed @ White River Coop in Bloomington

1745 Hrs - Return to Motel

END

CREWS - SAME AS ON P-112

DRILLERS - Installed isolation casing @
SWMW 16 - See notebook 2555
Finished well installation @
SWMW 01 (01T06) - See NB #1347

TITLE NSWC CRANE

PROJECT NO. 0945

BOOK NO. 1340

FRI. 1/16/04

Work continued from Page

Weather - Partly Cloudy temp 40°s

0700 Hrs - Arrive @ BLDG #3245
- Fax C&C - to OFFICE
- Response to T. Johnston's request to ID Seeps on SWMU13 map so that TJ. can plot RDX concentrations
- Paperwork & organize office
- Accept FED. EX Delivery (9 boxes) cases +

0945 Hrs - Check on 4x4 delivery; will be late ~ 1130 - 1200 Hrs
Drove M. Lanti back to MGBG... he drove the backhoe to BLDG #3245 in prep. to start drilling @ 16 MWT 18

1045 Hrs - Return to BLDG #3245
- Called T. Johnston left message
- Continue to organize office & check out US Environmental EQ. Received this date & on 1/13

1130 Hrs - Bloomington Gate called RSC delivery (4x4) Arrived Driver (Chris Munn) Needs Escorted will meet him @ the Crane Gate (will not allow delivery through the Bloomington Gate)

1210 Hrs - Drop off 4x6 @ MSGS (4x6 delivered instead of a 4x4)

1245 Hrs - Return to BLDG #3245

1255 Hrs - Left BLDG w/ T. Brent to pick up Hay/Straw @ Bioassay pole bldg drop off hay @ MGBG

1445 Hrs - Return to Bldg #3245
- Talk w/ T. Johnston - he will check on survey crew for Monday the 19th arrival.

1530 Hrs - Check on drillers & F.R. - talked to Fred regarding list of things Tom & Ralph need accomplished.

1600 Hrs - Return to BLDG #3245
- Called U.S. ENV. - Shipped 1 tomany VSIs - will return 1 for delivery on Monday 1/19th
- Check gas (Nitrogen) in (6) cylinders - 3 empty Called IN. Oxygen for tuesday delivery
- Prep to GW sample

1845 Hrs - Left NSWC Crane for Fed. Ex. → shipped 1 VSI

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Work continued to Page

SIGNATURE

DATE 1/16/04

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

CREW - SAME AS ON P. 112

Drilling - Completed 01T07 SEE NB # 1347
DEMOBED @ MGBG & MOVED to SWIMUIG

TITLE NSWC CRANE

PROJECT NO. 0845

BOOK NO. 1340

SAT 1/17/04

Work continued from Page

RAIN High 30°s Low 40°s

0700 Hrs - Arrive @ BLDG #3245
Prep to sample Groundwater
Cali. YSI & Turbidity meter
Load vehical

0850 Hrs - Arrive @ MGBG
Load 4X6 w/ EQ.

Sample ID	Start Purge	End Purge	Sample Time	Comments
TB01170401	NA	NA	0730	Trip Blank
01GW0903	0958	1220	1220	
01GW0803	1314	1504	1505	

1520 Hrs - Finish Clean up @ WES-1-8-82
Attempt to climb hill w/ 4X6 - surface of hills to wet & slippery - Needed to carry samples & Equipment to Avis Rental up slope

1610 Hrs - Load Avis Rental & Left MGBG

1635 Hrs - Arrive @ BLDG #3245
Clean EQ. & secure samples in Frig.
Paperwork

1750 Hrs - Left NSWC Crane w/ E.R. For Bloomington

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DATE 1/17/03

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

SAME AS ON P-112
CREWS - EXCEPT M.L. left on 1/17/04 Late Afternoon

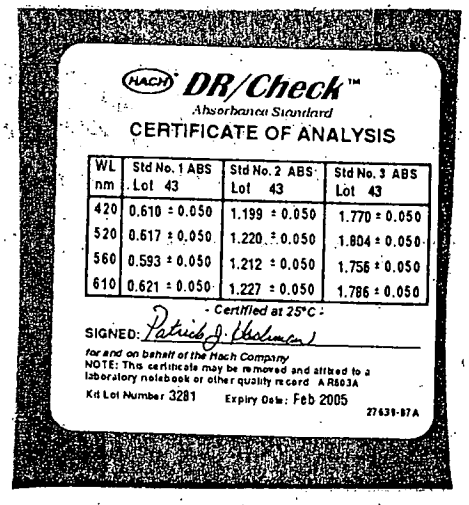
NA QC - DR/CHECK ABSORBANCE STANDARD
Lot#A3281 EXP. DATE = 2/05

	Program #	Standards 1	2	3
DR/890	42	0.620	1.217	1.799
	52	0.619	1.236	1.916
	56	0.601	1.203	1.757
	61	0.575	1.214	1.788
DR/850	52	0.630	1.207	1.799
	61	0.617	1.250	1.823

All above readings with the specified ranges for the DR/Check.

RUN Nitrite Standard Solution Accuracy Check

DR 890 = 0.097 mg/L DR 850 = 0.094 mg/L
Results should be between 0.090 & 0.110 mg/L



SUN 1-18-04

Work continued from Page

WEATHER: OVERCAST @ 20's

0700 HRS - ARRIVE @ BLDG #3245
- CHECK CAL ON YSI
- CALIBRATE LAMOTTE
- RUN ABSORBANCE STANDARD CHECKS ON COLORIMETERS SEE P. 122
  DR 890 - SN # 0060900 11362 (US ENVIRONMENTAL)
  DR 850 - TINUS CLR-4 SN# 98095 0003985

0815 HRS - LEFT BLDG FOR MGBG

0840 HRS - ARRIVE @ MGBG
CARRY EQ DOWN SLOPE FR. 4X6 GATOR

SAMPLE ID	START PURGE	END PURGE	VOL PURGED	SAMPLE TIME	COMMENT
01GW0702	0935	1125	8.6 L	1130	-
01GW2102	1210	1450	16.3 L	1452	-

1510 HRS - FINISH CLEAN UP @ 01-21
- CARRY EQ & SAMPLES UP SLOPE TO RENTAL CAR FROM 4X6 GATOR

1545 HRS - LEFT MGBG

1610 HRS - ARRIVE @ SWMU 16 to check in w/ F. RAMSER

1630 HRS - ARRIVE @ BLDG #3245
- SECURE GW SAMPLES IN FRIG.
- REMOVE INSTRUMENTS & METER FROM RENTAL CAR & CLEAN
- RUN NITRITE STANDARD SOLUTION ACCURACY CHECK ON BOTH THE DR/890 & 850 SEE RESULTS ON P. 122

1800 HRS - LEFT SITE FOR MOTEL

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE 1/18/04

WELL ID	TIME	W.L.
13MWT01		
13MWT02		
13MWT03		
13MWT04		
13MWT05		
13MWT06		
13MWT07		
13MWT08	1P	
13MWT09		
13MWT10		
13MWT11		
13MWT12		
13MWT13		
13MWT14		
13MWT15		
13MWT16		
13MWT17		

Driller completed well #
16MWT18 &
Demobed.

Driller: Don Smith
Joe McCloud
Scott Whidbon

TANUS: F. Ramsey
T. Rosahn
J. Goerdt (NEW ANNUAL)

J.G. sampled 01-03
see NB #

F.R. - Oversight of
Drillers & Surveyors
& SKIMU 16

SAMPLE ID	START PURGE	END PURGE	VOL PURGED	SAMPLE TIME	COMMENTS
TB011904U1	NA	NA	NA	1700	TRIP BLANK
01GW0303	1344	1744	20.15 L	1748	JG

TITLE NSWC CRANE

MON 1-19-04

PROJECT NO. 0045

BOOK NO. 1340

Work continued from Page

WEATHER Mostly Cloudy Temp Low 20°s

0705 Hrs - ARRIVE @ BLDG # 3245
ORIENT NEW ARRIVAL J. Goerdt

0800 Hrs - SURVEYORS haven't shown up as of yet - WILL CHECK @ Guard Gate for them (Holiday) they may have problems getting on base

0830 Hrs - ARRIVE back @ BLDG # 3245 w/ Surveyors Corey Allen & Jimmy Snell
Give them brief H&S training - go over survey package with them - survey locations & maps

1000 Hrs - go to MGBG ~~for~~ (TL) w/ J. Goerdt
Show Jim site, also get drillers to tow 6X4 gator to Mustard Gas site (up slope)

1130 Hrs - Return to BLDG # 3245
- CALL into OFFICE - talked to T. Johnston
- Call M. Lanti to return his TLD badge to us for analysis
- CALL Gator Rental Co. for repairs on Gator - belt slipped OFF (Back wheels not turning.

AFTERNOON - work performed @ SWMU 16

1730 Hrs - PACK samples collected 1/17-18/04 on CoC # 4386

1815 Hrs - LEFT NSWC CRANE for FED EX
SHIP samples on AB# 8412 2490 9522

1845 Hrs - Drop off @ FED EX.

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DATE 1-19-04

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

CREW: F. RAMSER (FR)
J. Goerdt (JG)
T. ROJAHN (TR)

SAMPLE ID	START PURGE	END PURGE	VOL PURGED	SAMPLE TIME	COMMENTS
01GW0403	0910	1140	10.7 L	1150	(JG)
01GW2303	1210	1420	5.8 L	1510	(TR)
01GW1702	1254	1534	13.0 L	1540	(JG)

F.R. completed synoptic water levels @ SWMU 13
slug tested 13MWT35 & 13MWT45

TITLE NSWC CRANE

PROJECT NO. 0845

BOOK NO. 1340

TUES 1-20-04

Work continued from Page

0705-Hrs Arrive @ BLDG #3245 - start Prep to sample GW
FAX CoFC #4386 to E. SEDLMYER
Check in w/ T. Brent Regarding Access of F.R. & survey crew to SWMU 13 - give notice to guards, Also, made T. Brent aware on vendor coming @ 0800Hrs RSC to repair 6x4 Gator

0800 Hrs - RSC mechanics @ Cafe parking lot
- Escorted to MGBG

0920Hrs - Returned to BLDG #3245 to finish prep to sample Groundwater
- M. Lant, called for address to send TLD Badge Back
- Called U.S. Env. about a bad Turbidity meter - will send new meter

1125 Hrs - Arrive @ MGBG - check in w/ J.G.

1210 - 1510 Hrs - Sample & Purge 01-23

1600Hrs - Placed Bladder pump in 01-20 & secured well

1630Hrs - Left MGBG for BLDG #3245

1655Hrs - Arrive @ BLDG #3245
Secure EQ & meters in BLDG along w/samples (secure in frig.)
- JG check YSI
- TR paperwork

1750 Hrs - JG left BLDG #3245 to purchase supplies
TR will wait for F.R. to return from SWMU 13

1830 Hrs - Left BLDG #3245 w/ F.R.

SCIENTIFIC BINDERY PRODUCTIONS · CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE [signature]

DATE 1-20-04

DISCLOSED TO AND UNDERSTOOD BY **DATE** **WITNESS** **DATE**

CREW: FR, JG, & T. ROJAHN

SAMPLE ID	Start Purge	END PURGE	VOL PURGED	SAMPLE TIME	Comments	
01GW2002	0930	1100	8.5L	1110	01FD0210401	(JG)
01GW2402	1010	1250	13.8L	1255	MNA RAN	(TR)
01GW2503	1233	1633	20.7L	1640	MNA RAN	(JG)
01GW0603	1530	1740	16.5L	1745	—	TR)

SEE NB #1347 FOR DETAILS ON FR'S activities - Summary to Follow:

Slug TEST 13MWT 46

DEVELOPED 01T06 & 01T07

Prep. & SHIPPED samples on CoC # 4387

TITLE NSWC CRANE

PROJECT NO. 0845

BOOK NO. 1340

WED 1-21-04

Work continued from Page

0700 Hrs - Arrive @ BLDG #3245
- Prep. to sample Groundwater
- Prep to do MNA
- Assign wells to J.G.
- P.R. to slug test @ SWMU 13, let surveyors IN and out of Security Fence, & show them SWMU 1
- Decon Bladder Pumps
- Call Hertz & RSC to arrange pick up.

0935 Hrs - Arrive @ MGBG
- SEE PAGE 128 FOR Groundwater samples collected this date

1900 Hrs - Left MGBG

1920 Hrs - Arrive @ BLDG #3245
- Secure samples in Frig
- Bring in Instruments & NA Test Kits etc.
- Prep to leave for Motel

2000 Hrs - Left NSWC CRANE

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DATE

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

1-21-04

B 100 P ©

CREW: FR, JG & TR

SAMPLE IN	Start PURGE	END PURGE	VOL. PURGED	SAMPLE TIME	COMMENTS
01GW1302	1125	1320	11.7L	1320	(FR)
01GW1003	0955	1325	12.0L	1330	(JG) RAN MNA
01GWT0502	1200	1410	10.0L	1415	(TR) RAN MNA
01GW1802	1355	1730	53.0L	NA	(FR) Purged Dry will sample 1/23/04
01GW20				NA	(JG) Late & Lines freezing. Will sample 1/23/04
SB01220401	—	—	—	1915	DI Source Water
RB01220401	—	—	—	1945	Bladder Rinsate

THURS 1-22-04

Work continued from Page WEATHER - Partly Sunny Temp in teens 20 w/wind chill

0700 Hrs - Arrive on Site - BLDG #3245
- Asign work
- Fax CofC # 4387 to E Sedlmyer, Also sent Daily summary of Drilling Quantities to T. Johnston

0830 Hrs - Meet Hertz driver @ Crane gate - showed him location of Backhoe @ BLDG #3245 (Dozer @ MGBG) Driver (M-Burgess) was able to pick up Dozer on his own

0855 Hrs - Return to BLDG #3245
- Prep map of SWMU 13 for ~~Surv~~ TC Surveyors to find Segs 13SP01 → 04
- Surveyors arrive @ 0915 Hrs - discuss progress - have some wells outs fence & all SW/SD locations as well as segs to locate
  - Almost finished @ MGBG; but need to resurvey repaired wells 01-06, 07 & 15; spoke w/ T. Johnston & R. Basinski to confirm this date
- Worked on paperwork until Chris Munn of RSC arrived @ Crane Gate for escort to MGBG

1100 Hrs - Escorted Chris to MGBG - stayed with him until he left/loaded 4x6 Gator for H&S reasons (Brakes not operating properly).

1200 Hrs - Start Purging @ 01T05
See page #130 for sample summary this date.

1750 Hrs - Finish sampling & running MNA @ 01T05

1800 Hrs - Check on J.G @ 01-12

1830 Hrs - Arrive @ BLDG #3245
- Collect Blank (Source Water) & Rinsate; Decon Pumps
- Paperwork Etc

2045 Hrs - J.G. Arrived @ BLDG #3245

2100 Hrs - Left NSWC Crane for Motel

SCIENTIFIC BINDERY PRODUCTIONS, CHICAGO 60606 MADE IN USA

Work continued to Page

SIGNATURE

DATE 1/22/04

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

CREW: J.G. & T.R.

SAMPLE ID	START PURGE	END PURGE	VOL PURGED	SAMPLE TIME	COMMENTS
01GW1802	← SEE PAGE 131			→ 0915 (TR)	PURGED 1/22 by FR SAMPLED 1/23 by (TR)
01GW1202	← SEE PAGE 131			→ NA (JG)	
" (1/23)	0855	1025 (1-22-04)	26 L	1030	BEGAN PURGE ON 1/22
01GW1403	1005	1245	15.9 L	1250	RAN MNA (TR)
01GW0103	1108	1248	15.0 L	1255	RAN MNA (JG)
01GW706	1520	1710	8.6 L	1715	(TR/JG)
01GW2702	1510	1720	13.0 L	1730	(JG)

FRI. 1-23-04

Work continued from Page

0700 Hrs - Arrive @ BLDG #3245

- Reassemble Deconned Pumps
- Prep for Groundwater Samplins
- Leave T. Johnston message to contact Labs for Sat. delivery
- Paperwork

0900 Hrs - Arrive @ MGBG

0915 Hrs - Sample 01-18, this well was purged day yesterday by F.R.
See Page 132 for sample summary

1600 Hrs - Had J.G. take off 01-06 and left MGBG for BLDG #3245

1625 Hrs - Arrive @ BLDG #3245

- Surveyor checked in - they have ~3 locations left to plot (1) SW/SP & 2 seeps @ SWMU 13; & wells 01-06, 07 & 15 to resurvey @ MGBG (do to repairs) - They will return on 1/27 to finish
- Prep. samples for shipment

for Sat. Delivery { CoC # 4389 to Microseeps on AB# 8412 2490 9644
CoC # 4390 to Pace on AB# 8412 2490 9555

Mon. Delivery { Also Prep Rad survey meter to ship to Env. Restoration Group Inc. on AB# 8412 2490 9566 w/ Low Grade Rad. Check Source

1800 Hrs - Left BLDG #3245 for Fed. Ex.

1830 Hrs - Drop off shipments @ Fed. Ex.

END

SIGNATURE

DATE 1-23-04

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

SAMPLE SUMMARY 1-24-04

SAMPLE ID	Start PURGE	END PURGE	Vol PURGED	SAMPLE TIME	COMMENTS
01GW1103	0911	1101	12.8 L	1110	(JG) RAN MNA
01GW2202	1430	1630	12.1 L	1632	(TK)
01GW2603	1439	1659	17.6 L	1705	(JG)
01GWT0204	1735	1855	5.2 L	1900	(JG)
01GWT07	1657	2007	12.9 L	2010	(TK)

TITLE NSWC CRANE

PROJECT NO. 0845

BOOK NO. 1340

SAT 1-24-04

Work continued from Page

0700 Hrs - Arrive on site (Bldg #3245)
Decon bladder pumps for SWMUs 1 & 16
Prep to sample groundwater @ SWMUs 1 & 16

0900 Hrs - Arrive @ SWMU 16
Run ~~synoptic~~ synoptic round of water level measurements
& purge (TN) 16 MW1 & 18

1320 Hrs - Arrive @ Bldg #3245
Pickup eq. for SWMU 1

1400 Hrs - Arrive @ SWMU 1 - check in ~~for~~ with JG & setup @ 01-22.
• See p. 134 for details.

2030 Hrs - Left MGBG

2055 Hrs - Arrive @ Bldg #3245
Secure samples
Decon bladder pumps
Call Fed. Ex to check on Sat. delivery.
Shipment to Microseeps ... OK
Shipment to Pace - delayed in Indy @ Memphis Hub & will not be delivered until Monday 1-26-04.

2140 Hrs - TR & JG left Bldg #3245 for motel.

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE Ted Rogal

DATE 1-24-04

DISCLOSED TO AND UNDERSTOOD BY **DATE** **WITNESS** **DATE**

SAMPLE SUMMARY 1-25-04

SAMPLE ID	START PURGE	END PURGE	VOL. PURGED	SAMPLE TIME	COMMENTS
01GW1503	0857	1017	7.4L	1020	(JG) Didn't Finish sampling will complete 1-26-04
01GWT0402	1245	1455	19.5L	1500	(JG)
01GW1902	1323	1543	9L	1545	(TL)
01GWT0302	1550	1730	12L	1740	(JG)

SUN 01-25-04
Work continued from Page

0700 Hrs - Arrive @ BLDG #3245

0700 Hrs - 1100 Hrs - Sample monitoring well 18MWT18 @ SWMU 16 SEE Notebook #1363 for details

1100 Hrs - Return to BLDG #3245
Run Rinsate Blanks:
RB01250401 - BLADDER PUMP @ 1130 Hrs
RB01250402 - Peristaltic Tubing @ 1136 Hrs

1250 Hrs - Arrive @ MGBG
SEE P. 136 for sampling information summary

1810 Hrs - Left MGBG
1850 Hrs - Arrive BLDG #3245
Drop off EQ & Refrigerate samples
1940 Hrs - Left Crane for Motel - Roads w/ ice

END

SAMPLE ID	START PURGE	END PURGE	VOL PURGED	SAMPLE TIME	COMMENTS
01GW1503	← 505	136	→	0940	(JG) FINISHED SAMPLING RAN NA
01GW0203	1045	1235	9.8 L	1240	(TK) RAN NA
01GW0503	1133	1337	25.2 L	NA	(JG) Purged this date
01GWC0103	1403	1803	35.9 L	1805	(JG)

TITLE NSWC CRANE

PROJECT NO. 0845

BOOK NO. 1340

MON. 1-26-04

Work continued from Page

0720 Hrs - ARRIVE @ BLDG #3245
- PREP to SAMPLE GROUNDWATER @ MGBG
- ATTEMPTED to FAX TOM EED COFCS FROM SAT delivery 4 X W/ NO RESULTS WILL try this AFTERNOON
- PAPERWORK

1000 Hrs - ARRIVE @ MGBG - ROADS W/ ICE
SEE P. 138 W/ SUMMARY INFORMATION ON WELLS purged & SAMPLED this date

1500 Hrs - (TR) LEFT MGBG - (JG) still sampling
1530 Hrs - ARRIVE @ BLDG #3245
- PREP SAMPLES FOR SHIPPING
PACS (COFC #s 4391 & 4392) AB # 8412 2491 0982
MICROSEEPS (COFC #s 4393) AB# 8412 2491 0993

1758 Hrs - LEFT CRAN FOR FED. EX
1845 Hrs - DROP OF SHIPMENTS @ FED. EX.

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DATE 1-26-04

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

SAMPLE SUMMARY 1/28/04

VG Collected 01GW0503

Start Purge :
END Purge :
Vol Purged :

SEE P 138

SAMPLE Time = 0910

TITLE NSWC CRANE

TUES 1-27-04

Work continued from Page

PROJECT NO. 0845

BOOK NO. 1340

0715 Hrs - Arrive @ BLDG #3245 - Roads icy
- Fax CoCs to OFFICE & LAUCKS
  Problem w/ Fax @ BLDG #3245... went next door.
- PAPERWORK
- GENERAL CLEAN UP begun
- Prep. EQ. FOR RETURN to vendors

1200 Hrs - Lunch

1235 Hrs - Return to BLDG #3245
- Load core boxes in VEHICALS & transport to MAGAZINE 1970

1400 Hrs - Return to BLDG #3245
- Complete prep. of U.S. ENVIROMENTA EQ. on AB# 8412 2491 4142 - 14 items
- Package sample DIGWOS:
  Mirosegrs (CoFC #4400) AB# 8412 2990 9544
  Pace (CoFC # 4398) AB# 8412 2990 ~~9532~~ 9533
- Package Pitt. Warehouse EQ on AB# ~~8412~~ 8216 5043 8348

1620 Hrs - LEFT Site FOR FED EX.

1710 Hrs - Drop off SHIPMENTS @ FED.EX.

END

MGBG WATER LEVELS 1/28/04

WELL ID	WL	TIME	PID	
01-01	28.30	0814	0.0	
02	11.63	0825	0.0	
03	5.49	0929	0.0	Needs Lock & new J plug
04	16.80	0818	0.0	
05	15.52	0820	7.2	
06	69.05	848	0.0	Replaced CAP
07	15.78	855	0.0	Paint mark Fading
08	12.80	0850	0.0	
09	12.60	0840	0.0	
10	22.19	0838	0.0	
11	6.64	0827	0.0	Cupler ~~new~~ No Lock
12	23.90	0834	0.0	
13	20.65	0833	0.0	
14	14.01	0919	0.0	Bent stick up
15	28.20	0914	0.0	Cupler need [illegible]
16	35.71	0905	0.0	Paint mark
17	20.70	0921	0.0	
18	14.62	0942	0.0	
19	21.65	908	0.0	
20	27.24	904	0.0	Paint mark
21	15.43	8:57	0.0	
22	18.54	9:11	0.0	
23	38.73	0901	0.0	
24	11.70	8:59	0.0	
25	21.79	912	0.0	
26	36.45	938	0.0	Steel protective casing
27	24.98	940	0.0	
01C01	138.54	945	0.0	Steel Protective casing
01T02	65.60	0811	0.0	
01T03	139.25	0823	0.0	
01T04	138.09	0916	0.0	
01T05	17.92	0933	0.0	
01T06	20.28	0927	0.0	
01T07	18.56	0924	0.0	

TITLE NSWC CRANE

WED 1-28-04

Work continued from Page

PROJECT NO. 0845

BOOK NO. 1340

0700 Hrs - Arrive @ BLDG #3245
Prep to take W.L. @ SWMU 1
0811 - 0945 Hrs - Synoptic W.L. @ SWMU 1
1095 Hrs - Return to BLDG #3245

- DEMOB
- CLEAN OFFICE
- PREP. M SCOPES & PID FOR SHIPMENT to U.S. ENV.
- PREP. OFFICE / FORMS Etc. FOR Shipment to PITT.

1215 - Drop off @ FED EX.
U.S. ENVIRONMENTAL = 8412 2491 1018
TETRA TECH = 8412 2491 1007

REMAINDER OF DAY TRAVEL

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DISCLOSED TO AND UNDERSTOOD BY **DATE** **WITNESS**

DATE 1-28-04

DATE

VOID THIS PAGE

FRI. 4/23/04

Work continued from Page

WEATHER Mostly Cloudy @ 60°SF

0903 Hrs - LEAVE ABG FOR MGBG

0918 Hrs - ARRIVE MGBG

Begin site restoration - start RAKING & smoothing out ruts; SEED & spread straw that was staged @ SWMU 1 (10 bails)

1200 Hrs - LUNCH

1230 Hrs - Arrive @ BLDG # 3245

Load straw bails (12) in Pick up

1310 Hrs - Return to MGBG

Finish smoothing out ruts & spreading seed & straw

1545 Hrs - Site Restoration complete, Left MGBG For ABG

END

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE

DATE 4/23/04

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

B 100 P ©

B.3.2

SWMU 01 Field Notebooks

AM: CLEAR COLD

1-22-04

0700 PER ARR AT FIELD OFFICE,
- PREP TO DPL WELLS @ SWMU 1
SEE NOTEBOOK # 1340 FOR
SAMPLING ACTIVITIES

2000 PER LV. FIELD OFFICE
- PREP TO DEMOB

SWR

SWR 1-22-04

NSWC CRANE

TITLE 1-21-04

PROJECT NO. 0845

BOOK NO.

Work continued from Page

1400 PUR + SURVEYORS GO TO SWMU 1.

1430 PUR + SURVEYORS ARR, MARK ALL TP LOC. END POINTS

1500 PUR PREPS TO DEVELOP 01T06

SWL 20.20 BTOC BEFORE DEVELOPMENT

TD = 31.40 BTOC

1540 SURGED W/BAILER THEN PURGED WATER W/BAILER WELL WENT DRY AFTER WITH DRAWING ~4.5 GALS

1600 MOVE

SWL 18.15 BTOC BEFORE DEVELOPMENT
TD = 30.24 BTOC

1630 PURGED W/BAILED ~5 GALS DRY 01T07
MUD YELLOW OPAQUE TO BOTTOM

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE Fred Wlaser DATE 1-21-04

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

B 100 P ©

NSCWC CRANE

96 1-17-04 AM / PM RAIN 30's

1300 WELL 01T07 INSTALLED

1330 BEGIN TO BUILD PAD
- DO LUNCH
- ALLOW FLUTE LINER TIME > 1 hr, NO REACTION SEEN, NO PID RESPONSE

01T07
WELL CONST.
SCREEN 19-29
SAND 16'-30'
BENTONITE: 3'-16'

1400 + PLACE CORESAMPLE INTO CORE BOXES LABELED ETC.

1430 PUR LV'S SITE (SWMU 1) WILL DO RECON. AT SWMU 13. SEE NOTE BOOK 2555 FOR ACTIVITIES.

Scott Ranson 1-17-04

NSWC CRANE AM: RAINY 30's

TITLE SWMU 1 **PROJECT NO.** 0845 **95**

1-17-04 **BOOK NO.**

Work continued from Page

0830 DRILLERS MOVE EQ FROM SWMU 16 TO SWMU 1 (MGBG)
- DECON RIG + TOOLS
- HAVING DIFFICULTIES MOVING AROUND ON WET SOIL

0930 SET UP ON WELL 01T07
+ DRIVE 8" OD CASING TO 10' BGS
- BEGIN TO CORE @ 10'

LOG FOR 01T07
0-8 OB SILT+CLAY
8-10 SOFT WEATHERED STRONGLY 0% RQD
BED ROCK SANDY SILTSTONE
10-20 SANDY SILTSTONE 0% RQD
YEL BRN INTERLAYER W/
MED BRN SILTY SANDSTONE WEATHER
MED SOFT TO SOFT

20-30 20-28 BRN SANDSTONE
MED SOFT WEATHERED

1105 28-30 VERIEGATED
SILT STONE
BLK GREY YEL BRN

COMPLETED DRILLING TO 30' PURGED H_2O OUT OF HOLE MEASURED H_2O @ 28.5, 28.3, 28.0
H_2O IN COMING IN HOLE

1115 MEASURED H_2O TO BE 27.5 FT BGS

1120 H_2O @ 27.4, HAVE DRILLERS INSTALL WELL @ ~~28.5 TO~~ 19 TO 29 ft below GROUND SURFACE

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE Fred M Ramser DATE 1-17-04

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

NSWC CRANE AM: 25°F 0845
CLOUDY

94 1-16-04

0700 DRILLERS ARR AT FIELD OFFICE, LOAD H_2O
- PUR CALIBRATE EQUIP
- DISCUSS PROJECT W/ TR

0800 DEPART FROM FIELD OFFICE FOR SUMM

0820 RIG WARMING, WL IN WELL @ 20' BGS
CURRENT TD = 26' DECIDED TO
SPL TO 30'

1000 INSTALLED OITOG

SUB TOTAL

PRO CASING STICKUP ~2.57'

4' BORE/W SPL

29'-2" PVC WELL

1050 FINISH DECON
LV MCBG FOR
FIELD OFFICE AND TO PREP FOR SUMM 16
SEE BOOK 2555 FOR THE ACTIVITIES CONTINUE
THROUGH THE DAY.

OITOG	
SAND 30-16	GLOBAL 17C ~10/20
SCREEN 19-29	SCH40 .020 SLO
BENTONITE	PURE GOLD 3/8 CHIPS TO THE TOP (2' BGS)
PVC STICKUP ~2.07'	

FINNISH TEST PITS SEE BOOK # 1340 FOR ALL TEST PIT ACTIVITES.
DRILLING CREW: JOE, SCOTT, RON
1440 BEGIN DRILLING @ OITP06

RAD READINGS ON 0-6' = $55 \times 10^{+2}$ CPM IN FROM LOADER @ DITP06
1630 DRILLED TO 26', CORED 7' TO 25
NO PID'S READINGS OB DRILLED/WO SPL 0-7'
NO FLUTE INDICATION BORK W/O/SPL 25-26
BLOW AIR INTO HOLE TWICE, SEEMS TO BE DRY, WILL ALLOW TO SIT OVER NIGHT.
1645 DRILLERS LV. SWMU 1

ACTIVITIES FOR TODAY:

0730 → 1430 HRS ⇒ 7HR OF TEST PIT.

1430 → 1700 DRILLING @ OITP06.

OB	W/O	SPL	0-7' (7')
BORK	W	SPL	7'-25' 18'
BORK	W/O	SPL	25-26' 1'

1700 FUR LVS SWMU (FIRE WATCH)

B.3.3

SWMU 01 Land Survey Data

SURVEY DATA FOR MUSTARD GAS BURIAL GROUNDS (SWMU 1)
NSWC CRANE
CRANE, INDIANA

LOCATION	Northing	Easting	Ground Surface Elevation	Top of Casing Elevation	Top of PVC Elevation
01TP01A	1281020.63	3030584.88	671.31	NA	NA
01TP01B	1281007.11	3030585.61	671.77	NA	NA
01TP02A	1281051.64	3030582.48	669.93	NA	NA
01TP02B	1281037.86	3030585.89	670.83	NA	NA
01TP03A	1281011.70	3030622.68	671.59	NA	NA
01TP03B	1281013.40	3030609.97	671.61	NA	NA
01TP04A	1280990.00	3030586.46	672.57	NA	NA
01TP04B	1280976.83	3030587.09	672.81	NA	NA
01TP05A	1281015.73	3030560.16	671.83	NA	NA
01TP05B	1281019.24	3030548.40	671.44	NA	NA
01TP06A	1281010.89	3030644.78	671.05	NA	NA
01TP06B	1281018.99	3030638.38	670.73	NA	NA
01TP07A	1280958.90	3030620.36	672.89	NA	NA
01TP07B	1280969.24	3030609.76	672.97	NA	NA
01TP08A	1281054.15	3030593.14	670.07	NA	NA
01TP08B	1281044.28	3030599.54	670.61	NA	NA
01T06	1280913.67	3030642.75	674.89	677.13	677.06
01T07	1281022.92	3030574.81	671.73	673.88	673.47
01PNW	1281079.88	3030519.07	663.77	NA	NA
01PNE	1281000.45	3030867.59	NA	NA	NA
01PSW	1280895.63	3030418.68	665.17	NA	NA
01PSE	1280716.38	3030712.82	678.18	NA	NA
01-06	1281351.06	3030702.83	595.79	NA	598.41
01-07	1281420.07	3030422.46	603.41	NA	605.81
01-15	1281201.54	3030290.52	662.47	NA	665.64

TP = Test Pit
P = Post (4 boundary corners)
01T06/01T07 - New Wells
01-06/01-07/01-15- Repaired Wells (PVC Pipe Only)
NOTE: 01PNE is a calculated position - boundary post could not be located

APPENDIX C

SWMU 01 ANALTYICAL RESULTS DATABASE

APPENDIX C.1

SWMU 01 Soil Data Summaries, Round 3

TABLE C-1

FREQUENCIES OF DETECTION FOR CHEMICALS DETECTED IN TEST PIT SOILS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

CAS Number	Chemical	Minimum Concentration		Maximum Concentration		Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
	Volatile Organics								
79-34-5	1,1,2,2-TETRACHLOROETHANE	20	J	24		UG/KG	01TP020506	2/6	2 - 2
67-64-1	ACETONE	41	J	56	J	UG/KG	01TP010607	2/6	17 - 27
75-15-0	CARBON DISULFIDE	1	J	3	J	UG/KG	01TP010607	2/6	1 - 1
79-01-6	TRICHLOROETHENE	1	J	1	J	UG/KG	01TP050607	1/6	1 - 1
75-69-4	TRICHLOROFLUOROMETHANE	11		11		UG/KG	01TP080506	1/6	5 - 6

Associated Samples:
01TP010607
01TP020506
01TP040607
01TP050607
01TP060506
01TP080506

TABLE C-2

DATA FOR CHEMICALS DETECTED AT LEAST ONCE IN TEST PIT SOILS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01TP01	01TP01	01TP02	01TP04	01TP05	01TP06	01TP08
SAMPLE	01TP010607	01TP010607-D	01TP020506	01TP040607	01TP050607	01TP060506	01TP080506
MATRIX	SB	SB	SB	SB	SB	SB	SB
DEPTH RANGE	6 - 7	6 - 7	5 - 6	6 - 7	6 - 7	5 - 6	5 - 6
QC_TYPE	NM	FD	NM	NM	NM	NM	NM
SAMPLE DATE	1/14/2004	1/14/2004	1/14/2004	1/14/2004	1/15/2004	1/15/2004	1/15/2004
Volatile Organics (ug/kg)							
1,1,2,2-TETRACHLOROETHANE	2 U	2 U	24	2 UJ	2 U	2 U	20 J
ACETONE	56 J	24 U	41 J	27 U	26 U	17 U	26 U
CARBON DISULFIDE	3 J	3 J	1 U	1 UJ	1 U	1 J	1 U
TRICHLOROETHENE	1 U	1 U	1 U	1 UJ	1 J	1 U	1 U
TRICHLOROFLUOROMETHANE	5 U	5 U	5 U	5 UJ	5 U	6 U	11

APPENDIX C.2

SWMU 01 Ground Water Data Summaries, Round 3

TABLE C-3

FREQUENCIES OF DETECTION FOR CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Chemical	Minimum Concentration		Maximum Concentration		Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
Volatile Organics								
1,1,1,2-TETRACHLOROETHANE	0.6	J	45		UG/L	01GWT0701	5/33	0.2 - 0.2
1,1,2,2-TETRACHLOROETHANE	0.6	J	660		UG/L	01GWT0701	16/34	0.3 - 0.3
1,1,2-TRICHLOROETHANE	0.7	J	16	J	UG/L	01GWT0701	13/34	0.2 - 0.2
1,1-DICHLOROETHANE	0.5	J	0.5	J	UG/L	01GWT0701	1/33	0.1 - 0.1
1,1-DICHLOROETHENE	0.5	J	4	J	UG/L	01GWT0701	5/33	0.2 - 0.2
1,2-DICHLOROETHANE	1		17	J	UG/L	01GWT0701	6/33	0.2 - 0.2
2-BUTANONE	4	J	4	J	UG/L	01GWT0402	1/33	1 - 1
BROMODICHLOROMETHANE	3	J	3	J	UG/L	01GWT0701	1/33	0.2 - 0.2
CARBON DISULFIDE	0.5	J	0.5	J	UG/L	01GW0603	1/33	0.1 - 0.1
CARBON TETRACHLORIDE	10	J	10	J	UG/L	01GWT0701	1/33	0.4 - 0.4
CHLOROFORM	0.5	J	790		UG/L	01GWT0701	12/34	0.2 - 0.2
CIS-1,2-DICHLOROETHENE	0.6	J	14	J	UG/L	01GWT0701	10/33	0.2 - 0.2
ETHANE	0.001	J	0.09	J	UG/L	01GW0503	12/12	-
ETHENE	0.006	J	0.058	J	UG/L	01GW1503	11/12	0.005 - 0.005
METHANE	0.03	J	56	J	UG/L	01GW1503	12/12	-
METHYLENE CHLORIDE	15	J	15	J	UG/L	01GWT0701	1/33	2 - 2
TETRACHLOROETHENE	1	J	130		UG/L	01GWT0701	12/34	0.1 - 0.1
TETRACHLOROETHENE	1		130		UG/L	01GWT0701	12/34	0.1 - 0.1
TRANS-1,2-DICHLOROETHENE	0.6	J	11	J	UG/L	01GWT0701	6/33	0.1 - 0.1
TRICHLOROETHENE	1		620		UG/L	01GWT0701	17/34	0.2 - 0.2
VINYL CHLORIDE	1	J	1	J	UG/L	01GWT0701	1/33	0.1 - 0.1
Miscellaneous Parameters								
ACETIC ACID	0.028	J	0.069	J	MG/L	01GW2402	11/12	0.07 - 0.07
BUTANOIC ACID	0.018	J	0.018	J	MG/L	01GW0203	2/12	0.07 - 0.07
CHLORIDE	0.77	J	93.7		MG/L	01GWT0502	12/12	-
HARDNESS	48	J	1010	J	MG/L	01GW0503	12/12	-
HYDROGEN	2	J	12		NM	01GW1503	12/12	-
HYDROGEN	2		12		NM	01GW1503	12/12	-
LACTIC ACID	0.017	J	0.073	J	MG/L	01GW1503	9/12	0.07 - 0.07
NITRITE/NITRATE-N	0.15		0.29		MG/L	01GW2503	2/12	0.1 - 0.1
PYRUVIC ACID	0.02	J	0.02	J	MG/L	01GW1503	1/12	0.07 - 0.07
SULFATE	15.6		840		MG/L	01GW0503	12/12	-
TOTAL INORGANIC CARBON	260		980		MG/L	01GW1503	12/12	-

TABLE C-3

FREQUENCIES OF DETECTION FOR CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Chemical	Minimum Concentration		Maximum Concentration		Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
TOTAL ORGANIC CARBON	1	J	1.9	J	MG/L	01GW0203	10/12	5 - 5
Field Parameters								
ALKALINITY	40		1000	>	MG/L	01GW1103	11/12	10 - 10
CARBON DIOXIDE	12		140		MG/L	01GW1403	12/12	-
DISSOLVED OXYGEN	0.05		5.5		MG/L	01GW0203	12/12	-
DISSOLVED OXYGEN - METER	-0.04		6.75		MG/L	01GWT0601	32/32	-
FERROUS IRON	0		3.3	>	MG/L	01GW2402	12/12	0 - 0
FERROUS IRON	0		3.3		MG/L	01GW1503	12/12	-
FERROUS IRON	0		3.3	>	MG/L	01GW1003	12/12	-
HYDROGEN SULFIDE (H2S)	0		0		MG/L	01GW1403	12/12	-
HYDROGEN SULFIDE (H2S)	0		0		MG/L	01GW1902	12/12	-
HYDROGEN SULFIDE (H2S)	0		0		MG/L	01GW0103	12/12	-
HYDROGEN SULFIDE (H2S)	0		0		MG/L	01GW1103	12/12	-
HYDROGEN SULFIDE (H2S)	0		0		MG/L	01GW1503	12/12	-
HYDROGEN SULFIDE (H2S)	0		0		MG/L	01GW0503	12/12	-
HYDROGEN SULFIDE (H2S)	0		0		MG/L	01GW1003	12/12	-
HYDROGEN SULFIDE (H2S)	0		0		MG/L	01GW2402	12/12	-
HYDROGEN SULFIDE (H2S)	0		0		MG/L	01GW2503	12/12	-
HYDROGEN SULFIDE (H2S)	0		0		MG/L	01GWT0502	12/12	-
HYDROGEN SULFIDE (H2S)	0		0		MG/L	01GW0203	12/12	-
MANGANESE	0		22	>	MG/L	01GW1403	12/12	-
NITRITE-N	0		0.17		MG/L	01GW1003	12/12	-
OXIDATION REDUCTION POTENTIAL	-149		346		MV	01GW1902	34/34	-
PH	5.39		7.95		S.U.	01GWC0103	34/34	-
SPECIFIC CONDUCTANCE	0.054		1297		MS/CM	01GW2002	34/34	-
SULFIDE	0		0.23		MG/L	01GW2503	12/12	-
TEMPERATURE	5.31		11.58		C	01GW2503	34/34	-
TURBIDITY	0		105		NTU	01GW1802	34/34	-

Associated Samples:

01GW0103	01GW1202	01GW2503
01GW0203	01GW1302	01GW2603
01GW0203-D	01GW1403	01GW2702
01GW0303	01GW1503	01GWC0103

TABLE C-3

FREQUENCIES OF DETECTION FOR CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Chemical	Minimum Concentration	Maximum Concentration	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
01GW0403	01GW1702	01GWT0204				
01GW0503	01GW1802	01GWT0302				
01GW0603	01GW1902	01GWT0402				
01GW0702	01GW2002	01GWT0502				
01GW0803	01GW2102	01GWT0601				
01GW0903	01GW2202	01GWT0701				
01GW1003	01GW2303					
01GW1103	01GW2402					

TABLE C-4

DATA FOR CHEMICALS DETECTED AT LEAST ONCE IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-01	01-01	01-02	01-02	01-03	01-04	01-05	01-05	01-06
SAMPLE	01GW0103	01GW0103-D	01GW0203	01GW0203-D	01GW0303	01GW0403	01GW0503	01GW0503-D	01GW0603
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	---	---	---	---	---	---	---	---	---
QC TYPE	NM	FD	NM	FD	NM	NM	NM	FD	NM
SAMPLE DATE	1/23/2004	1/23/2004	1/26/2004	1/26/2004	1/19/2004	1/20/2004	1/27/2004	1/27/2004	1/21/2004
Volatile Organics (ug/L)									
1,1,1,2-TETRACHLOROETHANE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1,2,2-TETRACHLOROETHANE	0.3 U	0.3 U	52 J	59	0.3 U	0.3 U	6	6	0.3 U
1,1,2-TRICHLOROETHANE	0.2 U	0.2 U	0.7 J	1	0.2 U	0.2 U	5	5	0.2 U
1,1-DICHLOROETHANE	0.1 U	0.1 U	0.1 UR	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
1,1-DICHLOROETHENE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,2-DICHLOROETHANE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
2-BUTANONE	1 UJ	1 UJ	1 UR	1 U	1 U	1 U	1 U	1 U	1 U
BROMODICHLOROMETHANE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
CARBON DISULFIDE	0.1 U	0.1 U	0.1 UR	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.5 J
CARBON TETRACHLORIDE	0.4 U	0.4 U	0.4 UR	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
CHLOROFORM	0.2 U	0.2 U	1 J	2	0.7 J	0.2 U	0.2 U	0.2 U	0.2 U
CIS-1,2-DICHLOROETHENE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	2	2	0.2 U
ETHANE	0.006 J		0.003 J				0.09 J		
ETHENE	0.01 J		0.009 J				0.02 J		
METHANE	0.24 J		0.04 J				0.49 J		
METHYLENE CHLORIDE	2 U	2 U	2 UR	2 U	2 U	2 U	2 U	2 U	2 U
TETRACHLOROETHENE	0.1 U	0.1 U	1 J	2	0.1 U	0.1 U	1	1	0.1 U
TRANS-1,2-DICHLOROETHENE	0.1 U	0.1 U	0.1 UR	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
TRICHLOROETHENE	0.2 U	0.2 U	30 J	31	0.2 U	0.2 U	320	320	0.2 U
VINYL CHLORIDE	0.1 U	0.1 U	0.1 UR	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Miscellaneous Parameters									
ACETIC ACID (MG/L)	0.03 J		0.064 J				0.07 UJ		
BUTANOIC ACID (MG/L)	0.07 UJ		0.018 J				0.07 UJ		
CHLORIDE (MG/L)	39.5		3 J				77 J		
HARDNESS (MG/L)	480		128 J				1010 J		
HYDROGEN (NM)	5.8		2.1				9.7		
LACTIC ACID (MG/L)	0.02 J		0.07 UJ				0.07 UJ		
NITRITE/NITRATE-N (MG/L)	0.1 U		0.1 U				0.1 U		
PYRUVIC ACID (MG/L)	0.07 UJ		0.07 UJ				0.07 UJ		
SULFATE (MG/L)	277		33.3				840		
TOTAL INORGANIC CARBON (MG/L)	860		390				880		

TABLE C-4

DATA FOR CHEMICALS DETECTED AT LEAST ONCE IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-01	01-01	01-02	01-02	01-03	01-04	01-05	01-05	01-06
SAMPLE	01GW0103	01GW0103-D	01GW0203	01GW0203-D	01GW0303	01GW0403	01GW0503	01GW0503-D	01GW0603
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	---	---	---	---	---	---	---	---	---
QC TYPE	NM	FD	NM	FD	NM	NM	NM	FD	NM
SAMPLE DATE	1/23/2004	1/23/2004	1/26/2004	1/26/2004	1/19/2004	1/20/2004	1/27/2004	1/27/2004	1/21/2004
TOTAL ORGANIC CARBON (MG/L)	1.4 J		1.9 J				1.7 J		
Field Parameters									
ALKALINITY (MG/L)	175		68				250		
CARBON DIOXIDE (MG/L)	40		15				40		
DISSOLVED OXYGEN (MG/L)	0.6		5.5				3		
DISSOLVED OXYGEN - METER (MG/L)	0.16				3.96	5.58	0.01		1.58
FERROUS IRON (MG/L)	0.86		0				2.2		
HYDROGEN SULFIDE (H2S) (MG/L)	0		0				0		
MANGANESE (MG/L)	3.4		0.1				1		
NITRITE-N (MG/L)	0		0.004				0.006		
OXIDATION REDUCTION POTENTIAL (MV)	-14.6		238		37.2	6.5	-14.4		24
PH	6.31		6.33		6.6	6.83	6.96		6.95
SPECIFIC CONDUCTANCE (MS/CM)	0.796		0.177		105	722	1.535		1.198
SULFIDE (MG/L)	0		0.03				0		
TEMPERATURE (C)	11.08		8.12		5.42	8.52	8.64		10.56
TURBIDITY (NTU)	5.6		4.4		24	0.5	5		0.25

TABLE C-4

DATA FOR CHEMICALS DETECTED AT LEAST ONCE IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-07	01-08	01-09	01-10	01-11	01-11	01-12	01-13	01-14	01-15
SAMPLE	01GW0702	01GW0803	01GW0903	01GW1003	01GW1103	01GW1103-D	01GW1202	01GW1302	01GW1403	01GW1503
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	---	---	---	---	---	---	---	---	---	---
QC TYPE	NM	NM	NM	NM	NM	FD	NM	NM	NM	NM
SAMPLE DATE	1/18/2004	1/17/2004	1/17/2004	1/22/2004	1/24/2004	1/24/2004	1/23/2004	1/22/2004	1/23/2004	1/25/2004
Volatile Organics (ug/L)										
1,1,1,2-TETRACHLOROETHANE	0.2 U	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U	1	0.2 U	0.2 U	0.2 U
1,1,2,2-TETRACHLOROETHANE	0.3 U	4 J	0.3 U	0.3 U	0.3 U	0.3 U	320	32	6	49
1,1,2-TRICHLOROETHANE	0.2 U	5 J	0.2 U	0.2 U	0.2 U	0.2 U	9	1	0.2 U	3
1,1-DICHLOROETHANE	0.1 U	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
1,1-DICHLOROETHENE	0.2 U	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U	0.5 J	0.2 U	0.2 U	0.2 U
1,2-DICHLOROETHANE	0.2 U	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U	2	0.2 U	0.2 U	1
2-BUTANONE	1 U	1 UJ	1 U	1 U	1 UJ	1 U	1 UJ	1 U	1 UJ	1 UJ
BROMODICHLOROMETHANE	0.2 U	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
CARBON DISULFIDE	0.1 U	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
CARBON TETRACHLORIDE	0.4 U	0.4 UJ	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
CHLOROFORM	0.2 U	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U	9 BJ	0.8 J	0.2 U	1
CIS-1,2-DICHLOROETHENE	0.2 U	1 J	0.2 U	0.2 U	0.2 U	0.2 U	5	0.6 J	1	2
ETHANE				0.002 J	0.001 J	0.002 J			0.046 J	0.051 J
ETHENE				0.016 J	0.006 J	0.011 J			0.024 J	0.058 J
METHANE				0.07 J	0.03 J	0.03 J			0.37 J	56 J
METHYLENE CHLORIDE	2 U	2 UJ	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
TETRACHLOROETHENE	0.1 U	0.1 UJ	0.1 U	0.1 U	1	1	4	0.1 U	0.1 U	1
TRANS-1,2-DICHLOROETHENE	0.1 U	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	2	0.1 U	0.1 U	0.6 J
TRICHLOROETHENE	0.2 U	10 J	0.2 U	0.2 U	3	4	220	18	21	51
VINYL CHLORIDE	0.1 U	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Miscellaneous Parameters										
ACETIC ACID (MG/L)				0.029 J	0.028 J	0.023 J			0.06 J	0.046 J
BUTANOIC ACID (MG/L)				0.07 UJ	0.07 UJ	0.07 UJ			0.07 UJ	0.07 UJ
CHLORIDE (MG/L)				4.9	0.77 J	0.66 J			68.7	80.2 J
HARDNESS (MG/L)				380	48 J	24 J			592	952 J
HYDROGEN (NM)				3.2	2 J	4.6 J			3.3	12
LACTIC ACID (MG/L)				0.017 J	0.02 J	0.07 UJ			0.024 J	0.073 J
NITRITE/NITRATE-N (MG/L)				0.1 U	0.1 U	0.1 U			0.1 U	0.1 U
PYRUVIC ACID (MG/L)				0.07 UJ	0.07 UJ	0.07 UJ			0.07 UJ	0.02 J
SULFATE (MG/L)				88.2	15.6	15.8			420	534
TOTAL INORGANIC CARBON (MG/L)				550	260	260			740	980

TABLE C-4

DATA FOR CHEMICALS DETECTED AT LEAST ONCE IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-07	01-08	01-09	01-10	01-11	01-11	01-12	01-13	01-14	01-15
SAMPLE	01GW0702	01GW0803	01GW0903	01GW1003	01GW1103	01GW1103-D	01GW1202	01GW1302	01GW1403	01GW1503
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	---	---	---	---	---	---	---	---	---	---
QC TYPE	NM	NM	NM	NM	NM	FD	NM	NM	NM	NM
SAMPLE DATE	1/18/2004	1/17/2004	1/17/2004	1/22/2004	1/24/2004	1/24/2004	1/23/2004	1/22/2004	1/23/2004	1/25/2004
TOTAL ORGANIC CARBON (MG/L)				1.5 J	5 U	5 U			1.5 J	1.1 J
Field Parameters										
ALKALINITY (MG/L)				250	1000 >	1000 >			240	325
CARBON DIOXIDE (MG/L)				25	37	42			140	35
DISSOLVED OXYGEN (MG/L)				0.6	3	3			0.05	0.2
DISSOLVED OXYGEN - METER (MG/L)	0.76	0.48	2.67	1.56	5.09		0.53	0.64	0.47	-0.01
FERROUS IRON (MG/L)				3.3 >	0	0			2.8	3.3
HYDROGEN SULFIDE (H2S) (MG/L)				0	0	0			0	0
MANGANESE (MG/L)				2.5	0.3	0.3			22 >	4.2
NITRITE-N (MG/L)				0.17	0.001	0.005			0	0.007
OXIDATION REDUCTION POTENTIAL (MV)	-49	-62	313	49.3	5.4		-11.9	159.6	-47	-7.7
PH	6.72	6.96	5.39	7.02	5.61		6.86	7.27	6.43	6.79
SPECIFIC CONDUCTANCE (MS/CM)	0.823	0.417	0.083	0.474	0.054		0.412	0.458	1.015	1.141
SULFIDE (MG/L)				0.03	0.02	0.01			0.05	0
TEMPERATURE (C)	8.8	11.48	10.74	6.97	7.02		8.74	9.44	8.7	5.69
TURBIDITY (NTU)	0.1	1.86	2.7	7.96	7.3		24	0	6.7	2.4

TABLE C-4

DATA FOR CHEMICALS DETECTED AT LEAST ONCE IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-17	01-18	01-19	01-20	01-20	01-21	01-22	01-23	01-24	01-25
SAMPLE	01GW1702	01GW1802	01GW1902	01GW2002	01GW2002-D	01GW2102	01GW2202	01GW2303	01GW2402	01GW2503
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	---	---	---	---	---	---	---	---	---	---
QC TYPE	NM	NM	NM	NM	FD	NM	NM	NM	NM	NM
SAMPLE DATE	1/20/2004	1/23/2004	1/25/2004	1/21/2004	1/21/2004	1/18/2004	1/24/2004	1/20/2004	1/21/2004	1/21/2004
Volatile Organics (ug/L)										
1,1,1,2-TETRACHLOROETHANE	0.6 J	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	2	0.2 U	0.2 U	1
1,1,2,2-TETRACHLOROETHANE	8	0.3 U	280	37	31	0.3 U	71	0.3 U	0.3 U	29
1,1,2-TRICHLOROETHANE	0.9 J	0.2 U	0.8 J	0.8 J	0.6 J	0.2 U	4	0.2 U	0.2 U	2
1,1-DICHLOROETHANE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
1,1-DICHLOROETHENE	0.5 J	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.9 J	0.2 U	0.2 U	0.5 J
1,2-DICHLOROETHANE	1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	4	0.2 U	0.2 U	2
2-BUTANONE	1 U	1 UJ	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
BROMODICHLOROMETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
CARBON DISULFIDE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
CARBON TETRACHLORIDE	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
CHLOROFORM	5	0.2 U	2 J	0.5 J	0.2 U	0.2 U	15	0.2 U	0.2 U	7
CIS-1,2-DICHLOROETHENE	1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	4	0.2 U	0.2 U	2
ETHANE			0.04 J						0.01 J	0.026 J
ETHENE			0.013 J						0.005 UJ	0.012 J
METHANE			11 J						1.4 J	0.16 J
METHYLENE CHLORIDE	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
TETRACHLOROETHENE	1	0.1 U	2	0.1 U	0.1 U	0.1 U	3	1	0.1 U	1
TRANS-1,2-DICHLOROETHENE	0.9 J	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	2	0.1 U	0.1 U	0.9 J
TRICHLOROETHENE	56	0.2 U	380	25	20	0.2 U	150	0.2 U	0.2 U	96
VINYL CHLORIDE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Miscellaneous Parameters										
ACETIC ACID (MG/L)			0.032 J						0.069 J	0.04 J
BUTANOIC ACID (MG/L)			0.07 UJ						0.07 UJ	0.07 UJ
CHLORIDE (MG/L)			46.6 J						4.4	41.4
HARDNESS (MG/L)			496 J						236	544
HYDROGEN (NM)			2.4						2	2.5
LACTIC ACID (MG/L)			0.018 J						0.06 J	0.033 J
NITRITE/NITRATE-N (MG/L)			0.15						0.1 U	0.29
PYRUVIC ACID (MG/L)			0.07 UJ						0.07 UJ	0.07 UJ
SULFATE (MG/L)			286						17.8	348
TOTAL INORGANIC CARBON (MG/L)			780						390	670

TABLE C-4

DATA FOR CHEMICALS DETECTED AT LEAST ONCE IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-17	01-18	01-19	01-20	01-20	01-21	01-22	01-23	01-24	01-25
SAMPLE	01GW1702	01GW1802	01GW1902	01GW2002	01GW2002-D	01GW2102	01GW2202	01GW2303	01GW2402	01GW2503
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	---	---	---	---	---	---	---	---	---	---
QC TYPE	NM	NM	NM	NM	FD	NM	NM	NM	NM	NM
SAMPLE DATE	1/20/2004	1/23/2004	1/25/2004	1/21/2004	1/21/2004	1/18/2004	1/24/2004	1/20/2004	1/21/2004	1/21/2004
TOTAL ORGANIC CARBON (MG/L)			1.4 J						5 U	1.5 J
Field Parameters										
ALKALINITY (MG/L)			260						180	10 U
CARBON DIOXIDE (MG/L)			18						12	25
DISSOLVED OXYGEN (MG/L)			3						0.2	0.25
DISSOLVED OXYGEN - METER (MG/L)	2.5	1.2	1.46	2.1		0.58	0.79	1.31	2.18	0.31
FERROUS IRON (MG/L)			0.01						3.3 >	0.03
HYDROGEN SULFIDE (H2S) (MG/L)			0						0	0
MANGANESE (MG/L)			0						1.5	0
NITRITE-N (MG/L)			0						0.006	0
OXIDATION REDUCTION POTENTIAL (MV)	55.9	-53.1	346	8.4		-62	76	-149	-90	52.7
PH	6.23	7.24	7.01	6.02		6.78	6.96	7.6	7.1	7.05
SPECIFIC CONDUCTANCE (MS/CM)	661	0.509	0.866	1297		0.618	0.915	1.305	0.313	1032
SULFIDE (MG/L)			0.03						0.01	0.23
TEMPERATURE (C)	11.51	8.62	8.35	9.51		8.95	9.48	7.72	9.75	11.58
TURBIDITY (NTU)	0.4	105	1.4	0.73		0.3	3.5	9.5	3.2	86.7

TABLE C-4

DATA FOR CHEMICALS DETECTED AT LEAST ONCE IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-26	01-27	01C01	01T02	01T03	01T04	01T05	01T06	01T07
SAMPLE	01GW2603	01GW2702	01GWC0103	01GWT0204	01GWT0302	01GWT0402	01GWT0502	01GWT0601	01GWT0701
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	---	---	---	---	---	---	---	---	---
QC TYPE	NM	NM	NM	NM	NM	NM	NM	NM	NM
SAMPLE DATE	1/24/2004	1/23/2004	1/26/2004	1/24/2004	1/25/2004	1/25/2004	1/22/2004	1/23/2004	1/24/2004
Volatile Organics (ug/L)									
1,1,1,2-TETRACHLOROETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	45
1,1,2,2-TETRACHLOROETHANE	0.3 U	0.6 J	0.3 U	0.3 U	0.3 U	0.3 U	3	0.3 U	660
1,1,2-TRICHLOROETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	16 J
1,1-DICHLOROETHANE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.5 J
1,1-DICHLOROETHENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	4 J
1,2-DICHLOROETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	17 J
2-BUTANONE	1 UJ	1 UJ	1 U	1 UJ	1 U	4 J	1 U	1 UJ	1 UJ
BROMODICHLOROMETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	3 J
CARBON DISULFIDE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
CARBON TETRACHLORIDE	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	10 J
CHLOROFORM	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	790
CIS-1,2-DICHLOROETHENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	14 J
ETHANE							0.004 J		
ETHENE							0.046 J		
METHANE							0.19 J		
METHYLENE CHLORIDE	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	15 J
TETRACHLOROETHENE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	130
TRANS-1,2-DICHLOROETHENE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	11 J
TRICHLOROETHENE	0.2 U	0.2 U	1	0.2 U	0.2 U	0.2 U	3	0.2 U	620
VINYL CHLORIDE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	1 J
Miscellaneous Parameters									
ACETIC ACID (MG/L)							0.05 J		
BUTANOIC ACID (MG/L)							0.07 UJ		
CHLORIDE (MG/L)							93.7		
HARDNESS (MG/L)							872		
HYDROGEN (NM)							2.5		
LACTIC ACID (MG/L)							0.034 J		
NITRITE/NITRATE-N (MG/L)							0.1 U		
PYRUVIC ACID (MG/L)							0.07 UJ		
SULFATE (MG/L)							778		
TOTAL INORGANIC CARBON (MG/L)							740		

TABLE C-4

DATA FOR CHEMICALS DETECTED AT LEAST ONCE IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-26	01-27	01C01	01T02	01T03	01T04	01T05	01T06	01T07
SAMPLE	01GW2603	01GW2702	01GWC0103	01GWT0204	01GWT0302	01GWT0402	01GWT0502	01GWT0601	01GWT0701
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	---	---	---	---	---	---	---	---	---
QC TYPE	NM	NM	NM	NM	NM	NM	NM	NM	NM
SAMPLE DATE	1/24/2004	1/23/2004	1/26/2004	1/24/2004	1/25/2004	1/25/2004	1/22/2004	1/23/2004	1/24/2004
TOTAL ORGANIC CARBON (MG/L)							1 J		
Field Parameters									
ALKALINITY (MG/L)							40		
CARBON DIOXIDE (MG/L)							35		
DISSOLVED OXYGEN (MG/L)							0.5		
DISSOLVED OXYGEN - METER (MG/L)	-0.04	0.26	0.01	0	0.28	0.49	1.38	6.75	1.33
FERROUS IRON (MG/L)							0.35		
HYDROGEN SULFIDE (H2S) (MG/L)							0		
MANGANESE (MG/L)							9.5		
NITRITE-N (MG/L)							0.004		
OXIDATION REDUCTION POTENTIAL (MV)	34.4	-25.7	-10.8	38.3	40.9	-6.4	198	196	185
PH	6.82	7.14	7.95	5.76	7.29	7.8	5.73	6.18	6.25
SPECIFIC CONDUCTANCE (MS/CM)	1.111	0.775	0.337	2.299	0.562	0.287	1.044	1.178	1.238
SULFIDE (MG/L)							0		
TEMPERATURE (C)	10.51	8.75	5.31	6.94	8.21	8.73	6.55	8.16	7.82
TURBIDITY (NTU)	8	8.5	25	8.1	8.8	9.5	8.2	9.8	10

APPENDIX C.3

SWMU 01 Database, Round 3

TABLE C-5

COMPLETE GROUNDWATER DATA SET
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-01	01-01	01-02	01-02	01-03	01-04	01-05	01-05	01-06	01-07	01-08	01-09	01-10
SAMPLE	01GW0103	01GW0103-D	01GW0203	01GW0203-D	01GW0303	01GW0403	01GW0503	01GW0503-D	01GW0603	01GW0702	01GW0803	01GW0903	01GW1003
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—	—	—	—	—	—	—	—
QC TYPE	NM	FD	NM	FD	NM	NM	NM	FD	NM	NM	NM	NM	NM
SAMPLE DATE	1/23/2004	1/23/2004	1/26/2004	1/26/2004	1/19/2004	1/20/2004	1/27/2004	1/27/2004	1/21/2004	1/18/2004	1/17/2004	1/17/2004	1/22/2004
Volatile Organics (ug/L)													
1,1,1,2-TETRACHLOROETHANE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
1,1,1-TRICHLOROETHANE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
1,1,2,2-TETRACHLOROETHANE	0.3 U	0.3 U	52 J	59	0.3 U	0.3 U	6	6	0.3 U	0.3 U	4 J	0.3 U	0.3 U
1,1,2-TRICHLOROETHANE	0.2 U	0.2 U	0.7 J	1	0.2 U	0.2 U	5	5	0.2 U	0.2 U	5 J	0.2 U	0.2 U
1,1-DICHLOROETHANE	0.1 U	0.1 U	0.1 UR	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U	0.1 U
1,1-DICHLOROETHENE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
1,2,3-TRICHLOROPROPANE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
1,2-DIBROMO-3-CHLOROPROPANE	0.5 U	0.5 U	0.5 UR	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U
1,2-DIBROMOETHANE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
1,2-DICHLOROETHANE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
1,2-DICHLOROPROPANE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
1,4-DIOXANE	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR
2-BUTANONE	1 UJ	1 UJ	1 UR	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U
2-HEXANONE	0.5 U	0.5 U	0.5 UR	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U
3-CHLOROPROPENE	0.1 U	0.1 U	0.1 UR	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U	0.1 U
4-METHYL-2-PENTANONE	0.4 U	0.4 U	0.4 UR	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 UJ	0.4 U	0.4 U
ACETONE	0.5 UR	0.5 UR	0.5 UR	0.5 UR	1 U	0.5 UR	0.5 UR	0.5 UR	0.5 UR	0.5 UR	1 U	0.5 UR	0.5 UR
ACETONITRILE	2 U	2 U	2 UR	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 UJ	2 U	2 U
ACROLEIN	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR
ACRYLONITRILE	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR
BENZENE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
BROMODICHLOROMETHANE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
BROMOFORM	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
BROMOMETHANE	0.3 U	0.3 U	0.3 UR	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 UJ	0.3 U	0.3 U
CARBON DISULFIDE	0.1 U	0.1 U	0.1 UR	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.5 J	0.1 U	0.1 UJ	0.1 U	0.1 U
CARBON TETRACHLORIDE	0.4 U	0.4 U	0.4 UR	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 UJ	0.4 U	0.4 U
CHLOROBENZENE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
CHLORODIBROMOMETHANE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
CHLOROETHANE	0.3 U	0.3 U	0.3 UR	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 UJ	0.3 U	0.3 U
CHLOROFORM	0.2 U	0.2 U	1 J	2	0.7 J	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
CHLOROMETHANE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
CHLOROPRENE	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR
CIS-1,2-DICHLOROETHENE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	2	2	0.2 U	0.2 U	1 J	0.2 U	0.2 U
CIS-1,3-DICHLOROPROPENE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
DIBROMOMETHANE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
DICHLORODIFLUOROMETHANE	0.1 U	0.1 U	0.1 UR	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U	0.1 U
ETHANE	0.006 J		0.003 J				0.09 J						0.002 J
ETHENE	0.01 J		0.009 J				0.02 J						0.016 J
ETHYL METHACRYLATE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
ETHYLBENZENE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
ISOBUTANOL	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR
METHACRYLONITRILE	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR
METHANE	0.24 J		0.04 J				0.49 J						0.07 J

TABLE C-5

COMPLETE GROUND WATER DATA SET
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-01	01-01	01-02	01-02	01-03	01-04	01-05	01-05	01-06	01-07	01-08	01-09	01-10
SAMPLE	01GW0103	01GW0103-D	01GW0203	01GW0203-D	01GW0303	01GW0403	01GW0503	01GW0503-D	01GW0603	01GW0702	01GW0803	01GW0903	01GW1003
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—	—	—	—	—	—	—	—
QC TYPE	NM	FD	NM	FD	NM	NM	NM	FD	NM	NM	NM	NM	NM
SAMPLE DATE	1/23/2004	1/23/2004	1/26/2004	1/26/2004	1/19/2004	1/20/2004	1/27/2004	1/27/2004	1/21/2004	1/18/2004	1/17/2004	1/17/2004	1/22/2004
METHYL IODIDE	0.06 U	0.06 U	0.06 UR	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 UJ	0.06 U	0.06 U
METHYL METHACRYLATE	0.8 U	0.8 U	0.8 UR	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 UJ	0.8 U	0.8 U
METHYLENE CHLORIDE	2 U	2 U	2 UR	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 UJ	2 U	2 U
PENTACHLOROETHANE	0.1 U	0.1 U	0.1 UR	0.1 U	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ
PROPIONITRILE	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR
STYRENE	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
TETRACHLOROETHENE	0.1 U	0.1 U	1 J	2	0.1 U	0.1 U	1	1	0.1 U	0.1 U	0.1 UJ	0.1 U	0.1 U
TOLUENE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
TOTAL XYLENES	0.6 U	0.6 U	0.6 UR	0.6 U	0.6 U	0.6 U	0.6 UJ	0.6 U	0.6 U	0.6 U	0.6 UJ	0.6 U	0.6 U
TRANS-1,2-DICHLOROETHENE	0.1 U	0.1 U	0.1 UR	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U	0.1 U
TRANS-1,3-DICHLOROPROPENE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
TRANS-1,4-DICHLORO-2-BUTENE	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR
TRICHLOROETHENE	0.2 U	0.2 U	30 J	31	0.2 U	0.2 U	320	320	0.2 U	0.2 U	10 J	0.2 U	0.2 U
TRICHLOROFLUOROMETHANE	0.2 U	0.2 U	0.2 UR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U
VINYL ACETATE	0.6 U	0.6 U	0.6 UR	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 UJ	0.6 U	0.6 U
VINYL CHLORIDE	0.1 U	0.1 U	0.1 UR	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U	0.1 U
Miscellaneous Parameters													
ACETIC ACID (MG/L)	0.03 J		0.064 J				0.07 UJ						0.029 J
ACETYLENE (NG/L)	1000 UJ		1000 UJ				1000 UJ						1000 UJ
BUTANE (NG/L)	25 UJ		25 UJ				6 J						25 UJ
BUTANOIC ACID (MG/L)	0.07 UJ		0.018 J				0.07 UJ						0.07 UJ
CHLORIDE (MG/L)	39.5		3 J				77 J						4.9
HARDNESS (MG/L)	480		128 J				1010 J						380
HEXANOIC ACID (MG/L)	0.1 UJ		0.1 UJ				0.1 UJ						0.1 UJ
HYDROGEN (NM)	5.8		2.1				9.7						3.2
I-HEXANOIC ACID (MG/L)	0.1 UJ		0.1 UJ				0.1 UJ						0.1 UJ
I-PENTANOIC ACID (MG/L)	0.07 UJ		0.07 UJ				0.07 UJ						0.07 UJ
ISOBUTANE (NG/L)	25 UJ		25 UJ				11 J						25 UJ
LACTIC ACID (MG/L)	0.02 J		0.07 UJ				0.07 UJ						0.017 J
NITRITE/NITRATE-N (MG/L)	0.1 U		0.1 U				0.1 U						0.1 U
PENTANOIC ACID (MG/L)	0.07 UJ		0.07 UJ				0.07 UJ						0.07 UJ
PROPANE (NG/L)	9 J		25 UJ				35 J						25 UJ
PROPIONIC ACID (MG/L)	0.07 UJ		0.07 UJ				0.07 UJ						0.07 UJ
PROPYLENE (NG/L)	25 UJ		25 UJ				25 UJ						25 UJ
PYRUVIC ACID (MG/L)	0.07 UJ		0.07 UJ				0.07 UJ						0.07 UJ
SULFATE (MG/L)	277		33.3				840						88.2
TOTAL INORGANIC CARBON (MG/L)	860		390				880						550
TOTAL ORGANIC CARBON (MG/L)	1.4 J		1.9 J				1.7 J						1.5 J
Field Parameters													
ALKALINITY (MG/L)	175		68				250						250
CARBON DIOXIDE (MG/L)	40		15				40						25
DISSOLVED OXYGEN (MG/L)	0.6		5.5				3						0.6
DISSOLVED OXYGEN - METER (MG/L)	0.16				3.96	5.58	0.01		1.58	0.76	0.48	2.67	1.56
FERROUS IRON (MG/L)	0.86		0				2.2						3.3 >

TABLE C-5

COMPLETE GROUNDWATER DATA SET
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-01	01-01	01-02	01-02	01-03	01-04	01-05	01-05	01-06	01-07	01-08	01-09	01-10
SAMPLE	01GW0103	01GW0103-D	01GW0203	01GW0203-D	01GW0303	01GW0403	01GW0503	01GW0503-D	01GW0603	01GW0702	01GW0803	01GW0903	01GW1003
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	---	---	---	---	---	---	---	---	---	---	---	---	---
QC TYPE	NM	FD	NM	FD	NM	NM	NM	FD	NM	NM	NM	NM	NM
SAMPLE DATE	1/23/2004	1/23/2004	1/26/2004	1/26/2004	1/19/2004	1/20/2004	1/27/2004	1/27/2004	1/21/2004	1/18/2004	1/17/2004	1/17/2004	1/22/2004
HYDROGEN SULFIDE (H2S) (MG/L)	0		0				0						0
MANGANESE+2 (MG/L)	3.4		0.1				1						2.5
NITRITE-N (MG/L)	0		0.004				0.006						0.17
OXIDATION REDUCTION POTENTIAL (MV)	-14.6		238		37.2	6.5	-14.4		24	-49	-62	313	49.3
PH	6.31		6.33		6.6	6.83	6.96		6.95	6.72	6.96	5.39	7.02
SPECIFIC CONDUCTANCE (MS/CM)	0.796		0.177		0.105	0.722	1.535		1.198	0.823	0.417	0.083	0.474
SULFIDE (MG/L)	0		0.03				0						0.03
TEMPERATURE (C)	11.08		8.12		5.42	8.52	8.64		10.56	8.8	11.48	10.74	6.97
TURBIDITY (NTU)	5.6		4.4		24	0.5	5		0.25	0.1	1.86	2.7	7.96

COMPLETE GROUND WATER DATA SET
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-11	01-11	01-12	01-13	01-14	01-15	01-17	01-18	01-19	01-20	01-20	01-21	01-22
SAMPLE	01GW1103	01GW1103-D	01GW1202	01GW1302	01GW1403	01GW1503	01GW1702	01GW1802	01GW1902	01GW2002	01GW2002-D	01GW2102	01GW2202
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—	—	—	—	—	—	—	—
QC TYPE	NM	FD	NM	NM	NM	NM	NM	NM	NM	NM	FD	NM	NM
SAMPLE DATE	1/24/2004	1/24/2004	1/23/2004	1/22/2004	1/23/2004	1/25/2004	1/20/2004	1/23/2004	1/25/2004	1/21/2004	1/21/2004	1/18/2004	1/24/2004
Volatile Organics (ug/L)													
1,1,1,2-TETRACHLOROETHANE	0.2 U	0.2 U	1	0.2 U	0.2 U	0.2 U	0.6 J	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	2
1,1,1-TRICHLOROETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1,2,2-TETRACHLOROETHANE	0.3 U	0.3 U	320	32	6	49	8	0.3 U	280	37	31	0.3 U	71
1,1,2-TRICHLOROETHANE	0.2 U	0.2 U	9	1	0.2 U	3	0.9 J	0.2 U	0.8 J	0.8 J	0.6 J	0.2 U	4
1,1-DICHLOROETHANE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
1,1-DICHLOROETHENE	0.2 U	0.2 U	0.5 J	0.2 U	0.2 U	0.2 U	0.5 J	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.9 J
1,2,3-TRICHLOROPROPANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,2-DIBROMO-3-CHLOROPROPANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-DIBROMOETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,2-DICHLOROETHANE	0.2 U	0.2 U	2	0.2 U	0.2 U	1	1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	4
1,2-DICHLOROPROPANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,4-DIOXANE	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR
2-BUTANONE	1 UJ	1 U	1 UJ	1 U	1 UJ	1 UJ	1 U	1 UJ	1 U	1 U	1 U	1 U	1 UJ
2-HEXANONE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
3-CHLOROPROPENE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4-METHYL-2-PENTANONE	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
ACETONE	0.5 UR	0.5 UR	0.5 UR	0.5 UR	0.5 UR	0.5 UR	0.5 UR	0.5 UR	0.5 UR	0.5 UR	0.5 UR	0.5 UR	0.5 UR
ACETONITRILE	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
ACROLEIN	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR
ACRYLONITRILE	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR
BENZENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
BROMODICHLOROMETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
BROMOFORM	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
BROMOMETHANE	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
CARBON DISULFIDE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
CARBON TETRACHLORIDE	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
CHLOROBENZENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
CHLORODIBROMOMETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
CHLOROETHANE	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
CHLOROFORM	0.2 U	0.2 U	9 BJ	0.8 J	0.2 U	1	5	0.2 U	2 J	0.5 J	0.2 U	0.2 U	15
CHLOROMETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
CHLOROPRENE	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR
CIS-1,2-DICHLOROETHENE	0.2 U	0.2 U	5	0.6 J	1	2	1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	4
CIS-1,3-DICHLOROPROPENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
DIBROMOMETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
DICHLORODIFLUOROMETHANE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
ETHANE	0.001 J	0.002 J			0.046 J	0.051 J			0.04 J				
ETHENE	0.006 J	0.011 J			0.024 J	0.058 J			0.013 J				
ETHYL METHACRYLATE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
ETHYLBENZENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
ISOBUTANOL	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR
METHACRYLONITRILE	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR
METHANE	0.03 J	0.03 J			0.37 J	56 J			11 J				

TABLE C-5

COMPLETE GROUND WATER DATA SET
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-11	01-11	01-12	01-13	01-14	01-15	01-17	01-18	01-19	01-20	01-20	01-21	01-22
SAMPLE	01GW1103	01GW1103-D	01GW1202	01GW1302	01GW1403	01GW1503	01GW1702	01GW1802	01GW1902	01GW2002	01GW2002-D	01GW2102	01GW2202
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	---	---	---	---	---	---	---	---	---	---	---	---	---
QC TYPE	NM	FD	NM	NM	NM	NM	NM	NM	NM	NM	FD	NM	NM
SAMPLE DATE	1/24/2004	1/24/2004	1/23/2004	1/22/2004	1/23/2004	1/25/2004	1/20/2004	1/23/2004	1/25/2004	1/21/2004	1/21/2004	1/18/2004	1/24/2004
METHYL IODIDE	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
METHYL METHACRYLATE	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
METHYLENE CHLORIDE	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
PENTACHLOROETHANE	0.1 U	0.1 U	0.1 UJ	0.1 UJ	0.1 U	0.1 U	0.1 UJ	0.1 UJ	0.1 U	0.1 UJ	0.1 UJ	0.1 UJ	0.1 U
PROPIONITRILE	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR
STYRENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U
TETRACHLOROETHENE	1	1	4	0.1 U	0.1 U	1	1	0.1 U	2	0.1 U	0.1 U	0.1 U	3
TOLUENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
TOTAL XYLENES	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
TRANS-1,2-DICHLOROETHENE	0.1 U	0.1 U	2	0.1 U	0.1 U	0.6 J	0.9 J	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	2
TRANS-1,3-DICHLOROPROPENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
TRANS-1,4-DICHLORO-2-BUTENE	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR
TRICHLOROETHENE	3	4	220	18	21	51	56	0.2 U	380	25	20	0.2 U	150
TRICHLOROFLUOROMETHANE	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
VINYL ACETATE	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
VINYL CHLORIDE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Miscellaneous Parameters													
ACETIC ACID (MG/L)	0.028 J	0.023 J			0.06 J	0.046 J			0.032 J				
ACETYLENE (NG/L)	1000 UJ	1000 UJ			1000 UJ	1000 UJ			1000 UJ				
BUTANE (NG/L)	25 UJ	25 UJ			9 J	13 J			8 J				
BUTANOIC ACID (MG/L)	0.07 UJ	0.07 UJ			0.07 UJ	0.07 UJ			0.07 UJ				
CHLORIDE (MG/L)	0.77 J	0.66 J			68.7	80.2 J			46.6 J				
HARDNESS (MG/L)	48 J	24 J			592	952 J			496 J				
HEXANOIC ACID (MG/L)	0.1 UJ	0.1 UJ			0.1 UJ	0.1 UJ			0.1 UJ				
HYDROGEN (NM)	2 J	4.6 J			3.3	12			2.4				
I-HEXANOIC ACID (MG/L)	0.1 UJ	0.1 UJ			0.1 UJ	0.1 UJ			0.1 UJ				
I-PENTANOIC ACID (MG/L)	0.07 UJ	0.07 UJ			0.07 UJ	0.07 UJ			0.07 UJ				
ISOBUTANE (NG/L)	25 UJ	25 UJ			9 J	12 J			7 J				
LACTIC ACID (MG/L)	0.02 J	0.07 UJ			0.024 J	0.073 J			0.018 J				
NITRITE/NITRATE-N (MG/L)	0.1 U	0.1 U			0.1 U	0.1 U			0.15				
PENTANOIC ACID (MG/L)	0.07 UJ	0.07 UJ			0.07 UJ	0.07 UJ			0.07 UJ				
PROPANE (NG/L)	25 UJ	25 UJ			31 J	50 J			32 J				
PROPIONIC ACID (MG/L)	0.07 UJ	0.07 UJ			0.07 UJ	0.07 UJ			0.07 UJ				
PROPYLENE (NG/L)	25 UJ	25 UJ			25 UJ	25 UJ			25 UJ				
PYRUVIC ACID (MG/L)	0.07 UJ	0.07 UJ			0.07 UJ	0.02 J			0.07 UJ				
SULFATE (MG/L)	15.6	15.8			420	534			286				
TOTAL INORGANIC CARBON (MG/L)	260	260			740	980			780				
TOTAL ORGANIC CARBON (MG/L)	5 U	5 U			1.5 J	1.1 J			1.4 J				
Field Parameters													
ALKALINITY (MG/L)	1000 >	1000 >			240	325			260				
CARBON DIOXIDE (MG/L)	37	42			140	35			18				
DISSOLVED OXYGEN (MG/L)	3	3			0.05	0.2			3				
DISSOLVED OXYGEN - METER (MG/L)	5.09		0.53	0.64	0.47	-0.01	2.5	1.2	1.46	2.1		0.58	0.79
FERROUS IRON (MG/L)	0	0			2.8	3.3			0.01				

TA[illegible] C-5

COMPLETE GROUND WATER DATA SET
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-11	01-11	01-12	01-13	01-14	01-15	01-17	01-18	01-19	01-20	01-20	01-21	01-22
SAMPLE	01GW1103	01GW1103-D	01GW1202	01GW1302	01GW1403	01GW1503	01GW1702	01GW1802	01GW1902	01GW2002	01GW2002-D	01GW2102	01GW2202
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	---	---	---	---	---	---	---	---	---	---	---	---	---
QC TYPE	NM	FD	NM	NM	NM	NM	NM	NM	NM	NM	FD	NM	NM
SAMPLE DATE	1/24/2004	1/24/2004	1/23/2004	1/22/2004	1/23/2004	1/25/2004	1/20/2004	1/23/2004	1/25/2004	1/21/2004	1/21/2004	1/18/2004	1/24/2004
HYDROGEN SULFIDE (H2S) (MG/L)	0	0			0	0			0				
MANGANESE+2 (MG/L)	0.3	0.3			22 >	4.2			0				
NITRITE-N (MG/L)	0.001	0.005			0	0.007			0				
OXIDATION REDUCTION POTENTIAL (MV)	5.4		-11.9	159.6	-47	-7.7	55.9	-53.1	346	8.4		-62	76
PH	5.61		6.86	7.27	6.43	6.79	6.23	7.24	7.01	6.02		6.78	6.96
SPECIFIC CONDUCTANCE (MS/CM)	0.054		0.412	0.458	1.015	1.141	0.661	0.509	0.866	1.297		0.618	0.915
SULFIDE (MG/L)	0.02	0.01			0.05	0			0.03				
TEMPERATURE (C)	7.02		8.74	9.44	8.7	5.69	11.51	8.62	8.35	9.51		8.95	9.48
TURBIDITY (NTU)	7.3		24	0	6.7	2.4	0.4	105	1.4	0.73		0.3	3.5

TABLE C-5

COMPLETE GROUNDWATER DATA SET
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-23	01-24	01-25	01-26	01-27	01C01	01T02	01T03	01T04	01T05	01T06	01T07
SAMPLE	01GW2303	01GW2402	01GW2503	01GW2603	01GW2702	01GWC0103	01GWT0204	01GWT0302	01GWT0402	01GWT0502	01GWT0601	01GWT0701
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	---	---	---	---	---	---	---	---	---	---	---	---
QC TYPE	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
SAMPLE DATE	1/20/2004	1/21/2004	1/21/2004	1/24/2004	1/23/2004	1/26/2004	1/24/2004	1/25/2004	1/25/2004	1/22/2004	1/23/2004	1/24/2004
Volatile Organics (ug/L)												
1,1,1,2-TETRACHLOROETHANE	0.2 U	0.2 U	1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	45
1,1,1-TRICHLOROETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1,2,2-TETRACHLOROETHANE	0.3 U	0.3 U	29	0.3 U	0.6 J	0.3 U	0.3 U	0.3 U	0.3 U	3	0.3 U	660
1,1,2-TRICHLOROETHANE	0.2 U	0.2 U	2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	16 J
1,1-DICHLOROETHANE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.5 J
1,1-DICHLOROETHENE	0.2 U	0.2 U	0.5 J	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	4 J
1,2,3-TRICHLOROPROPANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,2-DIBROMO-3-CHLOROPROPANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-DIBROMOETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,2-DICHLOROETHANE	0.2 U	0.2 U	2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	17 J
1,2-DICHLOROPROPANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,4-DIOXANE	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR
2-BUTANONE	1 U	1 U	1 U	1 UJ	1 UJ	1 U	1 UJ	1 U	4 J	1 U	1 UJ	1 UJ
2-HEXANONE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
3-CHLOROPROPENE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4-METHYL-2-PENTANONE	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
ACETONE	0.5 UR	0.5 UR	0.5 UR	0.5 UR	0.5 UR	0.5 UR	0.5 UR	0.5 UR	5 U	0.5 UR	0.5 UR	0.5 UR
ACETONITRILE	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
ACROLEIN	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR
ACRYLONITRILE	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR	2 UR
BENZENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
BROMODICHLOROMETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	3 J
BROMOFORM	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
BROMOMETHANE	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
CARBON DISULFIDE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
CARBON TETRACHLORIDE	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	10 J
CHLOROBENZENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
CHLORODIBROMOMETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
CHLOROETHANE	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
CHLOROFORM	0.2 U	0.2 U	7	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	790
CHLOROMETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
CHLOROPRENE	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR	0.1 UR
CIS-1,2-DICHLOROETHENE	0.2 U	0.2 U	2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	14 J
CIS-1,3-DICHLOROPROPENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
DIBROMOMETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
DICHLORODIFLUOROMETHANE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
ETHANE		0.01 J	0.026 J							0.004 J		
ETHENE		0.005 UJ	0.012 J							0.046 J		
ETHYL METHACRYLATE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
ETHYLBENZENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
ISOBUTANOL	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR	9 UR
METHACRYLONITRILE	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR	0.9 UR
METHANE		1.4 J	0.16 J							0.19 J		

COMPLETE GROUND WATER DATA SET
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-23	01-24	01-25	01-26	01-27	01C01	01T02	01T03	01T04	01T05	01T06	01T07
SAMPLE	01GW2303	01GW2402	01GW2503	01GW2603	01GW2702	01GWC0103	01GWT0204	01GWT0302	01GWT0402	01GWT0502	01GWT0601	01GWT0701
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—	—	—	—	—	—	—
QC TYPE	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
SAMPLE DATE	1/20/2004	1/21/2004	1/21/2004	1/24/2004	1/23/2004	1/26/2004	1/24/2004	1/25/2004	1/25/2004	1/22/2004	1/23/2004	1/24/2004
METHYL IODIDE	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
METHYL METHACRYLATE	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
METHYLENE CHLORIDE	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	15 J
PENTACHLOROETHANE	0.1 UJ	0.1 UJ	0.1 UJ	0.1 U	0.1 U	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U	0.1 U
PROPIONITRILE	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR	4 UR
STYRENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
TETRACHLOROETHENE	1	0.1 U	1	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	130
TOLUENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
TOTAL XYLENES	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
TRANS-1,2-DICHLOROETHENE	0.1 U	0.1 U	0.9 J	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	11 J
TRANS-1,3-DICHLOROPROPENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
TRANS-1,4-DICHLORO-2-BUTENE	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR	0.3 UR
TRICHLOROETHENE	0.2 U	0.2 U	96	0.2 U	0.2 U	1	0.2 U	0.2 U	0.2 U	3	0.2 U	620
TRICHLOROFLUOROMETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
VINYL ACETATE	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
VINYL CHLORIDE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	1 J
Miscellaneous Parameters												
ACETIC ACID (MG/L)		0.069 J	0.04 J							0.05 J		
ACETYLENE (NG/L)		1000 UJ	1000 UJ							1000 UJ		
BUTANE (NG/L)		25 UJ	5 J							25 UJ		
BUTANOIC ACID (MG/L)		0.07 UJ	0.07 UJ							0.07 UJ		
CHLORIDE (MG/L)		4.4	41.4							93.7		
HARDNESS (MG/L)		236	544							872		
HEXANOIC ACID (MG/L)		0.1 UJ	0.1 UJ							0.1 UJ		
HYDROGEN (NM)		2	2.5							2.5		
I-HEXANOIC ACID (MG/L)		0.1 UJ	0.1 UJ							0.1 UJ		
I-PENTANOIC ACID (MG/L)		0.07 UJ	0.07 UJ							0.07 UJ		
ISOBUTANE (NG/L)		25 UJ	10 J							25 UJ		
LACTIC ACID (MG/L)		0.06 J	0.033 J							0.034 J		
NITRITE/NITRATE-N (MG/L)		0.1 U	0.29							0.1 U		
PENTANOIC ACID (MG/L)		0.07 UJ	0.07 UJ							0.07 UJ		
PROPANE (NG/L)		6 J	15 J							25 UJ		
PROPIONIC ACID (MG/L)		0.07 UJ	0.07 UJ							0.07 UJ		
PROPYLENE (NG/L)		25 UJ	25 UJ							25 UJ		
PYRUVIC ACID (MG/L)		0.07 UJ	0.07 UJ							0.07 UJ		
SULFATE (MG/L)		17.8	348							778		
TOTAL INORGANIC CARBON (MG/L)		390	670							740		
TOTAL ORGANIC CARBON (MG/L)		5 U	1.5 J							1 J		
Field Parameters												
ALKALINITY (MG/L)		180	10 U							40		
CARBON DIOXIDE (MG/L)		12	25							35		
DISSOLVED OXYGEN (MG/L)		0.2	0.25							0.5		
DISSOLVED OXYGEN - METER (MG/L)	1.31	2.18	0.31	-0.04	0.26	0.01	0	0.28	0.49	1.38	6.75	1.33
FERROUS IRON (MG/L)		3.3 >	0.03	—						0.35		

TABLE C-5

COMPLETE GROUND WATER DATA SET
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01-23	01-24	01-25	01-26	01-27	01C01	01T02	01T03	01T04	01T05	01T06	01T07
SAMPLE	01GW2303	01GW2402	01GW2503	01GW2603	01GW2702	01GWC0103	01GWT0204	01GWT0302	01GWT0402	01GWT0502	01GWT0601	01GWT0701
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—	—	—	—	—	—	—
QC TYPE	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
SAMPLE DATE	1/20/2004	1/21/2004	1/21/2004	1/24/2004	1/23/2004	1/26/2004	1/24/2004	1/25/2004	1/25/2004	1/22/2004	1/23/2004	1/24/2004
HYDROGEN SULFIDE (H2S) (MG/L)		0	0							0		
MANGANESE+2 (MG/L)		1.5	0							9.5		
NITRITE-N (MG/L)		0.006	0							0.004		
OXIDATION REDUCTION POTENTIAL (MV)	-149	-90	52.7	34.4	-25.7	-10.8	38.3	40.9	-6.4	198	196	185
PH	7.6	7.1	7.05	6.82	7.14	7.95	5.76	7.29	7.8	5.73	6.18	6.25
SPECIFIC CONDUCTANCE (MS/CM)	1.305	0.313	1.032	1.111	0.775	0.337	2.299	0.562	0.287	1.044	1.178	1.238
SULFIDE (MG/L)		0.01	0.23							0		
TEMPERATURE (C)	7.72	9.75	11.58	10.51	8.75	5.31	6.94	8.21	8.73	6.55	8.16	7.82
TURBIDITY (NTU)	9.5	3.2	86.7	8	8.5	25	8.1	8.8	9.5	8.2	9.8	10

TABLE C-6

COMPLETE
SOIL DATA SET
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

LOCATION	01TP01	01TP01	01TP02	01TP04	01TP05	01TP06	01TP08
SAMPLE	01TP010607	01TP010607-D	01TP020506	01TP040607	01TP050607	01TP060506	01TP080506
MATRIX	SB	SB	SB	SB	SB	SB	SB
DEPTH RANGE	6 - 7	6 - 7	5 - 6	6 - 7	6 - 7	5 - 6	5 - 6
QC_TYPE	NM	FD	NM	NM	NM	NM	NM
SAMPLE DATE	1/14/2004	1/14/2004	1/14/2004	1/14/2004	1/15/2004	1/15/2004	1/15/2004
Volatile Organics (ug/kg)							
1,1,1,2-TETRACHLOROETHANE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
1,1,1-TRICHLOROETHANE	0.8 U	0.8 U	0.8 U	0.8 UJ	0.8 U	0.8 U	0.8 U
1,1,2,2-TETRACHLOROETHANE	2 U	2 U	24	2 UJ	2 U	2 U	20 J
1,1,2-TRICHLOROETHANE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
1,1-DICHLOROETHANE	0.9 U	0.9 U	0.9 U	0.9 UJ	0.9 U	1 U	0.9 U
1,1-DICHLOROETHENE	0.9 U	0.9 U	0.9 U	0.9 UJ	0.9 U	0.9 U	0.9 UJ
1,2,3-TRICHLOROPROPANE	1 U	2 U	2 U	2 UJ	2 U	2 U	2 U
1,2-DIBROMO-3-CHLOROPROPANE	3 U	3 U	3 U	3 UJ	3 U	3 U	3 U
1,2-DIBROMOETHANE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
1,2-DICHLOROETHANE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
1,2-DICHLOROPROPANE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
1,4-DIOXANE	100 UR	110 UR	110 UR	110 UR	97 UR	110 UR	110 UR
2-BUTANONE	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ
2-HEXANONE	4 U	4 U	4 U	4 UJ	4 U	4 U	4 U
3-CHLOROPROPENE	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ
4-METHYL-2-PENTANONE	2 U	2 U	2 U	2 UJ	2 U	2 U	2 U
ACETONE	56 J	24 U	41 J	27 U	26 U	17 U	26 U
ACETONITRILE	24 U	25 U	25 U	25 UJ	24 U	25 U	25 U
ACROLEIN	27 UR	28 UR	28 UR	28 UR	28 UR	29 UR	28 UR
ACRYLONITRILE	14 U	15 U	15 U	15 UJ	15 U	15 U	15 U
BENZENE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
BROMODICHLOROMETHANE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
BROMOFORM	2 U	2 U	2 U	2 UJ	2 U	2 U	2 U
BROMOMETHANE	2 U	2 U	2 U	2 UJ	2 U	2 U	2 U
CARBON DISULFIDE	3 J	3 J	1 U	1 UJ	1 U	1 J	1 U
CARBON TETRACHLORIDE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
CHLOROBENZENE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
CHLORODIBROMOMETHANE	2 U	2 U	2 U	2 UJ	2 U	2 U	2 U
CHLOROETHANE	5 U	6 U	6 U	6 UJ	5 U	6 U	6 U
CHLOROFORM	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U

COMPLETE
SOIL DATA SET
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA
PAGE 2 OF 2

LOCATION	01TP01	01TP01	01TP02	01TP04	01TP05	01TP06	01TP08
SAMPLE	01TP010607	01TP010607-D	01TP020506	01TP040607	01TP050607	01TP060506	01TP080506
MATRIX	SB	SB	SB	SB	SB	SB	SB
DEPTH RANGE	6 - 7	6 - 7	5 - 6	6 - 7	6 - 7	5 - 6	5 - 6
QC_TYPE	NM	FD	NM	NM	NM	NM	NM
SAMPLE DATE	1/14/2004	1/14/2004	1/14/2004	1/14/2004	1/15/2004	1/15/2004	1/15/2004
CHLOROMETHANE	2 U	2 U	2 U	2 UJ	2 U	2 U	2 U
CHLOROPRENE	3 UR	3 UR	3 UR	3 UR	3 UR	3 UR	3 UR
CIS-1,2-DICHLOROETHENE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
CIS-1,3-DICHLOROPROPENE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
DIBROMOMETHANE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
DICHLORODIFLUOROMETHANE	3 U	3 U	3 U	3 UJ	3 U	3 U	3 U
ETHYL METHACRYLATE	3 U	3 U	3 U	3 UJ	3 U	3 U	3 U
ETHYLBENZENE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
ISOBUTANOL	82 UR	86 UR	86 UR	85 UR	84 UR	87 UR	86 UR
METHACRYLONITRILE	18 U	19 U	19 U	19 UJ	18 U	19 U	19 U
METHYL IODIDE	4 UJ	4 UJ	4 UJ	4 UJ	4 UJ	4 UJ	4 UJ
METHYL METHACRYLATE	2 U	2 U	2 U	2 UJ	2 U	2 U	2 U
METHYLENE CHLORIDE	10 BU	2 BU	11 BU	2 BU	6 BU	5 BU	10 BU
PENTACHLOROETHANE	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U
PROPIONITRILE	25 UR	26 UR	26 UR	25 UR	25 UR	26 UR	26 UR
STYRENE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
TETRACHLOROETHENE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
TOLUENE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
TOTAL XYLENES	3 U	3 U	3 U	3 UJ	3 U	3 U	3 U
TRANS-1,2-DICHLOROETHENE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
TRANS-1,3-DICHLOROPROPENE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
TRANS-1,4-DICHLORO-2-BUTENE	2 UR	3 UR	3 UR	2 UR	2 UR	3 UR	3 UR
TRICHLOROETHENE	1 U	1 U	1 U	1 UJ	1 J	1 U	1 U
TRICHLOROFLUOROMETHANE	5 U	5 U	5 U	5 UJ	5 U	6 U	11
VINYL ACETATE	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
VINYL CHLORIDE	3 U	3 U	3 U	3 UJ	3 U	3 U	3 U

APPENDIX D

DATA QUALITY REVIEW

APPENDIX D

D.1 DATA QUALITY REVIEW

This appendix presents a detailed summary of the data quality review processes and conclusions regarding the usability of data for the recently collected CMS data. A similar discussion is presented in Section 3.0 of the RFI report (TtNUS, 2003) for the RFI Round 1 and Round 2 data.

D.1 DATA QUALITY REVIEW AND DATA REDUCTION METHODS

The data reviews began with field reviews and a detailed data validation, which is a comparison of data quality indicators (DQIs) against prescribed acceptance criteria. The DQIs used are measures to assess the bias and precision of the analytical calibrations and sample analyses. The output of this review was a set of alphabetic flags such as "U," "J," "R," or combinations thereof, that may have been assigned to individual results based on the validation effort. These flags were used to infer the general quality of the data. The data validation was followed by a summary of quantitative data quality measures to provide the user with a more quantitative estimate of any bias or imprecision associated with the data. Also evaluated were the measures of data completeness, sensitivity, comparability and representativeness.

Sections D.1.1 and D.1.2 provide an overview of the data validation process, Section D.1.3 presents an evaluation of the data quality beyond data validation, and Section D.1.4 describes various data reduction methods and special reviews that were undertaken to evaluate the MGBG data. Appendix C contains all the qualified data and the associated reasons for the data qualifications.

D.1.1 DATA VALIDATION PROCESS

Field analytical data and sampling location coordinates were reviewed both in the field and after completion of the field event to assure data users that the results were accurate. Calibration logs and QC check sample results were reviewed for accuracy. In addition, field data were reviewed for comparability among sampling locations and consistency with theoretical expectations. For example, low pH values would not be expected if alkalinity values were high. These evaluations were based, in part, on professional judgment. Well stabilization parameters were required to represent stable sampling conditions (manifested as reproducible measurements) prior to sample collection but were not required to compare well to field test kit results.

All of the results from analytical laboratory samples were validated according to several specifications. Assignment of data qualification flags for non-radiological data conformed to U.S. EPA Region 5 Standard Operating Procedures for Validation of Contract Laboratory Program Organic Data (U.S. EPA, 1993c) and Region 5 Standard Operating Procedures for Validation of Contract Laboratory Program Inorganic Data (U.S. EPA, 1993d); and the U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (U.S. EPA, 1994a) and U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (U.S. EPA, 1994b) to the greatest extent practicable for non-contract laboratory program data. Aside from field screening, radiological data were not generated during this field, hence data validation such as was conducted for non-radiological data, was not required.

Data validation specifications require that various data qualifiers be assigned when a deficiency is detected or when a result is less than its detection limit. If no qualifier is assigned to a result that has been validated, the data user is assured that no technical deficiencies were identified during validation. The qualification flags used are defined below:

U – Indicates that the chemical was not detected at the numerical detection limit (sample-specific detection limit) noted. Non-detected results from the laboratory are reported in this manner. This qualifier is also added to a positive result (reported by the laboratory) if the detected concentration is determined to be attributable to contamination introduced during field sampling or laboratory analysis.

UJ – Indicates that the chemical was not detected; however, the detection limit (sample-specific detection limit) is considered to be estimated based on problems encountered during laboratory analysis. The associated numerical detection limit is regarded as inaccurate or imprecise.

J – Indicates that the chemical was detected; however, the associated numerical result is not a precise representation of the concentration that is actually present in the sample. The laboratory reported concentration is considered to be an estimate of the true concentration.

UR – Indicates that the chemical may or may not be present. The non-detected analytical result reported by the laboratory is considered to be unreliable and unusable. This qualifier is applied in cases of gross technical deficiencies (i.e., holding times missed by a factor of two times the specified time limit, severe calibration non-compliances, and extremely low analyte recoveries).

R – Indicates that the chemical may or may not be present. The positive analytical result reported by the laboratory is considered to be unreliable and unusable. This qualifier is applied in cases of gross technical deficiencies.

BU - Indicates that an organic chemical was detected in this sample as well as the associated laboratory method blank, but has been qualified non-detected resultant of laboratory blank contamination (i.e., concentration was less than the blank action level).

BJ - Indicates that an organic chemical was detected in this sample as well as the associated method blank, and is considered estimated because the concentration is in excess of the blank action level.

The use of "B" qualifiers is a U.S. EPA Region 5-specific requirement.

The preceding data qualifiers may be categorized as indicative of major or minor problems. Major problems are defined as issues that result in the rejection of data and qualification with UR or R data validation qualifiers. These data were considered invalid and were not used for decision- making. Minor problems are defined as issues resulting in the estimation of data, and qualification with U, J, B, BJ, BU, and UJ data validation qualifiers. Estimated analytical results are considered to be suitable for decision-making purposes unless the data use requirements are very stringent and the qualifier indicates a deficiency that is incompatible with the intended data use. It is noteworthy that a U qualifier does not necessarily indicate that a data deficiency exists because all non-detect values are flagged with the U qualifier regardless of whether a quality deficiency has been detected.

In addition to qualifiers used to indicate real or potential data quality deficiencies, the ">" qualifier was used to indicate field results that exceeded the calibration range of the measuring system but could not be diluted. The only results affected in this manner were alkalinity (sample 01GW1103), ferrous iron (sample 01GW1003), manganous ion (sample 01GW1403), and sulfate (sample 01GWT0203). In addition, sulfide, hydrogen sulfide, manganous ion, and nitrite field test results that were less than the detection limit of the test kit were reported as zero ("0") rather than as a detection limit with a "U" qualifier flag.

D.1.2 DATA VALIDATION OUTPUTS

After data were validated, a list was developed of non-conformities requiring data qualifier flags that were used to alert the data user to inaccurate or imprecise data. For situations in which several QC criteria were out of specification, the data validator made professional judgements and /or comments on the validity of the overall data package. The reviewer then prepared a technical memorandum presenting qualification of the data, if necessary, and the rationale for making such qualifications. The net result was a data package that had been carefully reviewed for its adherence to prescribed technical requirements.

Validators incorporated data qualifiers into the electronic database and submitted the information to the data management group. A complete printout of the data with validation flags is presented in Appendix E. Pertinent quality estimates are summarized in a more quantitative format in the following section.

D.1.3 GENERAL DATA QUALITY REVIEW

DQIs are parameters that are monitored to help establish the quality of data generated during an investigation. Some of the DQIs are generated from analysis of field samples (e.g., field duplicates) and some are generated from the analysis of laboratory samples (e.g., laboratory duplicates). Individually, field and laboratory DQIs provide measures of the performance of the respective investigative operations (field or laboratory). During data validation, individual QC results were evaluated. If individual QC results were acceptable, no validation flag was assigned to an analytical result, otherwise a flag indicating the type of QC deficiency was assigned to the result. The data quality review provided in this section, which was implemented after the data validation process was completed, is not designed to identify data that are acceptable or unacceptable according to data QC criteria. Instead, it is designed to provide an overall quantitative measure of analytical performance not provided by data validation. Taken together, the DQIs provide a measure of overall analytical performance.

The data for the MGBG was of generally acceptable quality with the exception of 1,4-dioxane, acetone, acrolein, acrylonitrile, chloroprene, isobutanol, methacrylonitrile, propionitrile, and trans-1,4-dichloro-2-butene. The results for these compounds constitute the majority of results rejected for the volatile analyses. These rejections occurred primarily because these compounds yielded poor analytical responses. This is a systematic problem that occurs for one or more of these compounds in the majority of the samples analyzed from the MGBG. The poor analytical responses for these compounds was known in advance of the field effort but was considered to be inconsequential because these compounds are not chlorinated organic solvents and the COCs for the MGBG CMS are chlorinated organic solvents. Therefore, rejection of thee results has no adverse effect on attainment of project objectives.

In addition to the almost universal rejection of the compounds identified above, virtually an entire set of sample results was rejected for sample 01GW0203. The reasons and the corrective action taken to mitigate this problem are described in Section D.1.3.1.3.

The various DQIs are discussed in detail below. In addition to the DQIs discussed below, temperature blanks that accompanied each cooler containing samples were used to assess whether the samples had been stored at the appropriate temperature during shipping. All temperature blanks fell within the acceptance range of 4°C ± 2°C, indicating no deficiencies with regard to shipping temperature.

Each section below addresses data quality for a particular DQI for samples of a given matrix (solid or aqueous) and analytical fraction (e.g., VOCs).

D.1.3.1 Completeness

Completeness is a measure of the number of valid samples or measurements that are available relative to the number of samples or measurements that were intended to be generated. For this project, completeness was measured on three different bases: samples collected, field measurements, and laboratory measurements.

- Sample completeness was a measure of the usable samples collected as compared to those intended to be collected.
- Field measurement completeness was a measure of the usable field measurements made relative to those intended to be made.
- Laboratory measurement completeness was a measure of the amount of usable, valid laboratory measurements per matrix obtained for each target analyte.

Usable, valid samples (or results) were those judged, after data assessment, to represent the sampling populations and to have not been disqualified for use through data validation or additional data review. The total number of samples (or results) planned to be collected or generated are those listed in the MGBG QAPP (TtNUS, 2001b) for sampling round 1 (Round 1), and the MGBG SAP (TtNUS, 2002b) for sampling round 2 (Round 2). Completeness was determined using the following equation:

$$\%C = \frac{V}{T} \times 100$$

where	%C	=	percent completeness
	V	=	number of samples (or results) determined to be valid
	T	=	total number of planned samples (or results)

Discretionary samples and provisional wells were not included in the estimates of total planned samples.

D.1.3.1.1 Sample Completeness

Table D-1 compares the samples collected to the samples proposed. For the ground water percent completeness, the number of wells sampled was compared to the number of wells intended to be sampled (excluding four proposed provisional wells). The percent completeness shown in Table D-1 for ground water VOCs is 97% because well 01-16 could not be sampled. This well, which is chronically dry, was nearly dry at the time of sample collection. There is no adverse effect from not sampling this well because it is located in the interior of the well field and the missing data can be inferred from the data from surrounding wells.

No VOCs were detected through field screening so the default number (six) of soil samples was collected for VOC analysis. No gamma screening results yielded concentrations greater than two times the mean daily background level so collection of soil samples, which was not required under these conditions, did not occur.

D.1.3.1.2 Field Measurement Completeness

Field measurement completeness is a measure of the amount of valid field measurements obtained from all the field measurements taken in the project. Field measurements for Round 3 comprised only well stabilization parameters, VOC screening of test pit soils, gross gamma screening of test pit soils, and land surveying coordinates. The percent completeness for field measurements was 100%.

D.1.3.1.3 Laboratory Measurement Completeness

Under ideal conditions, the laboratory completeness objective would be 100 percent. However, samples can be rendered unusable during shipping and preparation (e.g., bottles broken or extracts accidentally destroyed) or analysis (e.g., loss of instrument sensitivity, strong matrix effects). Laboratory completeness objectives were 90 percent for each critical target analyte per sample matrix. It is possible for individual analytes to exhibit very low completeness values while achieving the overall completeness goals on the basis of analytical fraction. This occurred in a few cases and is discussed in more detail below for the affected analytes and fractions.

All of the planned hardness results were generated by Pace Analytical rather than in the field during sample collection. No adjustments to completeness calculations have been made.

Table D-2 presents the percent completeness among analytical fractions for solid samples and aqueous samples. Table D-2 also shows the number of valid results generated per analyte for each fraction. Table D-3 lists all the rejected (i.e., invalid) data and the reasons for the rejections.

For all but VOCs, the percent completeness is 100% on a per analyte basis. The calculated percent completeness for all analytes is 89.3 for VOCs in soil samples and 81.8 for VOCs in ground water samples. Both of these percentages are less than the 90 percent completeness target established in the MGBG QAPP (TtNUS, 2004). The VOC rejections that led to this low percentage were due primarily to of poor calibration sensitivities of 1,4-dioxane, acetone, acrolein, acrylonitrile, chloroprene, isobutanol, methacrylonitrile, propionitrile, and trans-1,4-dichloro-2-butene. This had no detrimental effect on the data use because chlorinate organic solvents are the COCs for this CMS. For ground water, another major factor in the percent completeness goals was the rejection of the VOC data for sample 01GW0203.

The values presented in Table D-2 also reflect the rejection of most of the VOC results for sample 01GW0203. This sample and its duplicate (01GW0203-D) were collected from well 01-02. During validation, the dilution factors for the VOC results of these two samples were noted to be different. The original sample was undiluted and had no detectable concentrations of VOCs whereas the duplicate sample required a 4-fold dilution and had moderate concentrations of select VOCs. This prompted an investigation to determine why the results were so different for essentially the same sample analysis and, if an error had occurred, whether the cause could have affected other samples. Though the discrepancy was detected after holding times had expired, the laboratory analyzed the remaining quantities of the original and duplicate samples to determine whether the results could yield insight into whether the original or duplicate samples result was the correct result. The re-analyses of both the original and duplicate sample agreed with the first analysis of the duplicate sample. In the interim, the laboratory had concluded that the original analysis of sample 01GW0203 was evidently a different sample (probably from another client) but they could not prove this. The results for the initial duplicate result and the re-analyses were within 10% of the mean for all three results. Therefore, it was concluded that the original sample VOC results were incorrect (although the root cause was not definitively identified) and the re-analysis results of sample 01GW0203 were used to represent that sample. The results for sample 01GW0203-D were unaffected by the apparent mix-up of samples when analyzing sample 01GW0203. A detailed comparison of detected VOCs for the time period from 2001 to 2004 is provided in Table 2-2. The close agreement between original and duplicate sample results can be viewed in that table.

The final outcome of these investigations was that all non-detect values for sample 01GW0203 were qualified as UR (non-detected and rejected) and the detectable concentrations were qualified as "J"

(estimated). One final comparison was then made between the results for the duplicate sample and the results for VOCs from well 01-02 obtained in the previous sampling round. These results were very consistent, thus validating the use of the duplicate sample re-analysis results for that chemical.

Another analytical process problem that occurred but did not adversely affect the data use was an apparent mix-up in the calibration verification file name for sample delivery group 53792. This group contained all of the test pit samples and the associated field and laboratory QC. During the laboratory's internal review the reviewer discovered that an incorrect data file had been evaluated as the continuing calibration verification. The correct continuing calibration file was then determined to have failed the applicable QC criteria. The laboratory was requested to analyze the remaining unused sample aliquots that were still stored in the EnCore samplers to verify whether the original results were acceptable. The re-analyses were conducted after the holding times had expired for these samples. The laboratory was also asked to re-evaluate the calibration by using the laboratory control standard (LCS) as the continuing calibration check. Results for some compounds were rejected for reason unrelated to this calibration verification problem. The re-analyses under a valid calibration were consistent with the original results. The original results for the LCS and LCS duplicate were also within QC acceptance criteria with four minor exceptions. These re-analysis and verifications confirmed that the quality of the original data was not compromised except for those data that were qualified for other reasons.

D.1.3.2 Sensitivity

A comparison of the observed minimum and maximum non-detect values for laboratory analyses to the targeted limits contained in Table 1-4 of the MGBG QAPP Addendum (TtNUS, 2004) is presented in Table D-4.. Observed exceedances of the target laboratory reporting limits occurred in several instances. At the outset of the project, it was known that the concentrations of several chemicals could not be measured at the desired MDLs. These MDLs were driven by previously selected risk-based target levels (RBTLs) that are not as important for the CMS as they are for the RFI because cleanup goals that most heavily influence CMS remedy evaluations are typically greater than RBTLs. For example, the target MDL for 1,1,2,2-tetrachloroethane is 0.2 ug/L yet the cleanup goal for this compound is greater than 0.3 ug/L. The maximum observed non-detect value was 0.3 ug/L. In addition, the analytical methods selected are standard methods used throughout the industry and were selected to be consistent with the same analytical methods used in previous sampling rounds so as to maintain data comparability. Development of methods with greater sensitivity was not feasible nor was it required for the chemicals of primary interest (i.e., chlorinated VOCs).

D.1.3.3 Laboratory Precision

Precision is a measure of the degree to which two or more measurements are in agreement and describes the reproducibility of measurements of the same parameter for samples analyzed under similar conditions.

Precision for chemical parameters is expressed as a Relative Percent Difference (RPD), which is defined as the ratio of the difference to the mean for the two values being evaluated. RPDs, typically expressed as percentages, are used to evaluate both field and laboratory duplicate precision and are calculated as follows:

$$RPD = \frac{|V1 - V2|}{(V1 + V2)/2} \times 100$$

where RPD = relative percent difference
V1, V2 = two results obtained by analyzing duplicate samples

The precision estimates obtained from duplicate field samples encompass the combined uncertainty associated with sample collection, homogenization, splitting, handling, laboratory and field storage (as applicable), preparation for analysis, and analysis. In contrast, precision estimates obtained from analyzing duplicate laboratory samples incorporate only homogenization, subsampling, preparation for analysis, laboratory storage (if applicable), and analysis uncertainties.

Field duplicates for MGBG test pit soils were collected as a single sample that was sampled in duplicate for VOCs, homogenized, split into two portions, and placed into separate sample bottles for the non-VOC analyses. Each sample bottle was assigned a unique nomenclature so as to be "blind" to the laboratory. Field duplicates were collected during a single act of sampling and were analyzed for chemical and radiological constituents to measure the precision of the sampling and analysis program, as well as the natural sample heterogeneity.

Field duplicates were collected at a rate of one duplicate per 10 environmental samples. One field duplicate was collected for the 6 test pit soil samples. Five field duplicates were collected for the 33 ground water samples. Therefore, the 10 percent frequency criterion for field duplicates specified in the MGBG QAPP (TtNUS, 2001b) was exceeded.

Laboratory precision QC samples [i.e., laboratory duplicates for inorganic chemicals and LCS/LCSD and matrix spike (MS) / matrix spike duplicate (MSD) samples for organic chemicals] were scheduled to be analyzed at a rate of one QC sample per 20 environmental samples. This 5 percent rate as specified in the MGBG QAPP Addendum (TtNUS, 2004) was achieved for all fractions. Laboratory precision was assessed by comparing calculated RPD values to precision control limits specified in the MGBG QAPP Addendum (TtNUS, 2004).

An RPD value greater than 50 percent for solid matrices and 30 percent for aqueous matrices is not common, although they are occasionally observed. In addition, such values are often overshadowed by the variability observed across site samples that are combined when evaluating uncertainty in site concentrations. Unless otherwise specified, RPD values cited in the discussions below refer to individual RPDs of a single pair of original and duplicate samples. A value of zero for individual RPD values indicates perfect repeatability.

Precision for All Samples in Soil and Water

VOCs were the only analytes measured in both soil and ground water; all others were measured in ground water only. Table D-5 presents the precision estimates in terms of relative percent difference for this project. No precision estimates were computed for pH because the pH measurement scale is logarithmic and RPD does not have the same meaning on that scale as it does for parameters measured on linear scales. If other parameters do not appear in Table D-5 it is because one or both of the replicate samples in a pair did not have a quantifiable concentration and an RPD value could not be computed. Blank spaces in Table D-5 also indicate that one or the other of the original or duplicate sample of a pair was a non-detect and an RPD value could not be computed.

Laboratory duplicate samples were not analyzed for the parameters determined in this field campaign. Instead, MS/MSDs, LCS/LCDs or field duplicate samples were used to estimate precision. Field duplicates were also analyzed, although most analyte concentrations in the field duplicate samples were less than the detection limits, so there were very few results for which precision estimates could be computed.

Several RPD values are equal to zero. This is frequently an artifact of the laboratory rounding the results to one or two significant figures so that the difference between original and duplicate sample concentrations or percent recoveries rounded to zero. This rounding obscured some of the slight variations in concentration between original and duplicate samples but it did not prevent an assessment of precision.

The minimum and maximum RPD values for some analytes appear to be identical. In those cases, one of two situations occurred. Either just one original and one duplicate sample was analyzed or, even though multiple duplicate pairs of samples were analyzed, only one duplicate pair yielded detectable concentrations in both samples.

Except for tetrachloroethene and chloroform (67.7 RPD) for the field duplicate samples, the precision estimates were generally within expectations (≤30% for ground water and ≤50% for soil) or the affected analytes are not COCs. RPD values that fall outside of these expected ranges are shaded in Table D-5. The poor precision observed for chloroform and tetrachloroethene is a consequence of the measured values (1 to 2 ug/L) being close to the detection limits and being reported to only one significant figure. Hence, the imprecision is not viewed to be significant. The imprecision associated with the field duplicates for organic gases and hydrogen is not explained as easily, and could reflect the difficulty with which sample collection can be replicated for these parameters. The limited amount of available data renders a complete assessment of this impossible. Nevertheless, the results are usable to evaluate natural attenuation of the chlorinated organic chemicals. As is shown in Section 2.2 the overall variability of these parameters across the site is greater than the replicate sample imprecision.

Special note is made in Section D.1.3.1.3 of the discrepancy between VOC results for sample 01GW0203 and its field duplicate. The details are not re-iterated here. It is noteworthy, however, that the observed lack of agreement described in that section caused an investigation that led to corrective action sufficient to mitigate the problem.

D.1.3.4 Laboratory Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy measurements are designed to detect biases resulting from sample handling and analysis. This parameter is assessed by measuring spiked samples (e.g., MSs) or well-characterized samples of certified analyte concentrations (e.g., LCSs) and by measuring blanks.

Accuracy requirements for field measurements are typically ensured through control over the sample collection and handling and through routine instrument calibration. Field accuracies were monitored through the use of blanks to detect cross-contamination and by monitoring adherence to procedures that prevent sample contamination or degradation. Source blanks were collected from analyte-free water and potable water sources to assess the water sources used for decontaminating sampling equipment. Equipment rinsate blanks were collected for this investigation to assess cross-contamination via sample

collection equipment. These blanks were obtained under representative field conditions by collecting the rinse water generated by running analyte-free water through sample collection equipment after decontamination and before use. Rinsate blanks were obtained for each type of sampling equipment. Where pre-cleaned, dedicated sampling equipment was used, one rinsate blank was collected as a "batch blank". Rinsate blanks were analyzed for the same chemical constituents as the associated environmental samples. Accuracy was also assured qualitatively through adherence to all sample handling and preservation requirements. Holding time requirements were not adhered to for several parameters in several samples and the associated data were appropriately qualified during data validation.

Accuracy in the laboratory is measured through the comparison of a spiked sample or LCS result to a known or calculated value and is expressed as a percent recovery (%R). It was also assessed by monitoring the analytical recovery of select surrogate compounds added to samples that are analyzed by organic chromatographic methods. LCSs were used to assess the accuracy of laboratory operations with minimal sample matrix effects. MS and surrogate compound analyses measure the combined accuracy effects of the sample matrix, sample preparation, and sample measurement. Spiking concentrations equaled or approximated the default concentrations detailed in the applicable sample preparation or analysis SOPs. LCS and MS analyses were performed more frequently than the prescribed one per 20 associated samples of like matrix (TtNUS, 2004). Laboratory accuracy was assessed by comparing calculated %R values to accuracy control limits specified in the MGBG QAPP (TtNUS, 2004).

Percent recovery is calculated using the following equation:

$$\%R = \frac{Ss - So}{S} \times 100$$

where	%R	=	percent recovery
	Ss	=	result of spiked sample
	So	=	result of non-spiked sample
	S	=	concentration of spiked amount.

Absence of bias is represented as a recovery of 100 percent. Mean recovery values less than 100 percent indicate a low bias, and recovery values greater than 100 percent indicate a high bias. Because measurement uncertainty exists in all bias estimates, a bias is not considered to be significant unless it falls outside the range of 100 percent ± 25 percent. The more extreme the bias value, the more significant the bias.

Unless otherwise specified, each percent R value cited in the discussions below refers to an individual percent R value. When appropriate, mean or average percent R values are also discussed. Data qualifiers assigned during data validation because of non-compliant bias indicators are presented in Appendix C.

Accuracy for All Analytes in Soil and Ground Water

Percent recovery data are presented in Table D-6. Blank spaces in the table indicate that there are no data for that combination of parameter and QC type.

Most of the target analyte recoveries across all soil and ground water LCS, LCSD, MS, and MSD samples ranged from 75 percent to 125 percent. Exceptions are highlighted in the table. The most extreme recovery values were associated with analytes (i.e., 1,4-dioxane, acetonitrile, acrolein, acrylonitrile, isobutanol, methacrylonitrile, proprionitrile) whose results were generally rejected because of poor calibration response. This has no detrimental effect on the attainment of project objectives. Because the remaining exceptions were either not COCs or the percent recoveries were not far outside the 75 to 100 percent range, the highlighted values are of little consequence to this CMS.

The only potentially significant exceptions to the inconsequential accuracy problems are represented by the MS/MSD recoveries for 1,1,2-trichloroethane, 1,2-dichloroethane, chloroform, and cis-1,2-dichloroethene. The recoveries for these MS and MSD samples were all high. This indicates a high bias for these compounds. Not enough matrix spike samples are available to estimate the degree of bias. It should be borne in mind that bias can vary with concentration.

D.1.3.5 Comparability

Comparability is defined as the confidence with which one data set can be compared with another (e.g., among sampling points and among sampling events). Comparability was achieved by using standardized sampling and analysis methods, as well as standardized data reporting formats. Comparability of field data was ensured by following the MGBG QAPP Addendum No. 1 and the associated SOPs (TtNUS, 2004). Comparability of laboratory measurements was achieved primarily through the use and documentation of standard sampling and analytical methods. The methods used for VOC analyses were the same as for the previous two sampling rounds. Several natural attenuation parameters added for this sampling round (Round 3) were analyzed by another laboratory. Results were reported in units that ensured comparability

with previous data and with current state and federal standards and guidelines. One noteworthy usage of measurement units is the use of nanoMolar (nM) for dissolved hydrogen concentrations rathern than mass units such as ug/L. However, because the molecular weight of hydrogen is 1 gram-atom/mole, the units of nM translate directly to ng/L (i.e., 1 nM = 1ng/L). Comparability of laboratory measurements was assessed primarily through the use of QC samples and through adherence to the QA plan. No comparability problems were detected.

The laboratory analyzed various QC samples along with the environmental samples to allow data users to assess the quality of the data. Tables D-7 and D-8 show the rates of data qualification that resulted from application of the data validation process for aqueous and solid samples, respectively. Quantitative summaries of precision and accuracy are provided in Sections D.1.3.3 and D.1.3.4, respectively.

The issue of comparability can be very important when comparing data sets that were generated at different times or at different laboratories. For this project, both conditions exist. The MGBG RFI data for this investigation were generated in 2001 and 2002 by Southwest Laboratory of Oklahoma and more recently in this latest sampling round by Pace Analytical. Pace Analyticla purchased Wouthwest Laboratory of Oklahoma in October 2003, but the facility and personnel were essentially unchanged after the purchase. The historical data set spans a seven-year period from 1980 to 1986, and the laboratory data quality are unknown for that time period. Despite these various time frames for data generation, no differences have been detected that would indicate the inability to compare data, at least qualitatively. Potentially different laboratory biases and analytical limitations and improvements over the past 20 years were considered when interpreting the data quantitatively for this project.

D.1.3.6 Representativeness

Representativeness is an expression of the degree to which data accurately and precisely depict the actual characteristics of a population or environmental condition existing at an individual sampling point and is contingent on a good design for the sampling program. All previously installed wells were sampled dring this data collection effort to obtain as complete an representative a view of current site conditions as possible to support the evaluation of remedial alternatives.

The soil samples collected from test pits were designed to represent the most contaminated soil from each pit. Only one sample was planned for collection in each of six pits because the previous data had indicated that there was not much chance of encountering contaminated soils. The field measurements yielded no detectable concentrations of VOCs so only one sample was collected form the bottom of each

pit in areas that were judged to best represent the extent and location of one or more VOC source areas within and near to the Primary Burial Area (PBA).

The new wells (01T06 and 01T07) were installed in locations designated to represent contaminants that could have migrated from the PBA in shallow ground water. These locations were also designated to narrow the location of the most contaminated portion of the ground water VOC plume and to fill data gaps in the ground water elevation gradients. Although, the primary interest has historically and continues to be VOC contamination in ground water, deeper wells were also monitored to ensure that contamination is not migrated deeper into bedrock.

The project planning document (MGBG QAPP Addendum No. 1) and the use of standardized sampling, handling, analytical, and reporting procedures were designed so that the final data would be accurate representations of actual site conditions. Few deviations were noted from the prescribed procedures and governing documents. These deviations, described in Section 2.0, have been evaluated for their impact on the ability to achieve project objectives. It is believed that all reported data are adequately representative of site conditions.

D.2 Evaluation of Dramatic Concentration Change for Chlorinated Volatile Compounds

Concentrations of select VOCs at well 01-02 decreased from tens of thousands of µg/L in 2001 to tens of µg/L in 2002. This was cause for concern because this magnitude of concentration change was not expected during a one-year period. Past VOC concentration data had also exhibited wide fluctuations, but those data were of unknown quality and it was not clear that the observed temporal fluctuations were real. A comparison of data for the three most recent sampling rounds spanning the period of 2001 to 1004 are presented in Table 2-2.

The 2002 raw laboratory data were reviewed, and the laboratory was asked to re-analyze the 2002 sample from well 01-02 even though the holding time had been exceeded. The laboratory re-analyzed each of the remaining three VOC sample vials for sample 01GW0202 collected from well 01-02. This re-analyses confirmed the original 2002 results of approximately 30 µg/L for TCE and approximately 20 µg/L for 1,1,2,2-PCA. These values differ significantly from the year 2001 results, but the year 2001 results are consistent with most previous results. Based on the data reviews, the observed historical fluctuations have been confirmed for ground water VOCs. The recent data confirm again these low concentration values for this one well that historically had yielded much greater VOC concentrations.

There is no reason to expect that a sampling error occurred; therefore, the measured concentrations in years 2001 and 2002 are believed to accurately represent ground water concentrations from well 01-02 at the time of sampling. Graphs showing some of the observed temporal variations are presented in Section 6.0.

APPENDIX D. 2

LABORATORY CLOSURE NOTIFICATION

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TABLE D-1

SUMMARY OF SAMPLES COLLECTED VERSUS SAMPLES PROPOSED (TALLIED BY ANALYTICAL FRACTION)
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample Type	Volatiles SW-846/8260B	Laboratory MNA Parameters									Field MNA Parameters[3]
		Nitrate + Nitrite (as N)	Chloride	Sulfate	Total Hardness (as CaCO3)	Dissolved Organic Gases[2]	Dissolved Hydrogen	Total Organic Carbon	Total Inorganic Carbon	Volatile Fatty Acids	
GW Samples Collected	33	11	11	11	11	11	11	11	11	11	11
GW Samples Planned for Collection	34	11	11	11	11	11	11	11	11	11	11
Percent GW Samples Collected	**97**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
GW Field Duplicates Collected	5	1	1	1	1	1	1	1	1	1	1
GW Field Duplicates Planned	4	1	1	1	1	1	1	1	1	1	1
Percent GW Field Duplicates Collected[4]	**125**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Ground Water Trip Blanks Collected[5]	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rinsate Blanks Collected[6]	3	1	1	1	1	NA	NA	1	1	1	NA
Source Water Blanks Collected	1	1	1	1	1	NA	NA	1	1	1	NA
Soil Samples Collected	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Soil Samples Planned for Collection	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Percent Soil Samples Collected	100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Soil Field Duplicates Collected	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Soil Field Duplicates Planned	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Percent Soil Field Duplicates Collected[4]	100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trip Blanks Collected for Soil Samples[5]	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

1 See Table 1-4 of the QAPP Addendum No. 1 for specific analysis requirements and analyte lists.

2 Dissolved organic gases included acetylene, i-butane, n-butane, ethane, ethene, methane, propane, and propene.

3 Monitored Natural Attenuation (MNA) parameters included field measurements of dissolved oxygen, alkalinity, carbon dioxide, nitrite (as N), iron (+2), manganese (+2), sulfide, and hydrogen sulfide (SOP CTO315-16). Hardness, which ws originally planned for field determination was measured in the laboratory instead.

4 Field duplicates were scheduled to be collected at a frequency of 1 per every 10 samples.

5 Trip blanks were submitted for analysis at a frequency of one per cooler containing samples for volatile analysis. Because the number of sample coolers shipped is not known in advance, there was no target number of trip blanks.

6 Rinsate blanks were scheduled to be collected at a frequency of 1 per every 10 samples of any matrix, with a minimum of one per day of sampling per sampling device or instrument. This criterion was not met because only three to four wells coujld be sampels on a given day and collecting one rinsate blank every day of sampling wopuld have increased the QC frequency to an unacceptably high rate.

GW = Ground water MNA - Monitored natural attenuation. NA - Not applicable.

TABLE D-2

NUMBER OF VALID RESULTS COMPARED TO TOTAL NUMBER OF RESULTS FOR EACH PARAMETER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample Matrix	Analytical Fraction	Parameter	Valid/Total	Percent Complete
GW	Chloride and Sulfate	CHLORIDE	11/11	100.0
		SULFATE	11/11	100.0
	Organic Gases	ACETYLENE	11/11	100.0
		ETHANE	11/11	100.0
		ETHENE	11/11	100.0
		ISOBUTANE	11/11	100.0
		METHANE	11/11	100.0
		n-BUTANE	11/11	100.0
		PROPANE	11/11	100.0
	Volatile Fatty Acids	PROPENE	11/11	100.0
		ACETIC ACID	11/11	100.0
		BUTANOIC ACID	11/11	100.0
		HEXANOIC ACID	11/11	100.0
		I-HEXANOIC ACID	11/11	100.0
		I-PENTANOIC ACID	11/11	100.0
		LACTIC ACID	11/11	100.0
		PENTANOIC ACID	11/11	100.0
		PROPIONIC ACID	11/11	100.0
	Hydrogen	PYRUVIC ACID	11/11	100.0
	Hardness	HYDROGEN	11/11	100.0
	Nitrate/Nitrite	HARDNESS	11/11	100.0
	Volatile Organic Compounds	NITRITE/NITRATE-N	11/11	100.0
		1,1,1,2-TETRACHLOROETHANE	32/33	97.0
		1,1,1-TRICHLOROETHANE	32/33	97.0
		1,1,2,2-TETRACHLOROETHANE	33/33	100.0
		1,1,2-TRICHLOROETHANE	33/33	100.0
		1,1-DICHLOROETHANE	32/33	97.0
		1,1-DICHLOROETHENE	32/33	97.0
		1,2,3-TRICHLOROPROPANE	32/33	97.0
		1,2-DIBROMO-3-CHLOROPROPANE	32/33	97.0
		1,2-DIBROMOETHANE	32/33	97.0
		1,2-DICHLOROETHANE	32/33	97.0
		1,2-DICHLOROPROPANE	32/33	97.0
		1,4-DIOXANE	0/33	0.0
		2-BUTANONE	32/33	97.0
		2-HEXANONE	32/33	97.0
		3-CHLOROPROPENE	32/33	97.0
		4-METHYL-2-PENTANONE	32/33	97.0
		ACETONE	3/33	0.09
		ACETONITRILE	32/33	97.0
		ACROLEIN	0/33	0.0
		ACRYLONITRILE	0/33	0.0
		BENZENE	32/33	97.0
		BROMODICHLOROMETHANE	32/33	97.0
		BROMOFORM	32/33	97.0
		BROMOMETHANE	32/33	97.0
		CARBON DISULFIDE	32/33	97.0

TABLE D-2

NUMBER OF VALID RESULTS COMPARED TO TOTAL NUMBER OF RESULTS FOR EACH PARAMETER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample Matrix	Analytical Fraction	Parameter	Valid/Total	Percent Complete
		CARBON TETRACHLORIDE	32/33	97.0
		CHLOROBENZENE	32/33	97.0
		CHLORODIBROMOMETHANE	32/33	97.0
		CHLOROETHANE	32/33	97.0
		CHLOROFORM	33/33	100.0
		CHLOROMETHANE	32/33	97.0
		CHLOROPRENE	0/33	0.0
		CIS-1,2-DICHLOROETHENE	32/33	97.0
		CIS-1,3-DICHLOROPROPENE	32/33	97.0
		DIBROMOMETHANE	32/33	97.0
		DICHLORODIFLUOROMETHANE	32/33	97.0
		ETHYL METHACRYLATE	32/33	97.0
		ETHYLBENZENE	32/33	97.0
		ISOBUTANOL	0/33	0.0
		METHACRYLONITRILE	0/33	0.0
		METHYL IODIDE	32/33	97.0
		METHYL METHACRYLATE	32/33	97.0
		METHYLENE CHLORIDE	32/33	97.0
		PENTACHLOROETHANE	32/33	97.0
		PROPIONITRILE	0/33	0.0
		STYRENE	33/33	100.0
		TETRACHLOROETHENE	33/33	100.0
		TOLUENE	32/33	97.0
		TOTAL XYLENES	32/33	97.0
		TRANS-1,2-DICHLOROETHENE	32/33	97.0
		TRANS-1,3-DICHLOROPROPENE	32/33	97.0
		TRANS-1,4-DICHLORO-2-BUTENE	0/33	0.0
		TRICHLOROETHENE	33/33	100.0
		TRICHLOROFLUOROMETHANE	32/33	97.0
		VINYL ACETATE	32/33	97.0
	Total Inorganic Carbon	VINYL CHLORIDE	32/33	97.0
	Total Organic Carbon	TOTAL INORGANIC CARBON	11/11	100.0
SB	Volatile Organic Compounds	TOTAL ORGANIC CARBON	11/11	100.0
		1,1,1,2-TETRACHLOROETHANE	6/6	100.0
		1,1,1-TRICHLOROETHANE	6/6	100.0
		1,1,2,2-TETRACHLOROETHANE	6/6	100.0
		1,1,2-TRICHLOROETHANE	6/6	100.0
		1,1-DICHLOROETHANE	6/6	100.0
		1,1-DICHLOROETHENE	6/6	100.0
		1,2,3-TRICHLOROPROPANE	6/6	100.0
		1,2-DIBROMO-3-CHLOROPROPANE	6/6	100.0
		1,2-DIBROMOETHANE	6/6	100.0
		1,2-DICHLOROETHANE	6/6	100.0
		1,2-DICHLOROPROPANE	6/6	100.0
		1,4-DIOXANE	0/6	0.0
		2-BUTANONE	6/6	100.0
		2-HEXANONE	6/6	100.0

TABLE D-2

NUMBER OF VALID RESULTS COMPARED TO TOTAL NUMBER OF RESULTS FOR EACH PARAMETER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample Matrix	Analytical Fraction	Parameter	Valid/Total	Percent Complete
		3-CHLOROPROPENE	6/6	100.0
		4-METHYL-2-PENTANONE	6/6	100.0
		ACETONE	6/6	100.0
		ACETONITRILE	6/6	100.0
		ACROLEIN	0/6	0.0
		ACRYLONITRILE	6/6	100.0
		BENZENE	6/6	100.0
		BROMODICHLOROMETHANE	6/6	100.0
		BROMOFORM	6/6	100.0
		BROMOMETHANE	6/6	100.0
		CARBON DISULFIDE	6/6	100.0
		CARBON TETRACHLORIDE	6/6	100.0
		CHLOROBENZENE	6/6	100.0
		CHLORODIBROMOMETHANE	6/6	100.0
		CHLOROETHANE	6/6	100.0
		CHLOROFORM	6/6	100.0
		CHLOROMETHANE	6/6	100.0
		CHLOROPRENE	0/6	0.0
		CIS-1,2-DICHLOROETHENE	6/6	100.0
		CIS-1,3-DICHLOROPROPENE	6/6	100.0
		DIBROMOMETHANE	6/6	100.0
		DICHLORODIFLUOROMETHANE	6/6	100.0
		ETHYL METHACRYLATE	6/6	100.0
		ETHYLBENZENE	6/6	100.0
		ISOBUTANOL	0/6	0.0
		METHACRYLONITRILE	6/6	100.0
		METHYL IODIDE	6/6	100.0
		METHYL METHACRYLATE	6/6	100.0
		METHYLENE CHLORIDE	6/6	100.0
		PENTACHLOROETHANE	6/6	100.0
		PROPIONITRILE	0/6	0.0
		STYRENE	6/6	100.0
		TETRACHLOROETHENE	6/6	100.0
		TOLUENE	6/6	100.0
		TOTAL XYLENES	6/6	100.0
		TRANS-1,2-DICHLOROETHENE	6/6	100.0
		TRANS-1,3-DICHLOROPROPENE	6/6	100.0
		TRANS-1,4-DICHLORO-2-BUTENE	0/6	0.0
		TRICHLOROETHENE	6/6	100.0
		TRICHLOROFLUOROMETHANE	6/6	100.0
		VINYL ACETATE	6/6	100.0
		VINYL CHLORIDE	6/6	100.0
			Overall	**87.6**
			Soil	**89.3**
			Aqueous	**81.8**

TABLE D-3

REJECTED RESULTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample No.	Parameter	Validation Qualifier	Qualifier Code
01GW0103	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW0203	1,1,1,2-TETRACHLOROETHANE	UR	H
	1,1,1-TRICHLOROETHANE	UR	H
	1,1-DICHLOROETHANE	UR	H
	1,1-DICHLOROETHENE	UR	H
	1,2,3-TRICHLOROPROPANE	UR	H
	1,2-DIBROMO-3-CHLOROPROPANE	UR	H
	1,2-DIBROMOETHANE	UR	H
	1,2-DICHLOROETHANE	UR	H
	1,2-DICHLOROPROPANE	UR	H
	1,4-DIOXANE	UR	CH
	2-BUTANONE	UR	H
	2-HEXANONE	UR	H
	3-CHLOROPROPENE	UR	H
	4-METHYL-2-PENTANONE	UR	H
	ACETONE	UR	H
	ACETONITRILE	UR	H
	ACROLEIN	UR	CH
	ACRYLONITRILE	UR	CH
	BENZENE	UR	H
	BROMODICHLOROMETHANE	UR	H
	BROMOFORM	UR	H
	BROMOMETHANE	UR	H
	CARBON DISULFIDE	UR	H
	CARBON TETRACHLORIDE	UR	H
	CHLOROBENZENE	UR	H
	CHLORODIBROMOMETHANE	UR	H
	CHLOROETHANE	UR	H
	CHLOROMETHANE	UR	H
	CHLOROPRENE	UR	CE
	CIS-1,2-DICHLOROETHENE	UR	H
	CIS-1,3-DICHLOROPROPENE	UR	H
	DIBROMOMETHANE	UR	H
	DICHLORODIFLUOROMETHANE	UR	H
	ETHYL METHACRYLATE	UR	H
	ETHYLBENZENE	UR	H
	ISOBUTANOL	UR	CH
	METHACRYLONITRILE	UR	CH

TABLE D-3

REJECTED RESULTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample No.	Parameter	Validation Qualifier	Qualifier Code
	METHYL IODIDE	UR	H
	METHYL METHACRYLATE	UR	H
	METHYLENE CHLORIDE	UR	H
	PENTACHLOROETHANE	UR	H
	PROPIONITRILE	UR	CH
	TOLUENE	UR	H
	TOTAL XYLENES	UR	H
	TRANS-1,2-DICHLOROETHENE	UR	H
	TRANS-1,3-DICHLOROPROPENE	UR	H
	TRANS-1,4-DICHLORO-2-BUTENE	UR	CH
	TRICHLOROFLUOROMETHANE	UR	H
	VINYL ACETATE	UR	H
	VINYL CHLORIDE	UR	H
01GW0203-D	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW0303	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW0403	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW0503	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C

TABLE D-3

REJECTED RESULTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample No.	Parameter	Validation Qualifier	Qualifier Code
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW0603	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW0702	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW0803	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW0903	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW1003	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C

TABLE D-3

REJECTED RESULTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample No.	Parameter	Validation Qualifier	Qualifier Code
01GW1103	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW1202	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW1302	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW1403	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW1503	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW1702	1,4-DIOXANE	UR	C

TABLE D-3

REJECTED RESULTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample No.	Parameter	Validation Qualifier	Qualifier Code
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW1802	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW1902	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW2002	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW2102	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW2202	1,4-DIOXANE	UR	C
	ACETONE	UR	C

TABLE D-3

REJECTED RESULTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample No.	Parameter	Validation Qualifier	Qualifier Code
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW2303	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW2402	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW2503	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW2603	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GW2702	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C

TABLE D-3

REJECTED RESULTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample No.	Parameter	Validation Qualifier	Qualifier Code
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GWC0103	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GWT0204	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GWT0302	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GWT0402	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GWT0502	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C

TABLE D-3

REJECTED RESULTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample No.	Parameter	Validation Qualifier	Qualifier Code
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GWT0601	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01GWT0701	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01TP010607	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01TP020506	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01TP040607	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01TP050607	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C

TABLE D-3

REJECTED RESULTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample No.	Parameter	Validation Qualifier	Qualifier Code
01TP060506	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
01TP080506	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
RB01220401	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
RB01250401	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
RB01250402	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
SB01220401	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
TB01140401	1,4-DIOXANE	UR	C
	ACRYLONITRILE	UR	C

TABLE D-3

REJECTED RESULTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample No.	Parameter	Validation Qualifier	Qualifier Code
	CHLOROPRENE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
TB01150401	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
TB01170401	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
TB01190401	1,4-DIOXANE	UR	C
	ACETONE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
TB01210401	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	C
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
TB01230401	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C
TB01260401	1,4-DIOXANE	UR	C
	ACROLEIN	UR	C
	ACRYLONITRILE	UR	C
	CHLOROPRENE	UR	CE
	ISOBUTANOL	UR	C

TABLE D-3

REJECTED RESULTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE, INDIANA

Sample No.	Parameter	Validation Qualifier	Qualifier Code
	METHACRYLONITRILE	UR	C
	PROPIONITRILE	UR	C
	TRANS-1,4-DICHLORO-2-BUTENE	UR	C

C = Calibration Noncompliance (i.e., % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
E = LCS/LCSD Recovery Noncompliance
H = Holding Time Exceedance
UR = Non-detected result was rejected.

TABLE D-4

SENSITIVITY ASSESSMENT, AQUEOUS AND SOIL SAMPLE LABORATORY VOC ANALYSES[1]
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

	Ground Water Samples, ug/L			Soil Samples, ug/kg		
Parameter	Min ND	Max ND	Target MDL	Min ND	Max ND	Target MDL
1,1,1,2-TETRACHLOROETHANE	0.2	0.2	0.43	1	1	7.1
1,1,1-TRICHLOROETHANE	0.2	0.2	88	0.8	0.8	97
1,1,2,2-TETRACHLOROETHANE	0.3	0.3	0.055	2	2	0.17
1,1,2-TRICHLOROETHANE	0.2	0.2	0.2	1	1	0.91
1,1-DICHLOROETHANE	0.1	0.1	47	0.9	1	0.575
1,1-DICHLOROETHENE	0.2	0.2	7	0.9	0.9	2.9
1,2,3-TRICHLOROPROPANE	0.2	0.2	0.0056	1	2	0.0037
1,2-DIBROMO-3-CHLOROPROPANE	0.5	0.5	0.048	3	3	0.092
1,2-DIBROMOETHANE	0.2	0.2	0.00076	1	1	0.029
1,2-DICHLOROETHANE	0.2	0.2	0.12	1	1	1.2
1,2-DICHLOROPROPANE	0.2	0.2	0.16	1	1	1.5
1,4-DIOXANE	9	9	6.1	97	110	1.7
2-BUTANONE	1	1	1900	2	2	136.96
2-HEXANONE	0.5	0.5	1500	4	4	1010
3-CHLOROPROPENE	0.1	0.1	1800	2	2	0.266
4-METHYL-2-PENTANONE	0.4	0.4	160	2	2	544.37
ACETONE	0.5	5	610	17	27	453.37
ACETONITRILE	2	2	100	24	25	420000
ACROLEIN	4	4	0.042	27	29	0.0144
ACRYLONITRILE	2	2	0.039	14	15	0.0157
BENZENE	0.2	0.2	0.34	1	1	1.7
BROMODICHLOROMETHANE	0.2	0.2	0.18	1	1	1.13
BROMOFORM	0.2	0.2	8.5	2	2	38
BROMOMETHANE	0.3	0.3	8.7	2	2	12
CARBON DISULFIDE	0.1	0.1	84.1	1	1	94.12
CARBON TETRACHLORIDE	0.4	0.4	0.17	1	1	3.3
CHLOROBENZENE	0.2	0.2	10	1	1	61.94
CHLORODIBROMOMETHANE	0.2	0.2	0.13	2	2	20
CHLOROETHANE	0.3	0.3	4.6	5	6	330
CHLOROFORM	0.2	0.2	6.2	1	1	27
CHLOROMETHANE	0.2	0.2	1.5	2	2	0.0785
CHLOROPRENE	0.1	0.1	14	3	3	1.06
CIS-1,2-DICHLOROETHENE	0.2	0.2	5	1	1	20
CIS-1,3-DICHLOROPROPENE	0.2	0.2	0.4	1	1	0.3
DIBROMOMETHANE	0.2	0.2	61	1	1	0.0859
DICHLORODIFLUOROMETHANE	0.1	0.1	390	3	3	1.33
ETHYL METHACRYLATE	0.2	0.2	550	3	3	0.602
ETHYLBENZENE	0.2	0.2	2.9	1	1	0.1
ISOBUTANOL	9	9	1800	82	87	2300
METHACRYLONITRILE	0.9	0.9	1	18	19	0.0297
METHYL IODIDE	0.06	0.06	0	4	4	NA
METHYL METHACRYLATE	0.8	0.8	1400	2	2	167.56
METHYLENE CHLORIDE	2	2	4.3	2	11	1.2
PENTACHLOROETHANE	0.1	0.1	56.4	5	5	689.18
PROPIONITRILE	4	4	6080	25	26	NA
STYRENE	0.2	0.2	56	1	1	180
TETRACHLOROETHENE	0.1	0.1	0.66	1	1	2.9
TOLUENE	0.2	0.2	253	1	1	590

TABLE D-4

SENSITIVITY ASSESSMENT, AQUEOUS AND SOIL SAMPLE LABORATORY VOC ANALYSES[1]
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

	Ground Water Samples, ug/L			Soil Samples, ug/kg		
Parameter	Min ND	Max ND	Target MDL	Min ND	Max ND	Target MDL
TOTAL XYLENES	0.6	0.6	117	3	3	1880
TRANS-1,2-DICHLOROETHENE	0.1	0.1	100	1	1	34
TRANS-1,3-DICHLOROPROPENE	0.2	0.2	0.4	1	1	0.3
TRANS-1,4-DICHLORO-2-BUTENE	0.3	0.3	0.0012	2	3	1.82
TRICHLOROETHENE	0.2	0.2	0.028	1	1	2.8
TRICHLOROFLUOROMETHANE	0.2	0.2	1300	5	6	3.07
VINYL ACETATE	0.6	0.6	248	1	1	12.95
VINYL CHLORIDE	0.1	0.1	0.02	3	3	0.67

µg/L = Micrograms per liter.
MDL = Method detection limit (for chemical analyses).
RL = Reporting limit
ug/kg = Micrograms per kilogram.

Shading indicates those chemicals for which the laboratory MDL (dark shading) or RL (light shading) exceeds the risk-based target level.

1. Value is based on the minimum of EPA Region 9 Preliminary Remediation Goals, Region 5 Ecological Data Quality Levels, Federal Ambient Water Quality Criteria, and Maximum Contaminant Levels presented in Appendix A, Tables A-11 through A-14. of the QAPP Addendum No. 1.
2. Not available.

TABLE D-5

PRECISION ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

			MS/MSD		LCS/LCSD		Field Duplicate	
Sample Matrix	**Analytical Fraction**	**Parameter**	**Min RPD**	**Max RPD**	**Min RPD**	**Max RPD**	**Min RPD**	**Max RPD**
SOIL	Volatile Organic Compounds	1,1,1,2-TETRACHLOROETHANE	11.6	11.6	3.8	10.7	NA	NA
		1,1,1-TRICHLOROETHANE	18.3	18.3	0.0	10.5	NA	NA
		1,1,2,2-TETRACHLOROETHANE	17.2	17.2	0.0	14.0	NA	NA
		1,1,2-TRICHLOROETHANE	7.1	7.1	4.3	16.0	NA	NA
		1,1-DICHLOROETHANE	14.8	14.8	0.0	9.5	NA	NA
		1,1-DICHLOROETHENE	4.7	4.7	3.8	35.5	NA	NA
		1,2,3-TRICHLOROPROPANE	4.3	4.3	3.7	4.4	NA	NA
		1,2-DIBROMO-3-CHLOROPROPANE	2.6	2.6	4.3	10.9	NA	NA
		1,2-DIBROMOETHANE	7.1	7.1	4.3	16.0	NA	NA
		1,2-DICHLOROETHANE	9.1	9.1	0.0	17.5	NA	NA
		1,2-DICHLOROETHANE-D4	3.7	3.7	2.0	18.2	3.0	3.0
		1,2-DICHLOROPROPANE	11.8	11.8	3.8	7.0	NA	NA
		1,4-DIOXANE	15.3	15.3	7.4	21.4	NA	NA
		2-BUTANONE	18.3	18.3	0.0	10.0	NA	NA
		2-HEXANONE	2.5	2.5	7.8	14.5	NA	NA
		3-CHLOROPROPENE	24.7	24.7	6.5	117.1	NA	NA
		4-BROMOFLUOROBENZENE	1.0	1.0	2.0	13.7	32.6	32.6
		4-METHYL-2-PENTANONE	0.7	0.7	0.0	22.6	NA	NA
		ACETONE	7.1	7.1	27.0	48.8	NA	NA
		ACETONITRILE	7.7	7.7	0.0	626.1	NA	NA
		ACROLEIN	35.7	35.7	4.4	48.3	NA	NA
		ACRYLONITRILE	2.7	2.7	0.0	14.3	NA	NA
		BENZENE	16.5	16.5	7.7	13.8	NA	NA
		BROMODICHLOROMETHANE	12.8	12.8	0.0	11.5	NA	NA
		BROMOFORM	4.0	4.0	0.0	11.5	NA	NA
		BROMOMETHANE	15.1	15.1	5.3	23.1	NA	NA
		CARBON DISULFIDE	18.3	18.3	7.7	24.1	0.0	0.0
		CARBON TETRACHLORIDE	16.5	16.5	10.5	16.0	NA	NA
		CHLOROBENZENE	15.1	15.1	4.7	10.5	NA	NA
		CHLORODIBROMOMETHANE	6.8	6.8	0.0	10.9	NA	NA

TABLE D-5

PRECISION ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

Sample Matrix	Analytical Fraction	Parameter	MS/MSD		LCS/LCSD		Field Duplicate	
			Min RPD	Max RPD	Min RPD	Max RPD	Min RPD	Max RPD
		CHLOROETHANE	21.1	21.1	4.0	22.2	NA	NA
		CHLOROFORM	13.0	13.0	3.6	4.7	NA	NA
		CHLOROMETHANE	17.8	17.8	9.1	22.7	NA	NA
		CHLOROPRENE	15.9	15.9	13.8	44.4	NA	NA
		CIS-1,2-DICHLOROETHENE	14.6	14.6	0.0	7.0	NA	NA
		CIS-1,3-DICHLOROPROPENE	11.2	11.2	4.5	10.7	NA	NA
		DIBROMOMETHANE	7.3	7.3	4.3	15.7	NA	NA
		DICHLORODIFLUOROMETHANE	15.9	15.9	3.8	18.2	NA	NA
		ETHYL METHACRYLATE	20.4	20.4	4.2	23.1	NA	NA
		ETHYLBENZENE	15.1	15.1	9.5	11.1	NA	NA
		FLUORODIBROMOMETHANE	0.0	0.0	0.0	11.7	50.9	50.9
		ISOBUTANOL	7.9	7.9	0.0	22.2	NA	NA
		METHACRYLONITRILE	14.4	14.4	4.0	31.1	NA	NA
		METHYL IODIDE	59.6	59.6	28.6	441.7	NA	NA
		METHYL METHACRYLATE	19.3	19.3	4.1	26.1	NA	NA
		METHYLENE CHLORIDE	13.5	13.5	5.6	10.3	NA	NA
		PENTACHLOROETHANE	16.6	16.6	10.7	25.0	NA	NA
		PROPIONITRILE	6.7	6.7	4.0	14.5	NA	NA
		STYRENE	18.7	18.7	6.9	9.1	NA	NA
		TETRACHLOROETHENE	16.4	16.4	3.9	22.2	NA	NA
		TOLUENE	16.5	16.5	4.8	10.5	NA	NA
		TOLUENE-D8	1.0	1.0	2.0	2.0	2.0	2.0
		TOTAL XYLENES	21.4	21.4	0.0	11.2	NA	NA
		TRANS-1,2-DICHLOROETHENE	18.7	18.7	0.0	10.5	NA	NA
		TRANS-1,3-DICHLOROPROPENE	9.4	9.4	4.4	10.7	NA	NA
		TRANS-1,4-DICHLORO-2-BUTENE	9.8	9.8	14.6	32.7	NA	NA
		TRICHLOROETHENE	17.0	17.0	7.7	10.5	NA	NA
		TRICHLOROFLUOROMETHANE	19.4	19.4	3.8	16.7	NA	NA
		VINYL ACETATE	22.2	22.2	0.0	24.0	NA	NA
		VINYL CHLORIDE	17.6	17.6	0.0	17.8	NA	NA

TABLE D-5

PRECISION ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

			MS/MSD		LCS/LCSD		Field Duplicate	
Sample Matrix	Analytical Fraction	Parameter	Min RPD	Max RPD	Min RPD	Max RPD	Min RPD	Max RPD
WATER	Choride and Sulfate	CHLORIDE	12.0	12.0	1.0	1.0	15.4	15.4
		SULFATE	2.7	2.7	1.2	2.6	1.3	1.3
	Organic Gases	ACETYLENE*	NC	NC	NC	NC	NA	NA
		ETHANE	NC	NC	2.1	2.1	66.7	66.7
		ETHENE	NC	NC	0.0	0.0	58.8	58.8
		ISOBUTANE*	NC	NC	NC	NC	NA	NA
		METHANE	NC	NC	0.0	0.0	0.0	0.0
		n-BUTANE	NC	NC	1.1	1.1	NA	NA
		PROPANE	NC	NC	0.0	0.0	NA	NA
		PROPENE	NC	NC	0.0	0.0	NA	NA
	Volatile Fatty Acids	ACETIC ACID	3.1	5.8	NC	NC	19.6	19.6
		BUTANOIC ACID	2.4	19.8	NC	NC	NA	NA
		HEXANOIC ACID	0.0	19.5	NC	NC	NA	NA
		I-HEXANOIC ACID	14.1	20.4	NC	NC	NA	NA
		I-PENTANOIC ACID	9.8	14.0	NC	NC	NA	NA
		LACTIC ACID	1.1	10.1	NC	NC	NA	NA
		PENTANOIC ACID	3.9	34.4	NC	NC	NA	NA
		PROPIONIC ACID	7.0	8.0	NC	NC	NA	NA
		PYRUVIC ACID	4.0	25.0	NC	NC	NA	NA
	Hydrogen	HYDROGEN	NC	NC	0.0	0.0	78.8	78.8
	Hardness	HARDNESS	21.1	21.1	9.1	9.1	66.7	66.7
	Nitrate/Nitrite as Nitroge	NITRITE/NITRATE	0.2	0.2	0.8	0.8	NA	NA
	Volatile Organic Compounds	1,1,1,2-TETRACHLOROETHANE	0.0	6.9	0.0	0.0	NA	NA
		1,1,1-TRICHLOROETHANE	0.0	8.7	0.0	18.2	NA	NA
		1,1,2,2-TETRACHLOROETHANE	0.0	0.0	0.0	20.0	0.0	17.6
		1,1,2-TRICHLOROETHANE	0.0	4.6	0.0	20.0	0.0	35.3
		1,1-DICHLOROETHANE	0.0	0.0	0.0	20.0	NA	NA
		1,1-DICHLOROETHENE	0.0	8.0	0.0	20.0	NA	NA
		1,2,3-TRICHLOROPROPANE	9.5	10.5	0.0	20.0	NA	NA
		1,2-DIBROMO-3-CHLOROPROPANE	0.0	10.5	0.0	22.2	NA	NA

TABLE D-5

PRECISION ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

Sample Matrix	Analytical Fraction	Parameter	MS/MSD		LCS/LCSD		Field Duplicate	
			Min RPD	Max RPD	Min RPD	Max RPD	Min RPD	Max RPD
		1,2-DIBROMOETHANE	0.0	0.0	0.0	20.0	NA	NA
		1,2-DICHLOROETHANE	5.1	9.5	0.0	20.0	NA	NA
		1,2-DICHLOROETHANE-D4	1.8	2.8	0.0	5.6	0.0	1.9
		1,2-DICHLOROPROPANE	0.0	0.0	0.0	20.0	NA	NA
		1,4-DIOXANE	5.7	7.8	3.8	35.3	NA	NA
		2-BUTANONE	0.0	8.0	0.0	18.2	NA	NA
		2-HEXANONE	0.0	0.0	0.0	20.0	NA	NA
		3-CHLOROPROPENE	0.0	0.0	0.0	20.0	NA	NA
		4-BROMOFLUOROBENZENE	1.9	2.7	0.0	5.5	0.9	2.9
		4-METHYL-2-PENTANONE	0.0	0.0	0.0	18.2	NA	NA
		ACETONE	0.0	16.7	0.0	18.2	NA	NA
		ACETONITRILE	0.0	8.7	0.0	20.0	NA	NA
		ACROLEIN	1.0	4.2	0.0	11.2	NA	NA
		ACRYLONITRILE	0.0	8.7	0.0	18.2	NA	NA
		BENZENE	0.0	0.0	0.0	20.0	NA	NA
		BROMODICHLOROMETHANE	0.0	0.0	0.0	20.0	NA	NA
		BROMOFORM	0.0	0.0	0.0	22.2	NA	NA
		BROMOMETHANE	0.0	9.5	0.0	22.2	NA	NA
		CARBON DISULFIDE	0.0	0.0	0.0	22.2	NA	NA
		CARBON TETRACHLORIDE	9.5	9.5	0.0	20.0	NA	NA
		CHLOROBENZENE	0.0	0.0	0.0	0.0	NA	NA
		CHLORODIBROMOMETHANE	0.0	0.0	0.0	0.0	NA	NA
		CHLOROETHANE	0.0	0.0	0.0	20.0	NA	NA
		CHLOROFORM	0.0	3.2	0.0	18.2	66.7	66.7
		CHLOROMETHANE	0.0	0.0	0.0	20.0	NA	NA
		CHLOROPRENE	18.2	25.0	0.0	22.2	NA	NA
		CIS-1,2-DICHLOROETHENE	0.0	10.5	0.0	20.0	0.0	0.0
		CIS-1,3-DICHLOROPROPENE	0.0	9.5	0.0	20.0	NA	NA
		DIBROMOMETHANE	0.0	9.5	0.0	20.0	NA	NA
		DICHLORODIFLUOROMETHANE	0.0	0.0	0.0	0.0	NA	NA

TABLE D-5

PRECISION ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA
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			MS/MSD		LCS/LCSD		Field Duplicate	
Sample Matrix	Analytical Fraction	Parameter	Min RPD	Max RPD	Min RPD	Max RPD	Min RPD	Max RPD
		ETHYL METHACRYLATE	0.0	0.0	0.0	20.0	NA	NA
		ETHYLBENZENE	0.0	10.5	0.0	20.0	NA	NA
		FLUORODIBROMOMETHANE	1.0	1.0	1.9	4.0	0.0	1.8
		ISOBUTANOL	1.7	3.5	0.0	29.1	NA	NA
		METHACRYLONITRILE	0.0	0.0	0.0	200.0	NA	NA
		METHYL IODIDE	0.0	11.8	0.0	200.0	NA	NA
		METHYL METHACRYLATE	0.0	0.0	0.0	200.0	NA	NA
		METHYLENE CHLORIDE	0.0	0.0	0.0	200.0	NA	NA
		PENTACHLOROETHANE	0.0	8.7	0.0	66.7	NA	NA
		PROPIONITRILE	0.0	8.7	0.0	18.2	NA	NA
		STYRENE	0.0	13.3	0.0	0.0	NA	NA
		TETRACHLOROETHENE	0.0	0.0	0.0	25.0	0.0	66.7
		TOLUENE	0.0	0.0	0.0	0.0	NA	NA
		TOLUENE-D8	1.9	1.9	0.0	2.0	0.0	2.0
		TOTAL XYLENES	0.0	3.0	0.0	12.4	NA	NA
		TRANS-1,2-DICHLOROETHENE	0.0	0.0	0.0	20.0	NA	NA
		TRANS-1,3-DICHLOROPROPENE	0.0	9.5	0.0	20.0	NA	NA
		TRANS-1,4-DICHLORO-2-BUTENE	0.0	0.0	0.0	20.0	NA	NA
		TRICHLOROETHENE	NC	NC	0.0	0.0	0.0	28.6
		TRICHLOROFLUOROMETHANE	0.0	0.0	0.0	15.4	NA	NA
		VINYL ACETATE	0.0	0.0	0.0	25.0	NA	NA
		VINYL CHLORIDE	0.0	0.0	0.0	18.2	NA	NA
	Total Inorganic Carbon	TOTAL INORGANIC CARBON	NC	NC	1.9	20.0	0.0	0.0
	Total Organic Carbon	TOTAL ORGANIC CARBON	0.0	7.6	NC	NC	NA	NA

LCS = Laboratory contro sample
LSCD = LCS duplicate
Max = Maximum
Min = minimum
MS = Matrix spike

***Note:** Acetylene and iso-butane were not included in LCSs, LCSDs, MSs, or MSDs, and the results were non-detect for original and duplicate field samples, therefore no RPD values could be computed.

TABLE D-5

PRECISION ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

			MS/MSD		LCS/LCSD		Field Duplicate	
Sample Matrix	Analytical Fraction	Parameter	Min RPD	Max RPD	Min RPD	Max RPD	Min RPD	Max RPD

MSD = matrix spike duplicate
NA = Not available, typically because one or both values in each QC pair was less than the detection limit.
NC = Not computed, typically because this parameter was not a requried QC measure.
RPD = Relative percent difference

Shaded cells in the RPD columns indicate values that exceed 50 percent RPD (soil) or 35 percent (water).

TABLE D-6

ACCURACY ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

Matrix	Subfraction	Parameter	Data	LCS %R	LCSD %R	MS %R	MSD %R
SOIL	Volatile Organic Compounds	1,1,1,2-TETRACHLOROETHANE	Minimum %R	88.0	90.0	106.0	119.0
			Average %R	102.0	101.3	106.0	119.0
			Maximum %R	112.0	108.0	106.0	119.0
		1,1,1-TRICHLOROETHANE	Minimum %R	82.0	86.0	104.0	125.0
			Average %R	100.0	99.3	104.0	125.0
			Maximum %R	114.0	108.0	104.0	125.0
		1,1,2,2-TETRACHLOROETHANE	Minimum %R	96.0	94.0	133.0	158.0
			Average %R	103.3	100.0	133.0	158.0
			Maximum %R	114.0	106.0	133.0	158.0
		1,1,2-TRICHLOROETHANE	Minimum %R	94.0	92.0	123.0	132.0
			Average %R	102.7	96.7	123.0	132.0
			Maximum %R	114.0	106.0	123.0	132.0
		1,1-DICHLOROETHANE	Minimum %R	84.0	88.0	106.0	123.0
			Average %R	99.3	99.3	106.0	123.0
			Maximum %R	112.0	108.0	106.0	123.0
		1,1-DICHLOROETHENE	Minimum %R	80.0	88.0	62.0	65.0
			Average %R	103.3	98.0	62.0	65.0
			Maximum %R	124.0	104.0	62.0	65.0
		1,2,3-TRICHLOROPROPANE	Minimum %R	90.0	88.0	138.0	144.0
			Average %R	100.0	99.3	138.0	144.0
			Maximum %R	108.0	106.0	138.0	144.0
		1,2-DIBROMO-3-CHLOROPROPANE	Minimum %R	94.0	96.0	154.0	158.0
			Average %R	100.7	100.7	154.0	158.0
			Maximum %R	110.0	104.0	154.0	158.0
		1,2-DIBROMOETHANE	Minimum %R	94.0	92.0	123.0	132.0
			Average %R	102.0	96.0	123.0	132.0
			Maximum %R	112.0	104.0	123.0	132.0
		1,2-DICHLOROETHANE	Minimum %R	92.0	92.0	115.0	126.0
			Average %R	102.7	97.3	115.0	126.0
			Maximum %R	114.0	104.0	115.0	126.0
		1,2-DICHLOROETHANE-D4	Minimum %R	99.0	90.0	107.0	111.0
			Average %R	99.0	94.7	107.0	111.0
			Maximum %R	99.0	98.0	107.0	111.0
		1,2-DICHLOROPROPANE	Minimum %R	90.0	92.0	112.0	126.0
			Average %R	102.7	101.3	112.0	126.0
			Maximum %R	114.0	110.0	112.0	126.0
		1,4-DIOXANE	Minimum %R	104.0	104.0	162.0	139.0
			Average %R	108.0	112.0	162.0	139.0
			Maximum %R	112.0	124.0	162.0	139.0
		2-BUTANONE	Minimum %R	80.0	76.0	125.0	104.0
			Average %R	82.0	80.7	125.0	104.0
			Maximum %R	84.0	84.0	125.0	104.0
		2-HEXANONE	Minimum %R	96.0	90.0	160.0	156.0
			Average %R	102.7	99.3	160.0	156.0
			Maximum %R	110.0	106.0	160.0	156.0
		3-CHLOROPROPENE	Minimum %R	62.0	64.0	71.0	91.0
			Average %R	83.3	98.0	71.0	91.0
			Maximum %R	106.0	130.0	71.0	91.0
		4-BROMOFLUOROBENZENE	Minimum %R	100.0	95.0	104.0	105.0
			Average %R	101.0	97.7	104.0	105.0
			Maximum %R	102.0	99.0	104.0	105.0
		4-METHYL-2-PENTANONE	Minimum %R	94.0	94.0	150.0	151.0
			Average %R	99.3	94.0	150.0	151.0

TABLE D-6

ACCURACY ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

Matrix	Subfraction	Parameter	Data	LCS %R	LCSD %R	MS %R	MSD %R
			Maximum %R	106.0	94.0	150.0	151.0
		ACETONE	Minimum %R	74.0	64.0	88.0	82.0
			Average %R	80.7	78.0	88.0	82.0
			Maximum %R	86.0	102.0	88.0	82.0
		ACETONITRILE	Minimum %R	88.0	88.0	112.0	121.0
			Average %R	94.0	190.7	112.0	121.0
			Maximum %R	102.0	380.0	112.0	121.0
		ACROLEIN	Minimum %R	90.0	88.0	33.0	23.0
			Average %R	102.0	90.0	33.0	23.0
			Maximum %R	116.0	94.0	33.0	23.0
		ACRYLONITRILE	Minimum %R	100.0	98.0	148.0	144.0
			Average %R	104.0	100.7	148.0	144.0
			Maximum %R	112.0	104.0	148.0	144.0
		BENZENE	Minimum %R	84.0	88.0	106.0	125.0
			Average %R	101.3	101.3	106.0	125.0
			Maximum %R	116.0	108.0	106.0	125.0
		BROMODICHLOROMETHANE	Minimum %R	90.0	90.0	110.0	125.0
			Average %R	102.7	98.7	110.0	125.0
			Maximum %R	114.0	108.0	110.0	125.0
		BROMOFORM	Minimum %R	94.0	94.0	123.0	128.0
			Average %R	102.7	98.7	123.0	128.0
			Maximum %R	110.0	104.0	123.0	128.0
		BROMOMETHANE	Minimum %R	76.0	78.0	98.0	114.0
			Average %R	90.7	89.3	98.0	114.0
			Maximum %R	104.0	98.0	98.0	114.0
		CARBON DISULFIDE	Minimum %R	82.0	88.0	104.0	125.0
			Average %R	100.7	99.3	104.0	125.0
			Maximum %R	116.0	108.0	104.0	125.0
		CARBON TETRACHLORIDE	Minimum %R	80.0	86.0	106.0	125.0
			Average %R	98.0	100.7	106.0	125.0
			Maximum %R	114.0	108.0	106.0	125.0
		CHLOROBENZENE	Minimum %R	86.0	88.0	104.0	121.0
			Average %R	102.0	102.0	104.0	121.0
			Maximum %R	114.0	110.0	104.0	121.0
		CHLORODIBROMOMETHANE	Minimum %R	92.0	92.0	113.0	121.0
			Average %R	102.7	99.3	113.0	121.0
			Maximum %R	110.0	104.0	113.0	121.0
		CHLOROETHANE	Minimum %R	100.0	96.0	102.0	126.0
			Average %R	103.3	98.7	102.0	126.0
			Maximum %R	108.0	102.0	102.0	126.0
		CHLOROFORM	Minimum %R	86.0	88.0	108.0	123.0
			Average %R	98.0	97.3	108.0	123.0
			Maximum %R	112.0	110.0	108.0	123.0
		CHLOROMETHANE	Minimum %R	86.0	82.0	87.0	104.0
			Average %R	87.3	90.7	87.0	104.0
			Maximum %R	88.0	98.0	87.0	104.0
		CHLOROPRENE	Minimum %R	54.0	66.0	58.0	68.0
			Average %R	82.0	86.7	58.0	68.0
			Maximum %R	116.0	108.0	58.0	68.0
		CIS-1,2-DICHLOROETHENE	Minimum %R	86.0	88.0	108.0	125.0
			Average %R	100.0	99.3	108.0	125.0
			Maximum %R	114.0	110.0	108.0	125.0
		CIS-1,3-DICHLOROPROPENE	Minimum %R	88.0	90.0	110.0	123.0

TABLE D-6

ACCURACY ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

Matrix	Subfraction	Parameter	Data	LCS %R	LCSD %R	MS %R	MSD %R
			Average %R	100.7	98.0	110.0	123.0
			Maximum %R	112.0	106.0	110.0	123.0
		DIBROMOMETHANE	Minimum %R	94.0	92.0	119.0	128.0
			Average %R	102.7	97.3	119.0	128.0
			Maximum %R	112.0	106.0	119.0	128.0
		DICHLORODIFLUOROMETHANE	Minimum %R	88.0	96.0	87.0	102.0
			Average %R	95.3	100.0	87.0	102.0
			Maximum %R	106.0	104.0	87.0	102.0
		ETHYL METHACRYLATE	Minimum %R	94.0	92.0	110.0	135.0
			Average %R	98.0	96.7	110.0	135.0
			Maximum %R	104.0	104.0	110.0	135.0
		ETHYLBENZENE	Minimum %R	84.0	88.0	104.0	121.0
			Average %R	102.0	103.3	104.0	121.0
			Maximum %R	114.0	114.0	104.0	121.0
		FLUORODIBROMOMETHANE	Minimum %R	102.0	97.0	105.0	105.0
			Average %R	102.3	99.7	105.0	105.0
			Maximum %R	103.0	102.0	105.0	105.0
		ISOBUTANOL	Minimum %R	96.0	96.0	185.0	171.0
			Average %R	101.3	104.0	185.0	171.0
			Maximum %R	108.0	120.0	185.0	171.0
		METHACRYLONITRILE	Minimum %R	90.0	92.0	129.0	149.0
			Average %R	97.3	98.0	129.0	149.0
			Maximum %R	102.0	104.0	129.0	149.0
		METHYL IODIDE	Minimum %R	42.0	48.0	33.0	61.0
			Average %R	50.0	98.0	33.0	61.0
			Maximum %R	60.0	154.0	33.0	61.0
		METHYL METHACRYLATE	Minimum %R	92.0	88.0	117.0	142.0
			Average %R	96.7	96.0	117.0	142.0
			Maximum %R	100.0	104.0	117.0	142.0
		METHYLENE CHLORIDE	Minimum %R	72.0	74.0	104.0	119.0
			Average %R	88.7	89.3	104.0	119.0
			Maximum %R	116.0	112.0	104.0	119.0
		PENTACHLOROETHANE	Minimum %R	64.0	56.0	144.0	170.0
			Average %R	93.3	92.0	144.0	170.0
			Maximum %R	112.0	114.0	144.0	170.0
		PROPIONITRILE	Minimum %R	100.0	98.0	154.0	144.0
			Average %R	104.7	103.3	154.0	144.0
			Maximum %R	110.0	110.0	154.0	144.0
		STYRENE	Minimum %R	88.0	92.0	102.0	123.0
			Average %R	103.3	104.7	102.0	123.0
			Maximum %R	116.0	112.0	102.0	123.0
		TETRACHLOROETHENE	Minimum %R	96.0	102.0	73.0	86.0
			Average %R	102.0	108.7	73.0	86.0
			Maximum %R	108.0	120.0	73.0	86.0
		TOLUENE	Minimum %R	84.0	86.0	106.0	125.0
			Average %R	99.3	99.3	106.0	125.0
			Maximum %R	114.0	108.0	106.0	125.0
		TOLUENE-D8	Minimum %R	100.0	99.0	104.0	105.0
			Average %R	100.7	100.3	104.0	105.0
			Maximum %R	101.0	102.0	104.0	105.0
		TOTAL XYLENES	Minimum %R	87.0	87.0	100.0	124.0
			Average %R	102.3	104.3	100.0	124.0
			Maximum %R	113.0	113.0	100.0	124.0

TABLE D-6

ACCURACY ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

Matrix	Subfraction	Parameter	Data	LCS %R	LCSD %R	MS %R	MSD %R
		TRANS-1,2-DICHLOROETHENE	Minimum %R	82.0	86.0	102.0	123.0
			Average %R	99.3	98.7	102.0	123.0
			Maximum %R	114.0	108.0	102.0	123.0
		TRANS-1,3-DICHLOROPROPENE	Minimum %R	90.0	92.0	112.0	123.0
			Average %R	100.7	98.0	112.0	123.0
			Maximum %R	112.0	106.0	112.0	123.0
		TRANS-1,4-DICHLORO-2-BUTENE	Minimum %R	82.0	88.0	87.0	96.0
			Average %R	98.0	98.0	87.0	96.0
			Maximum %R	110.0	114.0	87.0	96.0
		TRICHLOROETHENE	Minimum %R	84.0	88.0	102.0	121.0
			Average %R	100.7	101.3	102.0	121.0
			Maximum %R	114.0	108.0	102.0	121.0
		TRICHLOROFLUOROMETHANE	Minimum %R	96.0	104.0	79.0	96.0
			Average %R	104.0	106.0	79.0	96.0
			Maximum %R	110.0	108.0	79.0	96.0
		VINYL ACETATE	Minimum %R	76.0	76.0	75.0	60.0
			Average %R	95.3	88.7	75.0	60.0
			Maximum %R	110.0	102.0	75.0	60.0
		VINYL CHLORIDE	Minimum %R	90.0	98.0	88.0	105.0
			Average %R	96.7	102.0	88.0	105.0
			Maximum %R	106.0	106.0	88.0	105.0
WATER	Miscellaneous	CHLORIDE	Minimum %R	101.5	101.0	112.0	126.3
			Average %R	101.5	101.0	112.0	126.3
			Maximum %R	101.5	101.0	112.0	126.3
		HARDNESS	Minimum %R	110.0	105.0	85.0	105.0
			Average %R	110.0	105.0	85.0	105.0
			Maximum %R	110.0	105.0	85.0	105.0
		HYDROGEN	Minimum %R	102.0	102.0	NC	NC
			Average %R	102.0	102.0	NC	NC
			Maximum %R	102.0	102.0	NC	NC
		NITRITE/NITRATE	Minimum %R	99.4	99.0	95.6	95.8
			Average %R	99.4	99.0	95.6	95.8
			Maximum %R	99.4	99.0	95.6	95.8
		SULFATE	Minimum %R	99.3	99.9	117.4	114.3
			Average %R	99.6	100.6	117.4	114.3
			Maximum %R	99.9	101.2	117.4	114.3
		TOTAL INORGANIC CARBON	Minimum %R	100.0	102.0	NC	NC
			Average %R	102.0	104.7	NC	NC
			Maximum %R	103.0	110.0	NC	NC
		TOTAL ORGANIC CARBON	Minimum %R	94.0	NC	89.0	96.0
			Average %R	96.3	NC	98.3	100.7
			Maximum %R	101.0	NC	103.0	103.0
	Organic Gases	ACETYLENE*	Minimum %R	NC	NC	NC	NC
			Average %R	NC	NC	NC	NC
			Maximum %R	NC	NC	NC	NC
		ETHANE	Minimum %R	97.0	98.0	NC	NC
			Average %R	97.0	98.0	NC	NC
			Maximum %R	97.0	98.0	NC	NC
		ETHENE	Minimum %R	97.0	97.0	NC	NC
			Average %R	97.0	97.0	NC	NC
			Maximum %R	97.0	97.0	NC	NC
		ISOBUTANE*	Minimum %R	NC	NC	NC	NC
			Average %R	NC	NC	NC	NC

TABLE D-6

ACCURACY ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

Matrix	Subfraction	Parameter	Data	LCS %R	LCSD %R	MS %R	MSD %R
			Maximum %R	NC	NC	NC	NC
		METHANE	Minimum %R	98.0	98.0	NC	NC
			Average %R	98.0	98.0	NC	NC
			Maximum %R	98.0	98.0	NC	NC
		n-BUTANE	Minimum %R	97.0	96.0	NC	NC
			Average %R	97.0	96.0	NC	NC
			Maximum %R	97.0	96.0	NC	NC
		PROPANE	Minimum %R	100.0	100.0	NC	NC
			Average %R	100.0	100.0	NC	NC
			Maximum %R	100.0	100.0	NC	NC
		PROPENE	Minimum %R	85.0	85.0	NC	NC
			Average %R	85.0	85.0	NC	NC
			Maximum %R	85.0	85.0	NC	NC
	Volatile Fatty Acides	ACETIC ACID	Minimum %R	92.0	NC	99.0	96.0
			Average %R	95.3	NC	103.7	98.7
			Maximum %R	102.0	NC	106.0	100.0
		BUTANOIC ACID	Minimum %R	99.0	NC	83.0	81.0
			Average %R	100.7	NC	92.3	81.7
			Maximum %R	104.0	NC	100.0	82.0
		HEXANOIC ACID	Minimum %R	84.0	NC	85.0	74.0
			Average %R	86.3	NC	88.3	77.7
			Maximum %R	91.0	NC	90.0	85.0
		I-HEXANOIC ACID	Minimum %R	82.0	NC	91.0	75.0
			Average %R	90.3	NC	91.3	77.7
			Maximum %R	107.0	NC	92.0	79.0
		I-PENTANOIC ACID	Minimum %R	100.0	NC	86.0	78.0
			Average %R	101.0	NC	89.0	79.3
			Maximum %R	103.0	NC	92.0	80.0
		LACTIC ACID	Minimum %R	94.0	NC	88.0	85.0
			Average %R	95.7	NC	92.0	85.7
			Maximum %R	99.0	NC	94.0	87.0
		PENTANOIC ACID	Minimum %R	89.0	NC	75.0	65.0
			Average %R	94.0	NC	86.3	69.3
			Maximum %R	104.0	NC	92.0	78.0
		PROPIONIC ACID	Minimum %R	96.0	NC	89.0	83.0
			Average %R	99.7	NC	99.0	91.7
			Maximum %R	107.0	NC	104.0	96.0
		PYRUVIC ACID	Minimum %R	120.0	NC	77.0	70.0
			Average %R	121.3	NC	85.7	71.3
			Maximum %R	124.0	NC	90.0	74.0
	Volatile Organic Compounds	1,1,1,2-TETRACHLOROETHANE	Minimum %R	100.0	100.0	100.0	100.0
			Average %R	100.0	100.0	125.0	120.0
			Maximum %R	100.0	100.0	150.0	140.0
		1,1,1-TRICHLOROETHANE	Minimum %R	110.0	100.0	110.0	110.0
			Average %R	112.7	110.0	115.0	110.0
			Maximum %R	120.0	120.0	120.0	110.0
		1,1,2,2-TETRACHLOROETHANE	Minimum %R	90.0	90.0	100.0	100.0
			Average %R	100.9	101.8	100.0	100.0
			Maximum %R	110.0	110.0	100.0	100.0
		1,1,2-TRICHLOROETHANE	Minimum %R	100.0	100.0	110.0	110.0
			Average %R	106.4	104.5	166.0	161.0
			Maximum %R	110.0	110.0	222.0	212.0
		1,1-DICHLOROETHANE	Minimum %R	100.0	110.0	110.0	110.0

TABLE D-6

ACCURACY ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

Matrix	Subfraction	Parameter	Data	LCS %R	LCSD %R	MS %R	MSD %R
			Average %R	110.0	112.7	110.0	110.0
			Maximum %R	120.0	120.0	110.0	110.0
		1,1-DICHLOROETHENE	Minimum %R	100.0	100.0	100.0	100.0
			Average %R	103.6	106.4	110.0	115.0
			Maximum %R	110.0	110.0	120.0	130.0
		1,2,3-TRICHLOROPROPANE	Minimum %R	90.0	90.0	100.0	90.0
			Average %R	98.2	100.0	105.0	95.0
			Maximum %R	110.0	110.0	110.0	100.0
		1,2-DIBROMO-3-CHLOROPROPANE	Minimum %R	90.0	90.0	90.0	100.0
			Average %R	97.3	100.9	95.0	100.0
			Maximum %R	100.0	110.0	100.0	100.0
		1,2-DIBROMOETHANE	Minimum %R	100.0	100.0	110.0	110.0
			Average %R	103.6	103.6	110.0	110.0
			Maximum %R	110.0	110.0	110.0	110.0
		1,2-DICHLOROETHANE	Minimum %R	100.0	100.0	110.0	100.0
			Average %R	107.3	106.4	155.0	145.0
			Maximum %R	110.0	110.0	200.0	190.0
		1,2-DICHLOROETHANE-D4	Minimum %R	100.0	100.0	109.0	106.0
			Average %R	105.4	104.6	110.5	108.0
			Maximum %R	108.0	107.0	112.0	110.0
		1,2-DICHLOROPROPANE	Minimum %R	100.0	100.0	100.0	100.0
			Average %R	103.6	103.6	100.0	100.0
			Maximum %R	110.0	110.0	100.0	100.0
		1,4-DIOXANE	Minimum %R	68.0	80.0	106.0	98.0
			Average %R	392.0	450.4	107.0	100.0
			Maximum %R	3400.0	4000.0	108.0	102.0
		2-BUTANONE	Minimum %R	110.0	100.0	120.0	120.0
			Average %R	115.5	117.3	125.0	120.0
			Maximum %R	120.0	130.0	130.0	120.0
		2-HEXANONE	Minimum %R	100.0	100.0	110.0	110.0
			Average %R	106.4	107.3	110.0	110.0
			Maximum %R	110.0	110.0	110.0	110.0
		3-CHLOROPROPENE	Minimum %R	100.0	110.0	110.0	110.0
			Average %R	108.2	111.8	110.0	110.0
			Maximum %R	110.0	120.0	110.0	110.0
		4-BROMOFLUOROBENZENE	Minimum %R	101.0	100.0	107.0	105.0
			Average %R	105.8	104.8	109.0	106.5
			Maximum %R	109.0	107.0	111.0	108.0
		4-METHYL-2-PENTANONE	Minimum %R	100.0	100.0	120.0	120.0
			Average %R	109.1	110.0	120.0	120.0
			Maximum %R	110.0	120.0	120.0	120.0
		ACETONE	Minimum %R	100.0	100.0	110.0	110.0
			Average %R	110.9	114.5	110.0	120.0
			Maximum %R	120.0	130.0	110.0	130.0
		ACETONITRILE	Minimum %R	100.0	110.0	110.0	110.0
			Average %R	193.6	201.8	110.0	115.0
			Maximum %R	1000.0	1100.0	110.0	120.0
		ACROLEIN	Minimum %R	89.0	89.0	93.0	97.0
			Average %R	175.0	178.2	95.0	97.5
			Maximum %R	950.0	980.0	97.0	98.0
		ACRYLONITRILE	Minimum %R	110.0	100.0	110.0	120.0
			Average %R	201.8	193.6	115.0	120.0
			Maximum %R	1100.0	1000.0	120.0	120.0

TABLE D-6

ACCURACY ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

Matrix	Subfraction	Parameter	Data	LCS %R	LCSD %R	MS %R	MSD %R
		BENZENE	Minimum %R	100.0	100.0	100.0	100.0
			Average %R	100.0	100.9	100.0	100.0
			Maximum %R	100.0	110.0	100.0	100.0
		BROMODICHLOROMETHANE	Minimum %R	100.0	100.0	100.0	100.0
			Average %R	102.7	104.5	100.0	100.0
			Maximum %R	110.0	110.0	100.0	100.0
		BROMOFORM	Minimum %R	90.0	90.0	90.0	90.0
			Average %R	98.2	99.1	90.0	90.0
			Maximum %R	100.0	100.0	90.0	90.0
		BROMOMETHANE	Minimum %R	90.0	100.0	100.0	110.0
			Average %R	102.7	108.2	105.0	110.0
			Maximum %R	110.0	120.0	110.0	110.0
		CARBON DISULFIDE	Minimum %R	90.0	100.0	70.0	70.0
			Average %R	104.5	109.1	75.0	75.0
			Maximum %R	110.0	120.0	80.0	80.0
		CARBON TETRACHLORIDE	Minimum %R	100.0	100.0	110.0	100.0
			Average %R	104.5	104.5	110.0	100.0
			Maximum %R	110.0	110.0	110.0	100.0
		CHLOROBENZENE	Minimum %R	100.0	100.0	100.0	100.0
			Average %R	100.0	100.0	100.0	100.0
			Maximum %R	100.0	100.0	100.0	100.0
		CHLORODIBROMOMETHANE	Minimum %R	100.0	100.0	90.0	90.0
			Average %R	100.0	100.0	95.0	95.0
			Maximum %R	100.0	100.0	100.0	100.0
		CHLOROETHANE	Minimum %R	100.0	100.0	110.0	110.0
			Average %R	107.3	110.0	110.0	110.0
			Maximum %R	110.0	120.0	110.0	110.0
		CHLOROFORM	Minimum %R	100.0	100.0	110.0	110.0
			Average %R	108.2	110.0	215.0	210.0
			Maximum %R	110.0	120.0	320.0	310.0
		CHLOROMETHANE	Minimum %R	100.0	110.0	110.0	110.0
			Average %R	108.2	112.7	110.0	110.0
			Maximum %R	110.0	120.0	110.0	110.0
		CHLOROPRENE	Minimum %R	90.0	90.0	60.0	50.0
			Average %R	100.0	99.1	75.0	60.0
			Maximum %R	110.0	100.0	90.0	70.0
		CIS-1,2-DICHLOROETHENE	Minimum %R	100.0	100.0	110.0	110.0
			Average %R	107.3	105.5	155.0	145.0
			Maximum %R	110.0	110.0	200.0	180.0
		CIS-1,3-DICHLOROPROPENE	Minimum %R	100.0	100.0	100.0	100.0
			Average %R	102.7	103.6	105.0	100.0
			Maximum %R	110.0	110.0	110.0	100.0
		DIBROMOMETHANE	Minimum %R	100.0	100.0	100.0	100.0
			Average %R	103.6	104.5	105.0	100.0
			Maximum %R	110.0	110.0	110.0	100.0
		DICHLORODIFLUOROMETHANE	Minimum %R	100.0	100.0	100.0	100.0
			Average %R	103.6	103.6	100.0	100.0
			Maximum %R	110.0	110.0	100.0	100.0
		ETHYL METHACRYLATE	Minimum %R	100.0	100.0	90.0	90.0
			Average %R	108.2	109.1	100.0	100.0
			Maximum %R	110.0	110.0	110.0	110.0
		ETHYLBENZENE	Minimum %R	100.0	100.0	100.0	90.0
			Average %R	100.9	100.9	100.0	95.0

TABLE D-6

ACCURACY ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

Matrix	Subfraction	Parameter	Data	LCS %R	LCSD %R	MS %R	MSD %R
			Maximum %R	110.0	110.0	100.0	100.0
		FLUORODIBROMOMETHANE	Minimum %R	101.0	101.0	104.0	103.0
			Average %R	103.5	103.9	104.5	103.5
			Maximum %R	106.0	106.0	105.0	104.0
		ISOBUTANOL	Minimum %R	94.0	92.0	114.0	112.0
			Average %R	524.7	514.2	115.0	114.0
			Maximum %R	4700.0	4600.0	116.0	116.0
		METHACRYLONITRILE	Minimum %R	110.0	100.0	110.0	110.0
			Average %R	202.7	191.8	115.0	115.0
			Maximum %R	1100.0	1000.0	120.0	120.0
		METHYL IODIDE	Minimum %R	80.0	80.0	80.0	90.0
			Average %R	87.3	92.7	85.0	90.0
			Maximum %R	100.0	100.0	90.0	90.0
		METHYL METHACRYLATE	Minimum %R	100.0	100.0	90.0	90.0
			Average %R	104.5	106.4	100.0	100.0
			Maximum %R	110.0	110.0	110.0	110.0
		METHYLENE CHLORIDE	Minimum %R	100.0	110.0	110.0	110.0
			Average %R	109.1	114.5	110.0	110.0
			Maximum %R	120.0	130.0	110.0	110.0
		PENTACHLOROETHANE	Minimum %R	30.0	20.0	110.0	110.0
			Average %R	96.4	93.6	115.0	110.0
			Maximum %R	120.0	110.0	120.0	110.0
		PROPIONITRILE	Minimum %R	99.0	96.0	120.0	110.0
			Average %R	189.0	187.8	120.0	115.0
			Maximum %R	990.0	960.0	120.0	120.0
		STYRENE	Minimum %R	100.0	100.0	30.0	30.0
			Average %R	100.9	100.9	50.0	55.0
			Maximum %R	110.0	110.0	70.0	80.0
		TETRACHLOROETHENE	Minimum %R	80.0	80.0	80.0	80.0
			Average %R	96.4	100.9	100.0	100.0
			Maximum %R	150.0	160.0	120.0	120.0
		TOLUENE	Minimum %R	100.0	100.0	100.0	100.0
			Average %R	100.0	100.0	100.0	100.0
			Maximum %R	100.0	100.0	100.0	100.0
		TOLUENE-D8	Minimum %R	100.0	101.0	105.0	103.0
			Average %R	102.1	101.8	105.0	103.0
			Maximum %R	103.0	103.0	105.0	103.0
		TOTAL XYLENES	Minimum %R	97.0	97.0	90.0	90.0
			Average %R	118.8	120.5	95.0	93.5
			Maximum %R	300.0	310.0	100.0	97.0
		TRANS-1,2-DICHLOROETHENE	Minimum %R	100.0	100.0	100.0	100.0
			Average %R	104.5	107.3	120.0	120.0
			Maximum %R	110.0	110.0	140.0	140.0
		TRANS-1,3-DICHLOROPROPENE	Minimum %R	100.0	100.0	100.0	100.0
			Average %R	105.5	103.6	105.0	100.0
			Maximum %R	110.0	110.0	110.0	100.0
		TRANS-1,4-DICHLORO-2-BUTENE	Minimum %R	100.0	100.0	90.0	90.0
			Average %R	107.3	104.5	95.0	95.0
			Maximum %R	110.0	120.0	100.0	100.0
		TRICHLOROETHENE	Minimum %R	100.0	100.0	NC	NC
			Average %R	102.7	102.7	NC	NC
			Maximum %R	110.0	110.0	NC	NC
		TRICHLOROFLUOROMETHANE	Minimum %R	110.0	110.0	120.0	120.0

TABLE D-6

ACCURACY ASSESSMENT FOR SOIL AND GROUND WATER SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

Matrix	Subfraction	Parameter	Data	LCS %R	LCSD %R	MS %R	MSD %R
			Average %R	120.9	118.2	120.0	120.0
			Maximum %R	130.0	120.0	120.0	120.0
		VINYL ACETATE	Minimum %R	80.0	70.0	90.0	90.0
			Average %R	102.7	99.1	95.0	95.0
			Maximum %R	110.0	110.0	100.0	100.0
		VINYL CHLORIDE	Minimum %R	100.0	100.0	110.0	110.0
			Average %R	108.2	109.1	110.0	110.0
			Maximum %R	110.0	120.0	110.0	110.0

%R = Percent recovery
LCS Laboratory Control Sample
LCSD LCS Duplicate
MS Matrix Spike
MSD MS Duplicate
NC = Not computed, typically because this parameter was not a required QC measure.
QCs = Quality control samples

*Note: Acetylene and isobutane were omitted from the LCSs, LCSDs, MSs, and MSDs.

Shaded cells indicate values less than 75 percent or greater than 125 percent.

TABLE D-7

WATER SAMPLE QUALIFICATION RATES [1]
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

			Validation Qualifier				
Analytical Fraction	Parameter	Qualification Code	BJ	J	U	UJ	UR
CHLORIDE AND SULFATE	CHLORIDE	D	0.0	100.0	0.0	0.0	0.0
ORGANIC GASES	ACETYLENE	H	0.0	0.0	0.0	100.0	0.0
	ETHANE	H	0.0	58.3	0.0	0.0	0.0
		HP	0.0	41.7	0.0	0.0	0.0
	ETHENE	GH	0.0	18.2	0.0	0.0	0.0
		H	0.0	81.8	0.0	100.0	0.0
	ISOBUTANE	H	0.0	0.0	0.0	100.0	0.0
		HP	0.0	100.0	0.0	0.0	0.0
	METHANE	H	0.0	100.0	0.0	0.0	0.0
	n-BUTANE	H	0.0	100.0	0.0	100.0	0.0
		HP	0.0	0.0	0.0	41.7	0.0
	PROPANE	H	0.0	57.1	0.0	100.0	0.0
		HP	0.0	42.9	0.0	0.0	0.0
	PROPENE	H	0.0	0.0	0.0	100.0	0.0
FTYAC	ACETIC ACID	H	0.0	15.4	0.0	100.0	0.0
		HP	0.0	84.6	0.0	0.0	0.0
	BUTANOIC ACID	H	0.0	0.0	0.0	100.0	0.0
		HP	0.0	100.0	0.0	0.0	0.0
	HEXANOIC ACID	H	0.0	0.0	0.0	100.0	0.0
	I-HEXANOIC ACID	H	0.0	0.0	0.0	100.0	0.0
	I-PENTANOIC ACID	H	0.0	0.0	0.0	100.0	0.0
	LACTIC ACID	H	0.0	10.0	0.0	100.0	0.0
		HP	0.0	90.0	0.0	0.0	0.0
	PENTANOIC ACID	DH	0.0	0.0	0.0	7.1	0.0
		H	0.0	0.0	0.0	92.9	0.0
	PROPIONIC ACID	H	0.0	0.0	0.0	100.0	0.0
		HP	0.0	100.0	0.0	0.0	0.0
	PYRUVIC ACID	H	0.0	0.0	0.0	100.0	0.0
		HP	0.0	100.0	0.0	0.0	0.0
HYDROGEN	HYDROGEN	G	0.0	100.0	0.0	0.0	0.0
HARDNESS	HARDNESS	G	0.0	100.0	0.0	0.0	0.0
VOLATILE ORGANIC COMPOUNDS	1,1,1,2-TETRACHLOROETHANE	H	0.0	0.0	0.0	0.0	100.0
		P	0.0	100.0	0.0	0.0	0.0
		R	0.0	0.0	0.0	100.0	0.0
	1,1,1-TRICHLOROETHANE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	1,1,2,2-TETRACHLOROETHANE	H	0.0	33.3	0.0	0.0	0.0
		P	0.0	33.3	0.0	0.0	0.0
		R	0.0	33.3	0.0	0.0	0.0
	1,1,2-TRICHLOROETHANE	DP	0.0	14.3	0.0	0.0	0.0
		HP	0.0	14.3	0.0	0.0	0.0
		P	0.0	42.9	0.0	0.0	0.0
		R	0.0	28.6	0.0	0.0	0.0
	1,1-DICHLOROETHANE	H	0.0	0.0	0.0	0.0	100.0
		PR	0.0	100.0	0.0	0.0	0.0
		R	0.0	0.0	0.0	100.0	0.0

TABLE D-7

WATER SAMPLE QUALIFICATION RATES [1]
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

			Validation Qualifier				
Analytical Fraction	Parameter	Qualification Code	BJ	J	U	UJ	UR
	1,1-DICHLOROETHENE	H	0.0	0.0	0.0	0.0	100.0
		P	0.0	80.0	0.0	0.0	0.0
		R	0.0	20.0	0.0	100.0	0.0
	1,2,3-TRICHLOROPROPANE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	1,2-DIBROMO-3-CHLOROPROPANE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	1,2-DIBROMOETHANE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	1,2-DICHLOROETHANE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	100.0	0.0	100.0	0.0
	1,2-DICHLOROPROPANE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	1,4-DIOXANE	C	0.0	0.0	0.0	0.0	98.0
		CH	0.0	0.0	0.0	0.0	2.0
	2-BUTANONE	C	0.0	50.0	0.0	86.7	0.0
		CP	0.0	25.0	0.0	0.0	0.0
		CR	0.0	0.0	0.0	6.7	0.0
		H	0.0	0.0	0.0	0.0	100.0
		P	0.0	25.0	0.0	0.0	0.0
		R	0.0	0.0	0.0	6.7	0.0
	2-HEXANONE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	3-CHLOROPROPENE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	4-METHYL-2-PENTANONE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	ACETONE	B	0.0	0.0	100.0	0.0	0.0
		C	0.0	12.5	0.0	0.0	97.4
		CP	0.0	87.5	0.0	0.0	0.0
		H	0.0	0.0	0.0	0.0	2.6
	ACETONITRILE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	ACROLEIN	C	0.0	0.0	0.0	0.0	97.9
		CH	0.0	0.0	0.0	0.0	2.1
	ACRYLONITRILE	C	0.0	0.0	0.0	0.0	98.0
		CH	0.0	0.0	0.0	0.0	2.0
	BENZENE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	BROMODICHLOROMETHANE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	100.0	0.0	100.0	0.0
	BROMOFORM	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	BROMOMETHANE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	CARBON DISULFIDE	H	0.0	0.0	0.0	0.0	100.0
		P	0.0	100.0	0.0	0.0	0.0

TABLE D-7

WATER SAMPLE QUALIFICATION RATES [1]
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

Analytical Fraction	Parameter	Qualification Code	Validation Qualifier BJ	J	U	UJ	UR
		R	0.0	0.0	0.0	100.0	0.0
	CARBON TETRACHLORIDE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	100.0	0.0	100.0	0.0
	CHLOROBENZENE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	CHLORODIBROMOMETHANE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	CHLOROETHANE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	CHLOROFORM	A	100.0	0.0	0.0	0.0	0.0
		D	0.0	20.0	0.0	0.0	0.0
		H	0.0	20.0	0.0	0.0	0.0
		P	0.0	60.0	0.0	0.0	0.0
		R	0.0	0.0	0.0	100.0	0.0
	CHLOROMETHANE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	CHLOROPRENE	C	0.0	0.0	0.0	0.0	57.1
		CE	0.0	0.0	0.0	0.0	42.9
	CIS-1,2-DICHLOROETHENE	H	0.0	0.0	0.0	0.0	100.0
		P	0.0	33.3	0.0	0.0	0.0
		R	0.0	66.7	0.0	0.0	0.0
	CIS-1,3-DICHLOROPROPENE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	DIBROMOMETHANE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	DICHLORODIFLUOROMETHANE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	ETHYL METHACRYLATE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	ETHYLBENZENE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	ISOBUTANOL	C	0.0	0.0	0.0	0.0	97.9
		CH	0.0	0.0	0.0	0.0	2.1
	METHACRYLONITRILE	C	0.0	0.0	0.0	0.0	97.9
		CH	0.0	0.0	0.0	0.0	2.1
	METHYL IODIDE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	METHYL METHACRYLATE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	METHYLENE CHLORIDE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	100.0	0.0	100.0	0.0
	PENTACHLOROETHANE	C	0.0	0.0	0.0	75.9	0.0
		E	0.0	0.0	0.0	20.7	0.0
		ER	0.0	0.0	0.0	3.4	0.0
		H	0.0	0.0	0.0	0.0	100.0
	PROPIONITRILE	C	0.0	0.0	0.0	0.0	97.9
		CH	0.0	0.0	0.0	0.0	2.1

TABLE D-7

WATER SAMPLE QUALIFICATION RATES [1]
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

			Validation Qualifier				
Analytical Fraction	Parameter	Qualification Code	BJ	J	U	UJ	UR
	STYRENE	D	0.0	0.0	0.0	50.0	0.0
		H	0.0	0.0	0.0	25.0	0.0
		R	0.0	0.0	0.0	25.0	0.0
	TETRACHLOROETHENE	H	0.0	100.0	0.0	0.0	0.0
		R	0.0	0.0	0.0	100.0	0.0
	TOLUENE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	TOTAL XYLENES	D	0.0	0.0	0.0	50.0	0.0
		H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	50.0	0.0
	TRANS-1,2-DICHLOROETHENE	H	0.0	0.0	0.0	0.0	100.0
		P	0.0	75.0	0.0	0.0	0.0
		R	0.0	25.0	0.0	100.0	0.0
	TRANS-1,3-DICHLOROPROPENE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	TRANS-1,4-DICHLORO-2-BUTENE	C	0.0	0.0	0.0	0.0	98.0
		CH	0.0	0.0	0.0	0.0	2.0
	TRICHLOROETHENE	H	0.0	50.0	0.0	0.0	0.0
		R	0.0	50.0	0.0	0.0	0.0
	TRICHLOROFLUOROMETHANE	C	0.0	0.0	0.0	83.3	0.0
		H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	16.7	0.0
	VINYL ACETATE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	0.0	0.0	100.0	0.0
	VINYL CHLORIDE	H	0.0	0.0	0.0	0.0	100.0
		R	0.0	100.0	0.0	100.0	0.0
TOTAL ORGANIC CARBON	TOTAL ORGANIC CARBON	P	0.0	100.0	0.0	0.0	0.0

Validation Qualifiers:
BJ = Result was classified as not detect and QC data indicate larger than normal uncertainties
J = Result is estimated, possibly because the vlaue lies between the detection and reporting limits.
U = Result was classified as not detected.
UJ = Result was not detected and QC data indicated presence of larger then normal uncertainties.
UR = Parameter was not detected and was rejected because of QC deficiencies.

Qualification Codes:
A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (i.e., % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
G = Field Duplicate Imprecision
H = Holding Time Exceedance
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
R = Surrogates Recovery Noncompliance

TABLE D-7

WATER SAMPLE QUALIFICATION RATES [1]
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

			Validation Qualifier				
Analytical Fraction	Parameter	Qualification Code	BJ	J	U	UJ	UR

[1] Table shows, for each qualifier, the percentage of data that were qualified as indicated for the reason indicated by the Qualification Code. Unqualified data are not included in these tallies.

TABLE D-8

SOIL SAMPLE QUALIFICATION RATES[1]
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

			Validation Qualifier				
Analytical Fraction	Parameter	Qualification Code	BU	J	U	UJ	UR
VOLATILE ORGANIC COMPOUNDS	1,1,1,2-TETRACHLOROETHANE	N	0.0	0.0	0.0	100.0	0.0
	1,1,1-TRICHLOROETHANE	N	0.0	0.0	0.0	100.0	0.0
	1,1,2,2-TETRACHLOROETHANE	D	0.0	100.0	0.0	0.0	0.0
		N	0.0	0.0	0.0	100.0	0.0
	1,1,2-TRICHLOROETHANE	N	0.0	0.0	0.0	100.0	0.0
	1,1-DICHLOROETHANE	N	0.0	0.0	0.0	100.0	0.0
	1,1-DICHLOROETHENE	D	0.0	0.0	0.0	50.0	0.0
		N	0.0	0.0	0.0	50.0	0.0
	1,2,3-TRICHLOROPROPANE	N	0.0	0.0	0.0	100.0	0.0
	1,2-DIBROMO-3-CHLOROPROPANE	N	0.0	0.0	0.0	100.0	0.0
	1,2-DIBROMOETHANE	N	0.0	0.0	0.0	100.0	0.0
	1,2-DICHLOROETHANE	N	0.0	0.0	0.0	100.0	0.0
	1,2-DICHLOROPROPANE	N	0.0	0.0	0.0	100.0	0.0
	1,4-DIOXANE	C	0.0	0.0	0.0	0.0	100.0
	2-BUTANONE	C	0.0	0.0	0.0	85.7	0.0
		CN	0.0	0.0	0.0	14.3	0.0
	2-HEXANONE	N	0.0	0.0	0.0	100.0	0.0
	3-CHLOROPROPENE	C	0.0	0.0	0.0	85.7	0.0
		CN	0.0	0.0	0.0	14.3	0.0
	4-METHYL-2-PENTANONE	N	0.0	0.0	0.0	100.0	0.0
	ACETONE	B	0.0	50.0	100.0	0.0	0.0
		BC	0.0	50.0	0.0	0.0	0.0
	ACETONITRILE	N	0.0	0.0	0.0	100.0	0.0
	ACROLEIN	C	0.0	0.0	0.0	0.0	100.0
	ACRYLONITRILE	N	0.0	0.0	0.0	100.0	0.0
	BENZENE	N	0.0	0.0	0.0	100.0	0.0
	BROMODICHLOROMETHANE	N	0.0	0.0	0.0	100.0	0.0
	BROMOFORM	N	0.0	0.0	0.0	100.0	0.0
	BROMOMETHANE	N	0.0	0.0	0.0	100.0	0.0
	CARBON DISULFIDE	N	0.0	0.0	0.0	100.0	0.0
		P	0.0	66.7	0.0	0.0	0.0
		PR	0.0	33.3	0.0	0.0	0.0
	CARBON TETRACHLORIDE	N	0.0	0.0	0.0	100.0	0.0
	CHLOROBENZENE	N	0.0	0.0	0.0	100.0	0.0
	CHLORODIBROMOMETHANE	N	0.0	0.0	0.0	100.0	0.0
	CHLOROETHANE	C	0.0	0.0	0.0	100.0	0.0
	CHLOROFORM	N	0.0	0.0	0.0	100.0	0.0
	CHLOROMETHANE	N	0.0	0.0	0.0	100.0	0.0
	CHLOROPRENE	C	0.0	0.0	0.0	0.0	100.0
	CIS-1,2-DICHLOROETHENE	N	0.0	0.0	0.0	100.0	0.0
	CIS-1,3-DICHLOROPROPENE	N	0.0	0.0	0.0	100.0	0.0
	DIBROMOMETHANE	N	0.0	0.0	0.0	100.0	0.0
	DICHLORODIFLUOROMETHANE	N	0.0	0.0	0.0	100.0	0.0
	ETHYL METHACRYLATE	N	0.0	0.0	0.0	100.0	0.0
	ETHYLBENZENE	N	0.0	0.0	0.0	100.0	0.0
	ISOBUTANOL	C	0.0	0.0	0.0	0.0	100.0
	METHACRYLONITRILE	N	0.0	0.0	0.0	100.0	0.0
	METHYL IODIDE	CDE	0.0	0.0	0.0	14.3	0.0

TABLE D-8

SOIL SAMPLE QUALIFICATION RATES[1]
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE, CRANE INDIANA

			Validation Qualifier				
Analytical Fraction	Parameter	Qualification Code	BU	J	U	UJ	UR
		CE	0.0	0.0	0.0	85.7	0.0
	METHYL METHACRYLATE	N	0.0	0.0	0.0	100.0	0.0
	METHYLENE CHLORIDE	A	100.0	0.0	0.0	0.0	0.0
	PENTACHLOROETHANE	N	0.0	0.0	0.0	100.0	0.0
	PROPIONITRILE	C	0.0	0.0	0.0	0.0	100.0
	STYRENE	N	0.0	0.0	0.0	100.0	0.0
	TETRACHLOROETHENE	N	0.0	0.0	0.0	100.0	0.0
	TOLUENE	N	0.0	0.0	0.0	100.0	0.0
	TOTAL XYLENES	N	0.0	0.0	0.0	100.0	0.0
	TRANS-1,2-DICHLOROETHENE	N	0.0	0.0	0.0	100.0	0.0
	TRANS-1,3-DICHLOROPROPENE	N	0.0	0.0	0.0	100.0	0.0
	TRANS-1,4-DICHLORO-2-BUTENE	C	0.0	0.0	0.0	0.0	100.0
	TRICHLOROETHENE	N	0.0	0.0	0.0	100.0	0.0
		P	0.0	100.0	0.0	0.0	0.0
	TRICHLOROFLUOROMETHANE	N	0.0	0.0	0.0	100.0	0.0
	VINYL ACETATE	N	0.0	0.0	0.0	100.0	0.0
	VINYL CHLORIDE	N	0.0	0.0	0.0	100.0	0.0

Validation Qualifiers:
BU = Result was classified as not detect because of laboratory contamination.
J = Result is estimated, possibly because the vlaue lies between the detection and reporting limits.
U = Result was classified as not detected.
UJ = Result was not detected and QC data indicated presence of larger then normal uncertainties.
UR = Parameter was not detected and was rejected because of QC deficiencies.

Qualification Codes:
A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (i.e., % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
N = Internal Standard Noncompliance
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
R = Surrogates Recovery Noncompliance

[1] Table shows, for each qualifier, the percentage of data that were qualified for the reason indicated by the Qualification Code. Unqualified data are not included in these tallies.

APPENDIX D.2

LAB CLOSURE

Pace Analytical®

April 5, 2004

Dear Valued Customer,

We are announcing today the planned closure of our Tulsa laboratory, formerly Southwest Labs of Oklahoma, which Pace Analytical purchased on Oct 1, 2003. You are being sent this information because Pace is currently performing work for you in the Tulsa laboratory. We wanted to notify you so that you would be aware of this issue and would not plan to send samples to the Tulsa lab in the future.

The Tulsa laboratory will stop accepting samples the week of April 5, 2004. Upon completion of all current projects, the lab will be closed. Pace Analytical will continue to support all of your needs for dioxin and air toxics from our Minnesota laboratory. Radiochemistry will be relocated to our Waltz Mill, PA facility. Pace also has eleven laboratories across the US and Puerto Rico to serve your routine environmental testing needs. We will work with you to find a home for any future work that has requirements that cannot be met by Pace.

Pace has made the decision to close this laboratory because we have recently uncovered practices in connection with certain tests in our volatile organics department that were not consistent with EPA Method requirements and are not in compliance with the Pace Quality Program. These compliance issues have been disclosed to the EPA. These practices have been corrected and any current work will not be impacted. We are communicating any specific data concerns to our customers. We have evaluated the work that was performed for you and found that some of your projects have been affected. The issue that we have uncovered is related to documentation of standards. **The sample results reported to you will not change, only the supporting documentation is affected.** We will be contacting you as quickly as possible to determine how you would like us to proceed.

We want you to know that we strictly adhere to our quality programs at Pace. We apologize for any inconvenience that the closure of this laboratory will cause you and we will work hard to repair any damage this might cause to our relationship. Pace is known throughout the industry for its data quality and ethical standards. We will attempt to contact you today to answer any questions that you might have.

Sincerely,

Jack Dullaghan
Chief Operating Officer
Pace Analytical Services, Inc.

APPENDIX E

TEMPORAL CONCENTRATION AND MASS PLOTS FOR REPRESENTATIVE CHEMICALS OF CONCERN

APPENDIX E.1

1,1,2,2-TETRACHLOROETHANE

TABLE E.1-1. DATA FOR RATE CONSTANT CALCULATIONS FOR 1,1,2,2-TETRACHLOROETHANE ATTENUATION IN GROUND WATER

Well	Date Sampled	Concentration	Validation Qualifier	Units	ln conc
01-02	10/5/1982	36000		UG/L	10.49
01-02	11/18/1982	589000		UG/L	13.29
01-02	1/8/1985	525		UG/L	6.26
01-02	1/29/1986	66000		UG/L	11.10
01-02	9/18/01	38000		UG/L	10.55
01-02	6/27/02	30		UG/L	3.40
01-02	2/3/04	59		UG/L	4.08
01-05	10/5/1982	58		UG/L	4.06
01-05	1/7/1985	85.9		UG/L	4.45
01-05	1/29/1986	7		UG/L	1.95
01-05	10/3/01	9	J	UG/L	2.20
01-05	6/27/02	8		UG/L	2.08
01-05	2/4/04	6		UG/L	1.79
01-11	1/7/1985	138		UG/L	4.93
01-11	1/29/1986	760		UG/L	6.63
01-11	8/30/01	170		UG/L	5.14
01-11	6/25/02	1		UG/L	0.00
01-11	2/3/04	1	U	UG/L	0.00
01-12	1/25/1983	6000		UG/L	8.70
01-12	1/7/1985	518		UG/L	6.25
01-12	1/29/1986	280		UG/L	5.63
01-12	9/18/01	230		UG/L	5.44
01-12	1/29/04	320		UG/L	5.77
01-15	2/15/1983	1500		UG/L	7.31
01-15	4/20/1983	1450		UG/L	7.28
01-15	1/7/1985	230		UG/L	5.44
01-15	1/28/1986	27		UG/L	3.30
01-15	09/17/01	250		UG/L	5.52
01-15	06/27/02	230		UG/L	5.44
01-15	02/02/04	49		UG/L	3.89
01-19	1/8/1985	146		UG/L	4.98
01-19	1/28/1986	300		UG/L	5.70
01-19	10/03/01	270		UG/L	5.60
01-19	02/03/04	280		UG/L	5.63
01-22	7/14/1983	50		UG/L	3.91
01-22	1/8/1985	65.3		UG/L	4.18
01-22	1/28/1986	120		UG/L	4.79
01-22	10/9/01	150	J	UG/L	5.01
01-22	2/2/04	71		UG/L	4.26
01-25	1/28/86	42		UG/L	3.74
01-25	9/19/01	32		UG/L	3.47
01-25	6/25/02	24		UG/L	3.18
01-25	1/28/04	29		UG/L	3.37

FIGURE E.1-1 TEMPORAL GROUND WATER DATA FOR WELL 01-02
1,1,2,2-TETRACHLOROETHANE

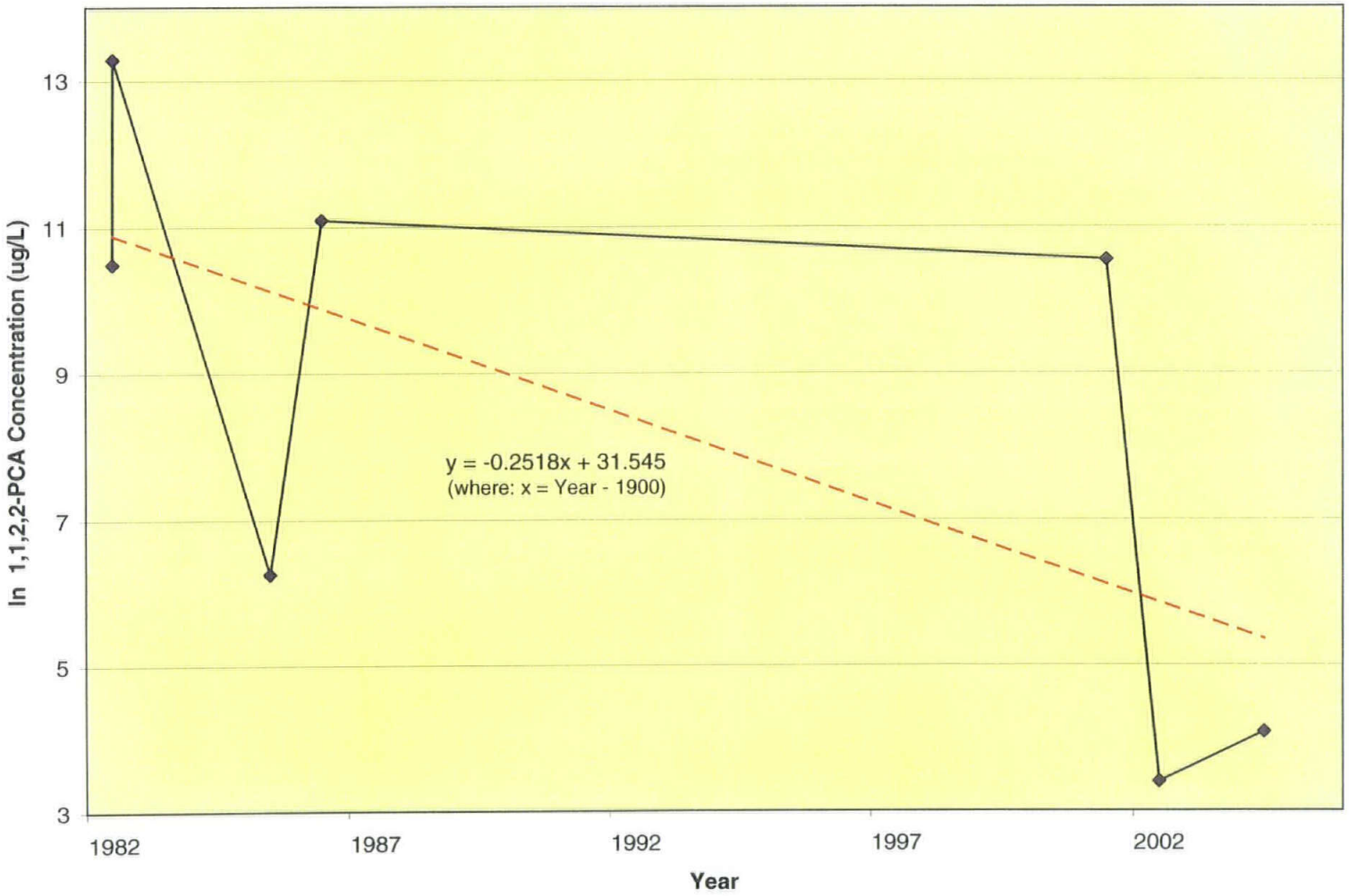


FIGURE E.1-2. TEMPORAL GROUND WATER DATA FOR WELL 01-05
1,1,2,2-TETRACHLOROETHANE

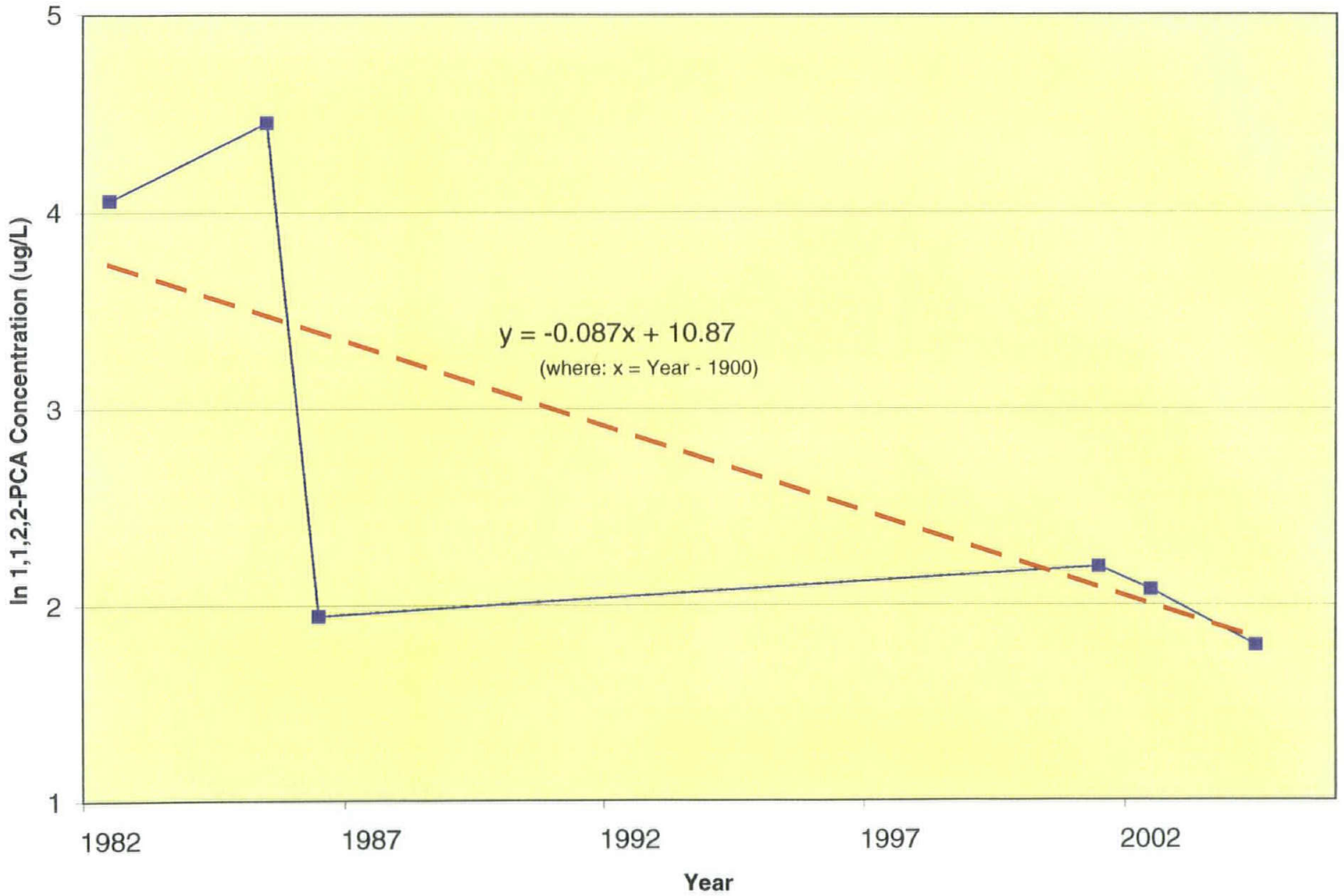


FIGURE E.1-3. TEMPORAL GROUND WATER DATA FOR WELL 01-11
1,1,2,2-TETRACHLOROETHANE

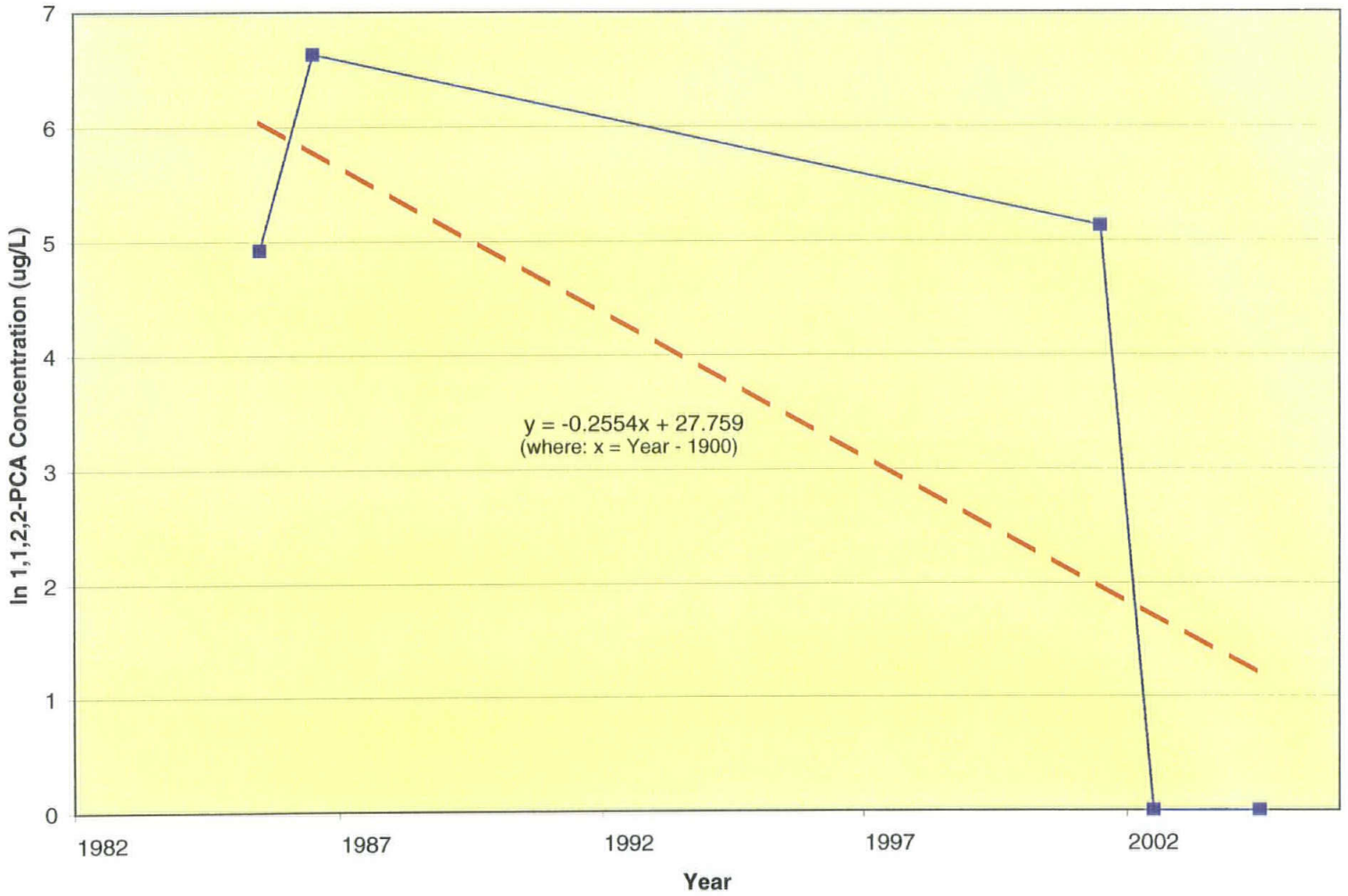


FIGURE E.1-4. TEMPORAL GROUND WATER DATA FOR WELL 01-12
1,1,2,2-TETRACHLOROETHANE

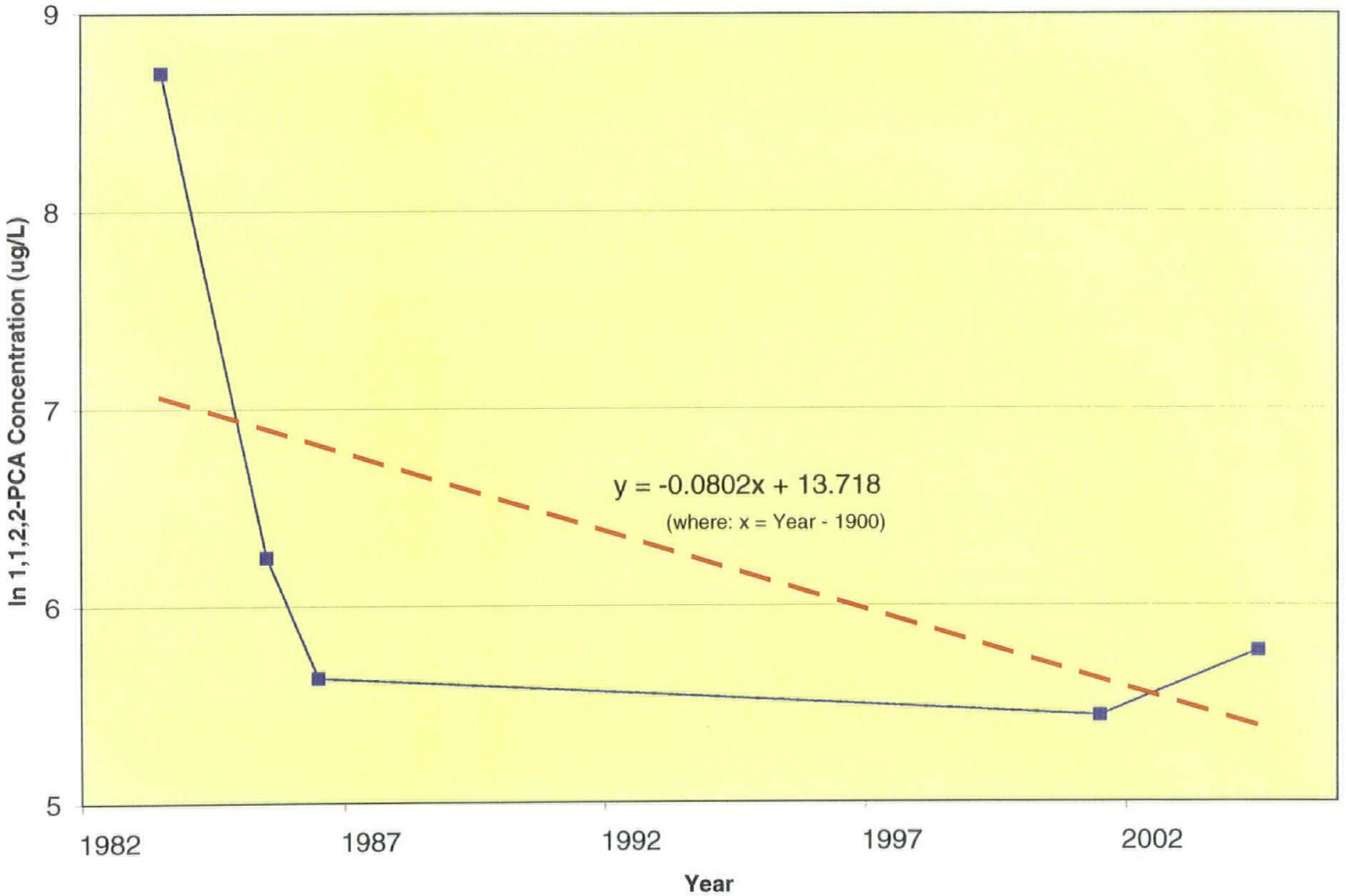


FIGURE E.1-5. TEMPORAL GROUND WATER DATA FOR WELL 01-15
1,1,2,2-TETRACHLOROETHANE

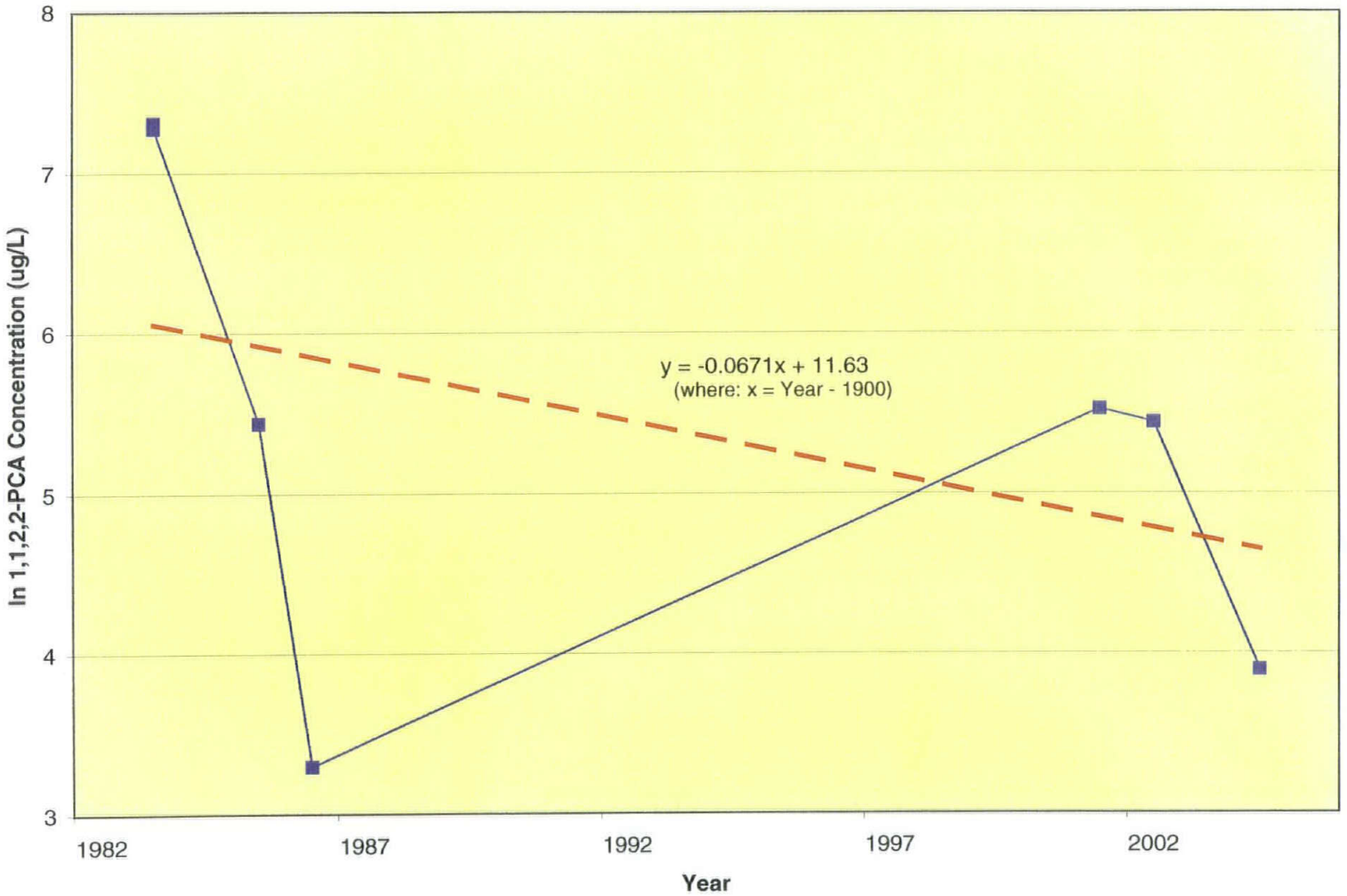


FIGURE E.1-6. TEMPORAL GROUND WATER DATA FOR WELL 01-19
1,1,2,2-TETRACHLOROETHANE

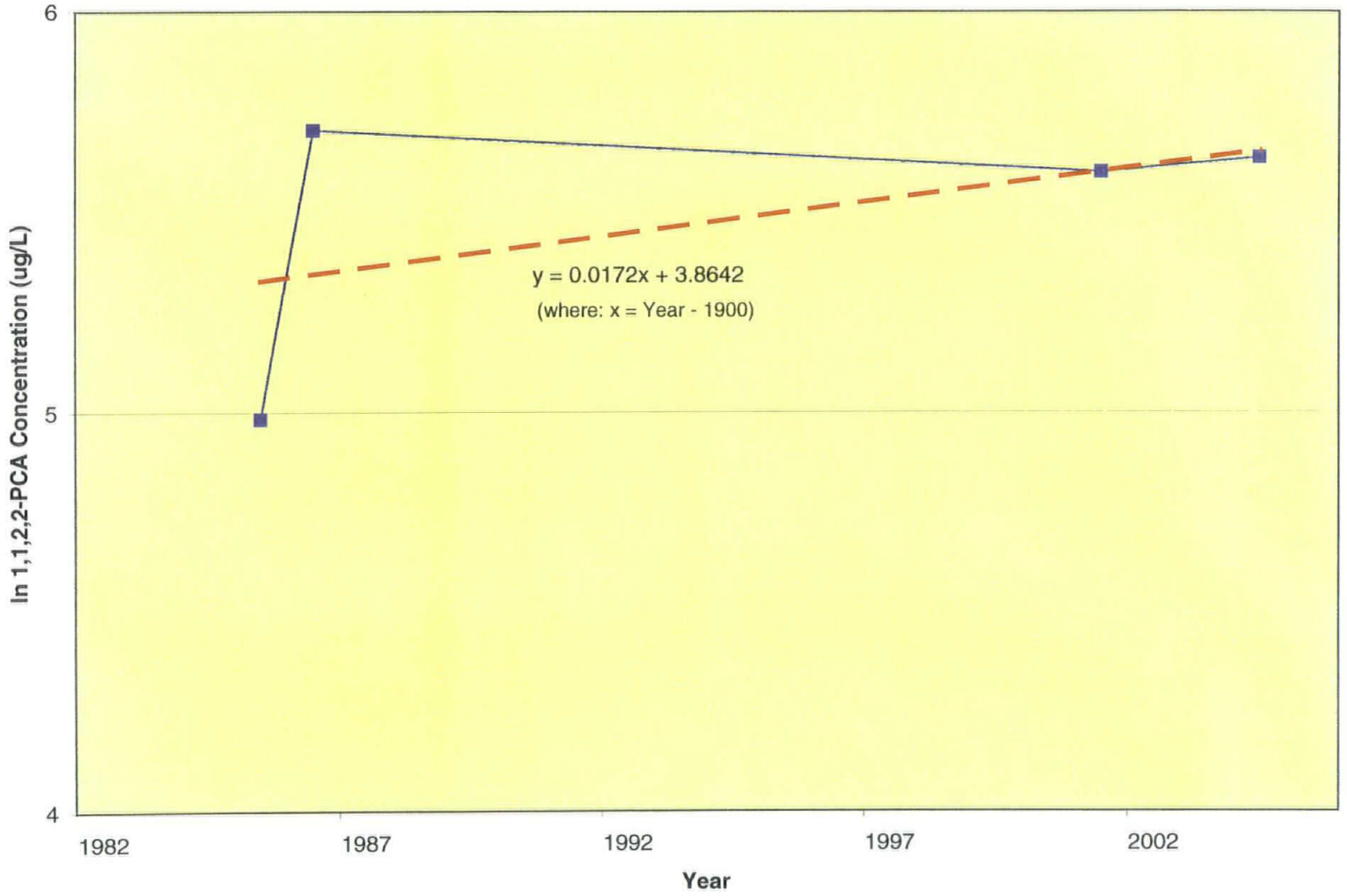


FIGURE E.1-7. TEMPORAL GROUND WATER DATA FOR WELL 01-22
1,1,2,2-TETRACHLOROETHANE

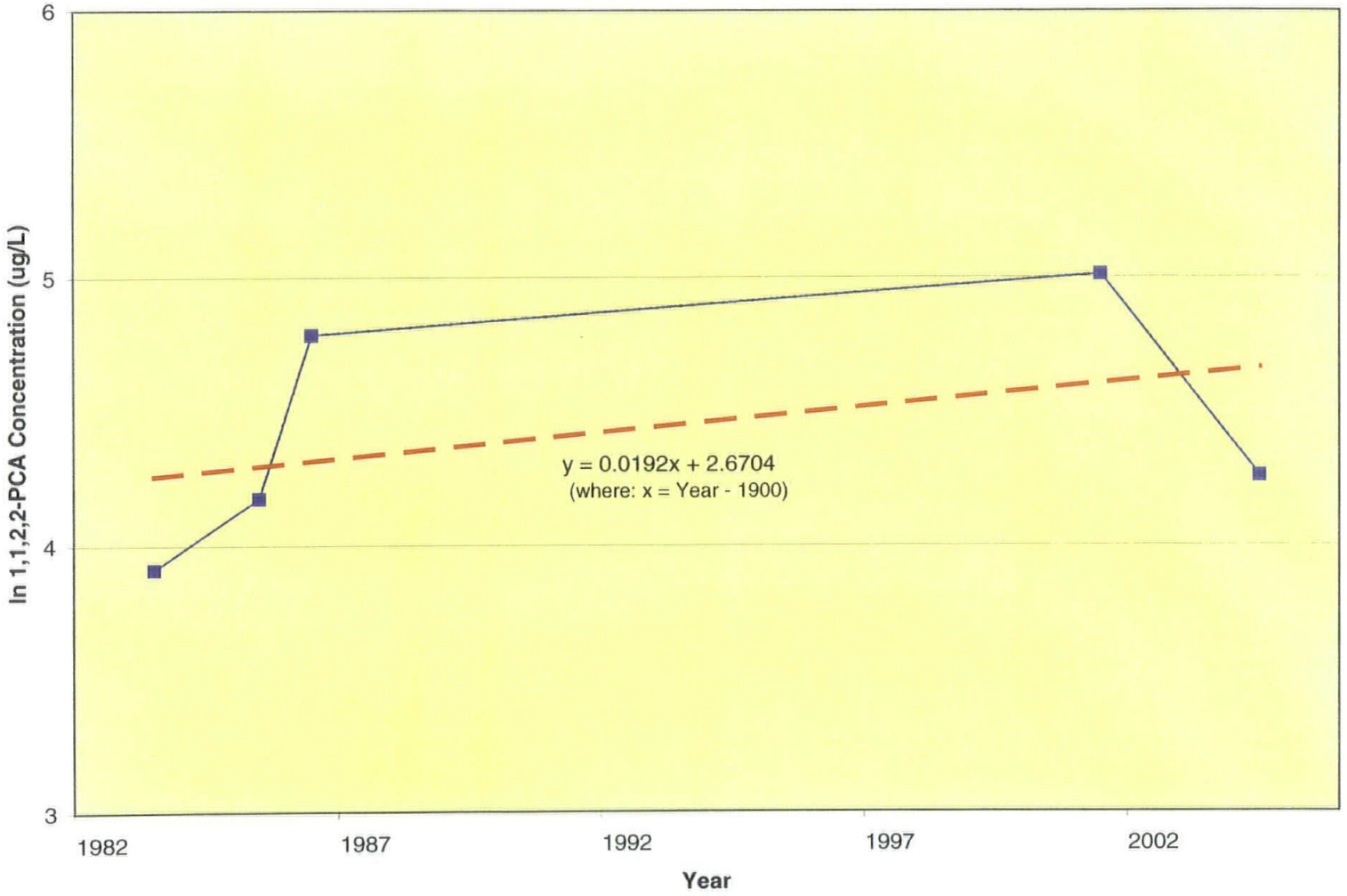


FIGURE E.1-8. TEMPORAL GROUND WATER DATA FOR WELL 01-25
1,1,2,2-TETRACHLOROETHANE

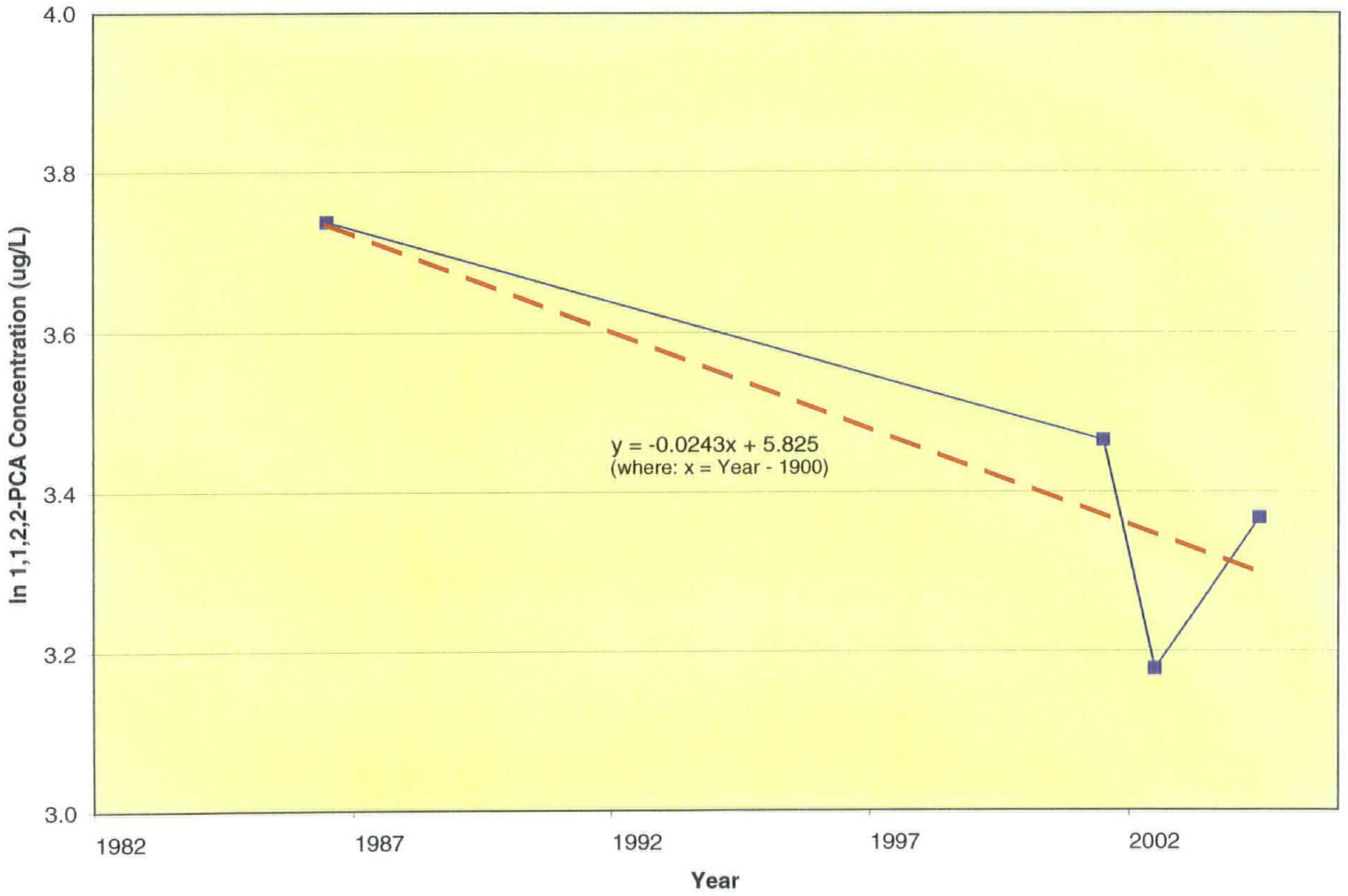


FIGURE E.1-9. RATE CONSTANT CALCULATIONS FOR 1,1,2,2-TETRACHLOROETHANE ATTENUATION IN GROUND WATER

Well No.	Attenuation Rate Constant[1] ($year^{-1}$)
01-02	-0.2518
01-05	-0.087
01-11	-0.2554
01-12	-0.0802
01-15	-0.0671
01-19	0.0172
01-22	0.0192
01-25	-0.0243

1 Assumes first order decay model.
Constants computed from linear least squares fit of concentration data over time.

Calculations by: J. Schubert, TtNUS
Checked by: T. Johnston, TtNUS

Slope value statistics for boxed values to left:

minimum=	-0.2554				
maximum=	0.0172				
median=	-0.0836	=k	$t_{1/2}$ =LN(2)/(-k)	8.3	years

where $t_{1/2}$ = half life.

Decay Model: **First order; uses median decay rate to compute C_{MCS}.**

$C_t = C_0 \cdot e^{-kt}$ where C_t = concentration at time = t.
and C_0 = initial concentration (at t=0)

Time, t_{RBCL}, required to reach RBCL without treatment
Using maximum concentration and median slope:

C_t = MCS = 0.9 ug/L C_0 = 660 ug/L = maximum concentration in 2004
-k = -0.0836 $t_{MCS} = [Ln(C_t/C_0)]/(-k)$
t = LN(0.9/660)/(-0.0836) = 80 years

Note: The maximum value in 2004 (C_0 = 660 ug/L) was detected in well 01T07. This value is not shown in Table E.1-1; however, it is listed in Table 2-2 and posted on Figure 2-2.

Using Median concentration and median slope:

C_t = RBCL = 0.9 ug/L C_0 = 29 ug/L = median well concentration in 2004.
-k = -0.0836 $t_{MCS} = [Ln(C_t/C_0)]/(-k)$
t = LN(0.9/29)/(-0.0836) = 42 years

% TCE Concentration Reduction to Achieve Cleanup Goals or PRGs:

(Med-MCS)/Med 0.98 where Med = median concentration

FIGURE E.2-9. RATE CONSTANT CALCULATIONS FOR TRICHLOROETHENE ATTENUATION IN GROUND WATER

Well No.	Attenuation Rate Constant[1] ($year^{-1}$)
01-02	-0.2657
01-05	-0.0467
01-11	-0.1538
01-12	-0.0728
01-15	0.0102
01-19	0.0275
01-22	0.0142
01-25	0.0191

1 Assumes first order decay model.
Constants computed from linear least squares fit of concentration data over time.

Slope value statistics for boxed values to left:

minimum= -0.2657
maximum= 0.0275
median= -0.05975 $t_{1/2}$ = 11.6 years

Decay Model: **First order; uses median decay rate to compute C_{MCS}.**

$C_t = C_0 \cdot e^{-kt}$ where C_t = concentration at time = t.
and C_0 = initial concentration (at t=0)

Time, t_{RBCL}, required to reach RBCL without treatment
Using maximum concentration and median slope:

C_t = MCS = 5 ug/L C_0 = 620 ug/L = maximum concentration in 2004
-k = -0.05975 $t_{MCS} = [Ln(C_t/C_0)]/(-k)$
t = LN(5/660)/(-0.05975) = 80 years

Note: The maximum value in 2004 (C_o = 620 ug/L) was detected in well 01T07. This value is not shown in Table E.2-1; however, it is listed in Table 2-2 and posted on Figure 2-1.

Using Median concentration and median slope:

C_t = MCS = 5 ug/L C_0 = 30 ug/L = median concentration in 2004
-k = -0.05975 $t_{MCS} = [Ln(C_t/C_0)]/(-k)$
t = LN(5/30)/(-0.05975) = 30 years

% TCE Concentration Reduction to Achieve Cleanup Goals or PRGs:

(Med-MCS)/Med 0.96 where Med = median concentration

Calculations by: J. Schubert, TtNUS
Checked by: T. Johnston, TtNUS

FIGURE E.3-9. RATE CONSTANT CALCULATIONS FOR CHLOROFORM ATTENUATION IN GROUND WATER

Well No.	Attenuation Rate Constant[1] ($year^{-1}$)
01-02	-0.0357
01-05	NA
01-11	-0.0409
01-12	-0.0376
01-15	-0.1016
01-19	-0.041
01-22	0.0604
01-25	-0.0173

1 Assumes first order decay model.
Constants computed from linear least squares fit of concentration data over time.

Calculations by: J. Schubert, TtNUS
Checked by: T. Johnston, TtNUS

Slope value statistics for boxed values to left:

minimum=	-0.1016			
maximum=	-0.0357			
median=	-0.0409	$t_{1/2}$ =	16.9	years

Decay Model: **First order; uses median decay rate to compute C_{prg}.**

$C_t = C_0 \cdot e^{-kt}$ where C_t = concentration at time = t.
and C_0 = initial concentration (at t=0)

Time, t_{RBCL}, required to reach RBCL without treatment
Using Maximum Conncetration and median slope:

C_t = MCS = 80 ug/L C_0 = 790 ug/L = maximum concentration in 2004
-k = -0.0409 $t_{MCS} = [Ln(C_t/C_0)]/(-k)$
t = LN(80/790)/(-0.0409) = 60 years

Note: The maximum value in 2004 (C_o = 790 ug/L) was detected in well 01T07. This value is not shown in Table E.3-1; however, it is listed in Table 2-2.

Using Median concentration and median slope:
Does not apply because median concentration is 2 ug/L, which is already less than the MCS (80 ug/L).

APPENDIX E.2

TRICHLORETHENE

TABLE E.2-1. DATA FOR RATE CONSTANT CALCULATIONS FOR TRICHLOROETHENE ATTENUATION IN GROUND WATER

Well	Date Sampled	Concentration	Validation Qualifier	Units	ln conc
01-02	10/5/1982	36000		UG/L	10.49
01-02	11/18/1982	589000		UG/L	13.29
01-02	1/8/1985	525		UG/L	6.26
01-02	1/29/1986	66000		UG/L	11.10
01-02	9/18/01	38000		UG/L	10.55
01-02	6/27/02	30		UG/L	3.40
01-02	2/3/04	59		UG/L	4.08
01-05	10/5/1982	58		UG/L	4.06
01-05	1/7/1985	85.9		UG/L	4.45
01-05	1/29/1986	7		UG/L	1.95
01-05	10/9/01	550	J	UG/L	6.31
01-05	6/27/02	840		UG/L	6.73
01-05	2/4/04	320		UG/L	5.77
01-11	1/11/1983	150		UG/L	5.01
01-11	1/29/1986	500		UG/L	6.21
01-11	8/30/01	180	J	UG/L	5.19
01-11	6/25/02	15		UG/L	2.71
01-11	2/2/04	3		UG/L	1.10
01-12	1/25/1983	2300		UG/L	7.74
01-12	1/29/1986	180		UG/L	5.19
01-12	9/18/01	190		UG/L	5.25
01-12	1/29/04	220		UG/L	5.39
01-15	2/15/1983	330		UG/L	5.80
01-15	4/20/1983	145		UG/L	4.98
01-15	1/7/1985	301		UG/L	5.71
01-15	1/28/1986	12		UG/L	2.48
01-15	9/17/01	310		UG/L	5.74
01-15	6/27/02	360		UG/L	5.89
01-15	2/2/04	51		UG/L	3.93
01-19	6/27/1983	180		UG/L	5.19
01-19	1/8/1985	221		UG/L	5.40
01-19	1/28/1986	240		UG/L	5.48
01-19	10/3/01	300		UG/L	5.70
01-19	2/3/04	380		UG/L	5.94
01-22	7/14/1983	80		UG/L	4.38
01-22	1/8/1985	117		UG/L	4.76
01-22	1/28/1986	140		UG/L	4.94
01-22	10/9/01	120	J	UG/L	4.79
01-22	2/2/04	150		UG/L	5.01
01-25	1/28/1986	59		UG/L	4.08
01-25	9/19/01	65	J	UG/L	4.17
01-25	6/25/02	74		UG/L	4.30
01-25	1/28/04	96		UG/L	4.56

exactly the same as 1122 PCA

FIGURE E.2-1. TEMPORAL GROUND WATER DATA FOR WELL 01-02
TRICHLOROETHENE

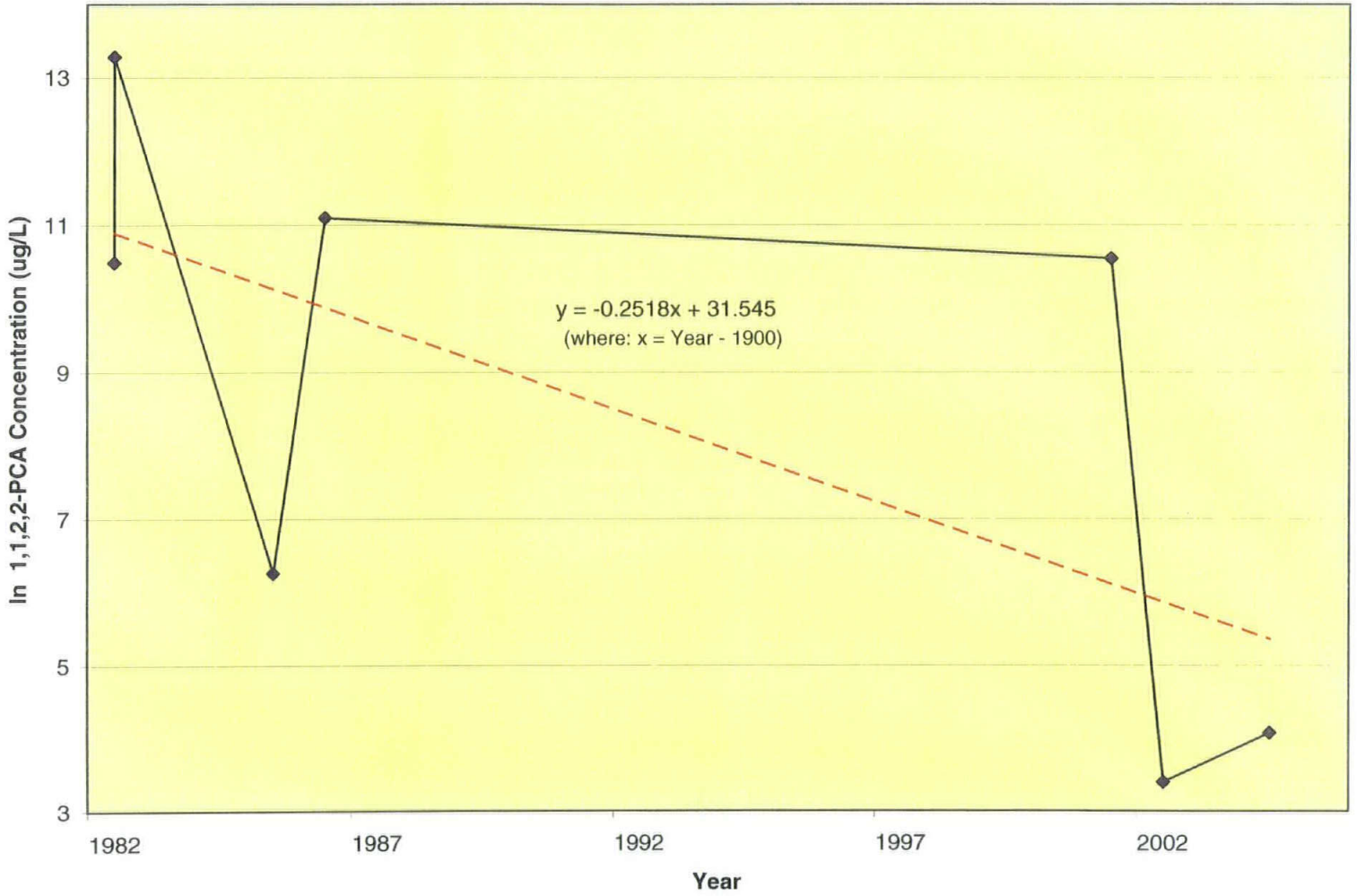


FIGURE E.2-2. TEMPORAL GROUND WATER DATA FOR WELL 01-05
TRICHLOROETHENE

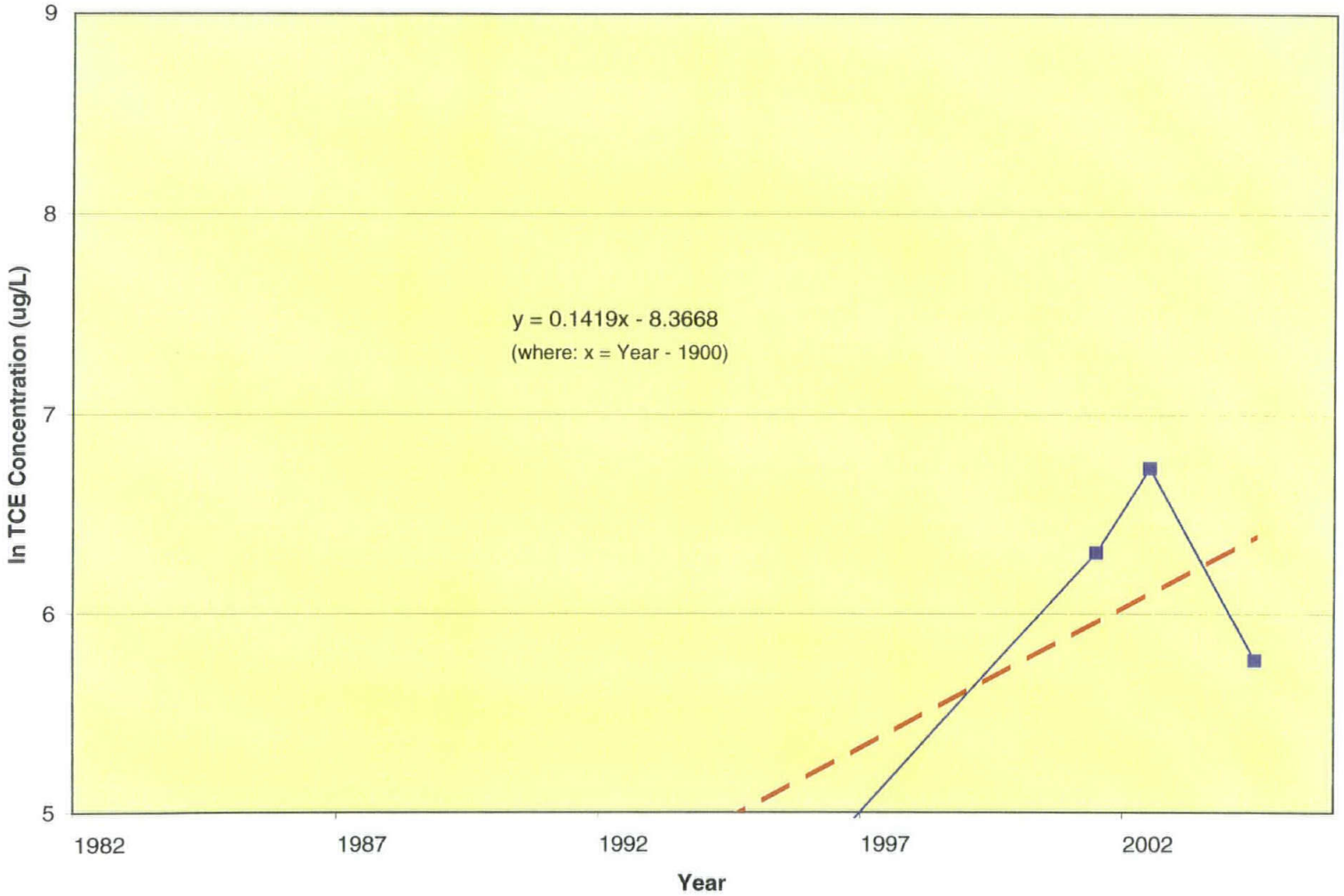


FIGURE E.2-3. TEMPORAL GROUND WATER DATA FOR WELL 01-11
TRICHLOROETHENE

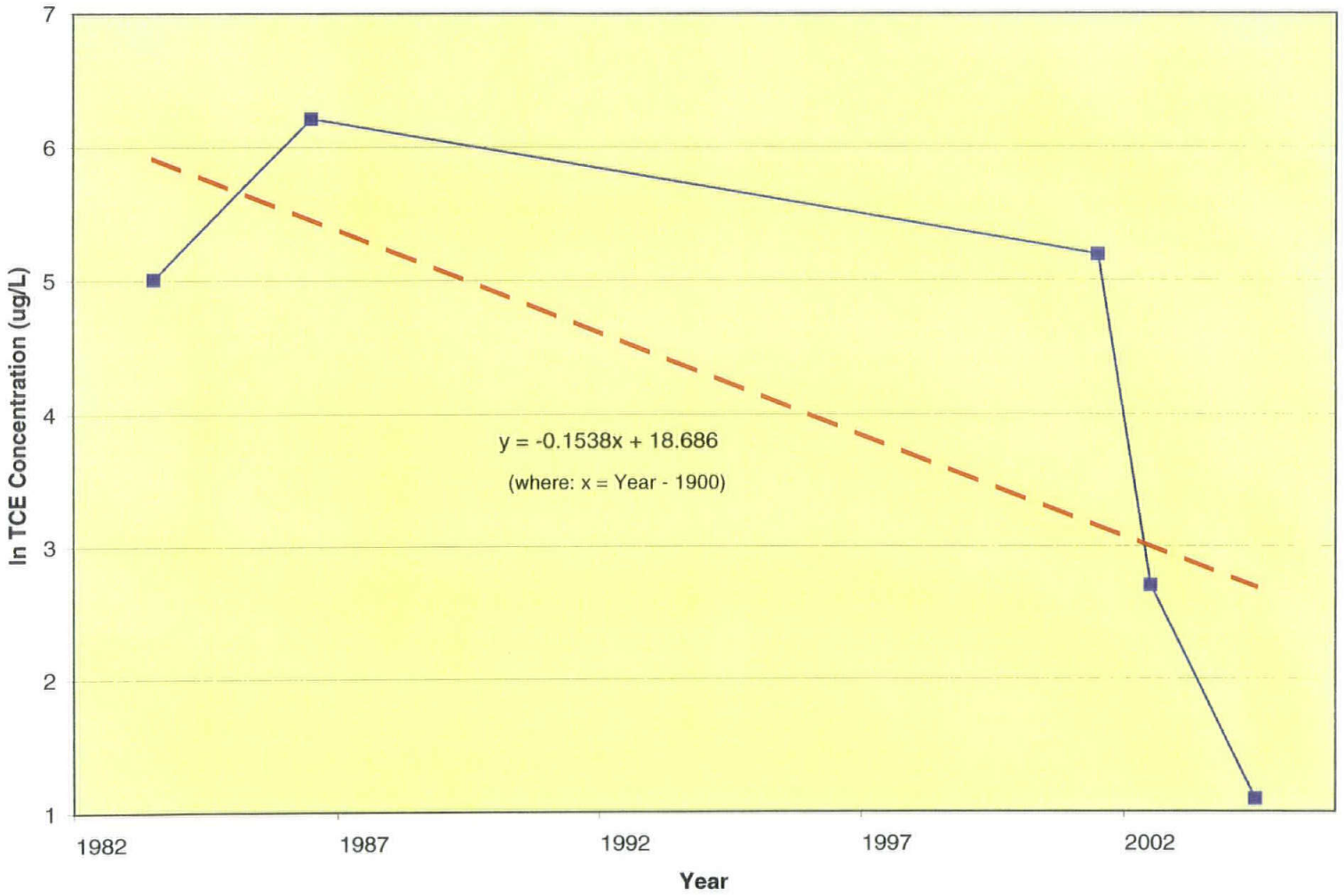


FIGURE E.2-4. TEMPORAL GROUND WATER DATA FOR WELL 01-12
TRICHLOROETHENE

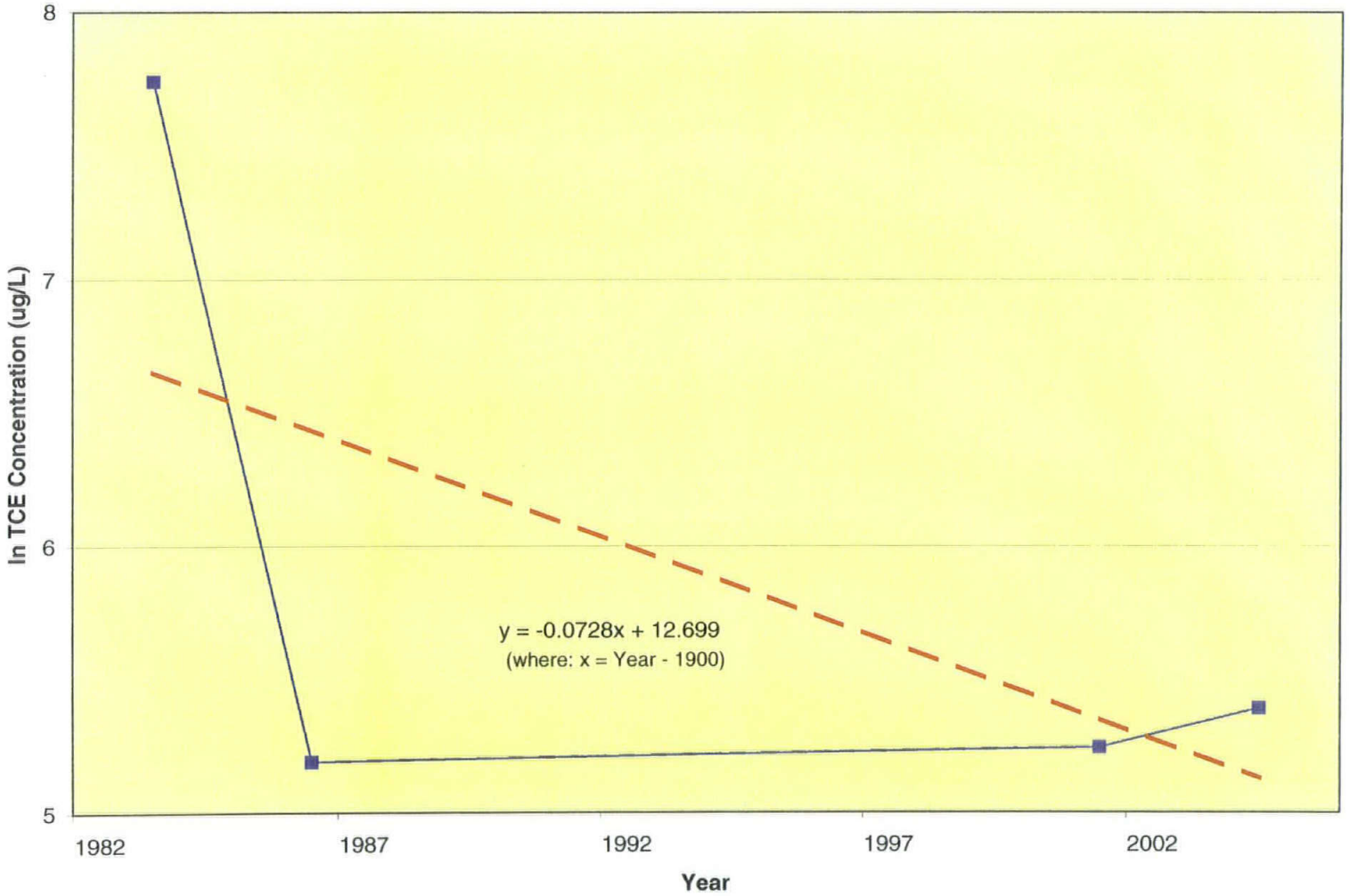


FIGURE E.2-5. TEMPORAL GROUND WATER DATA FOR WELL 01-15
TRICHLOROETHENE

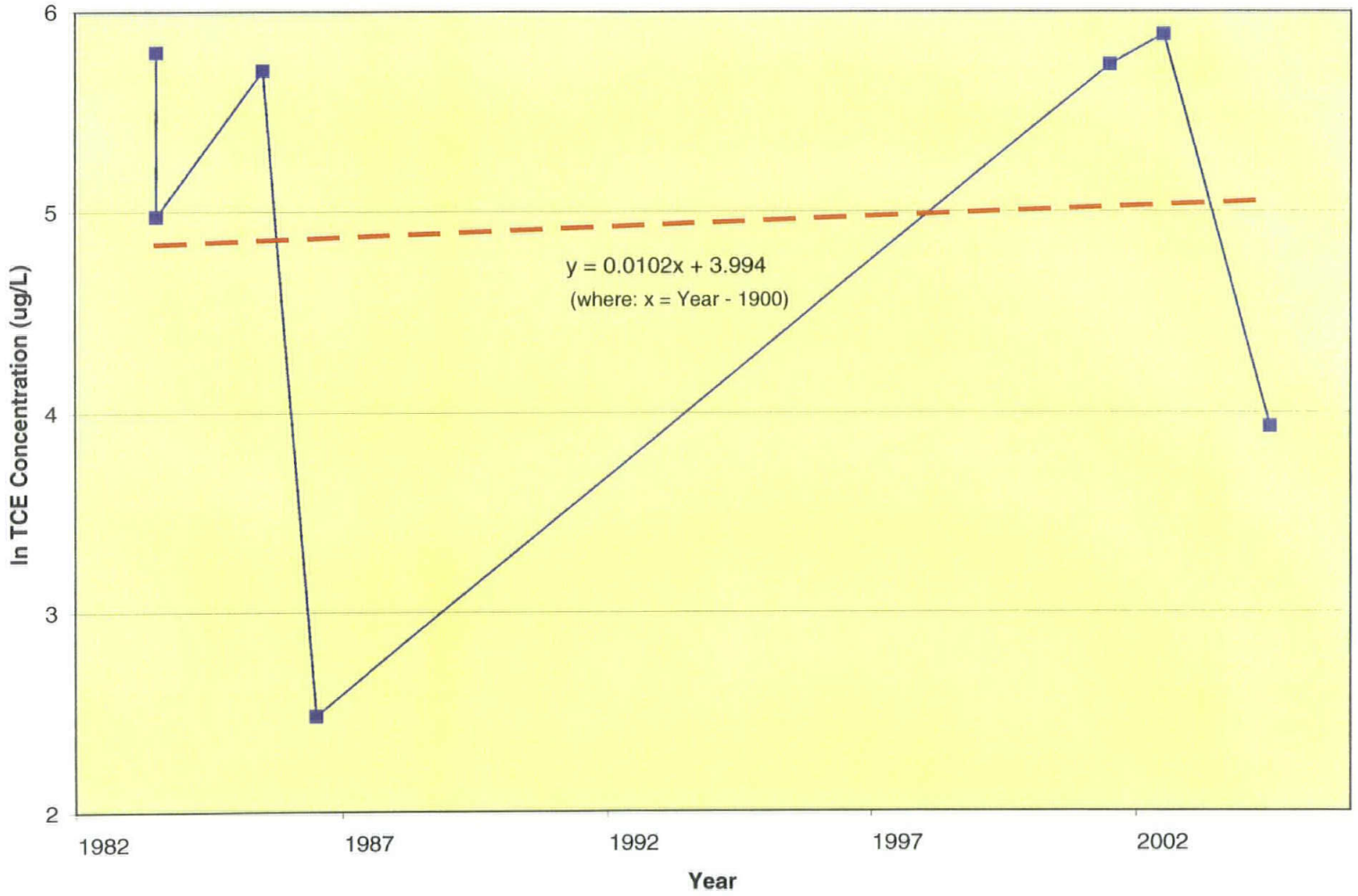


FIGURE E.2-6. TEMPORAL GROUND WATER DATA FOR WELL 01-19
TRICHLOROETHENE

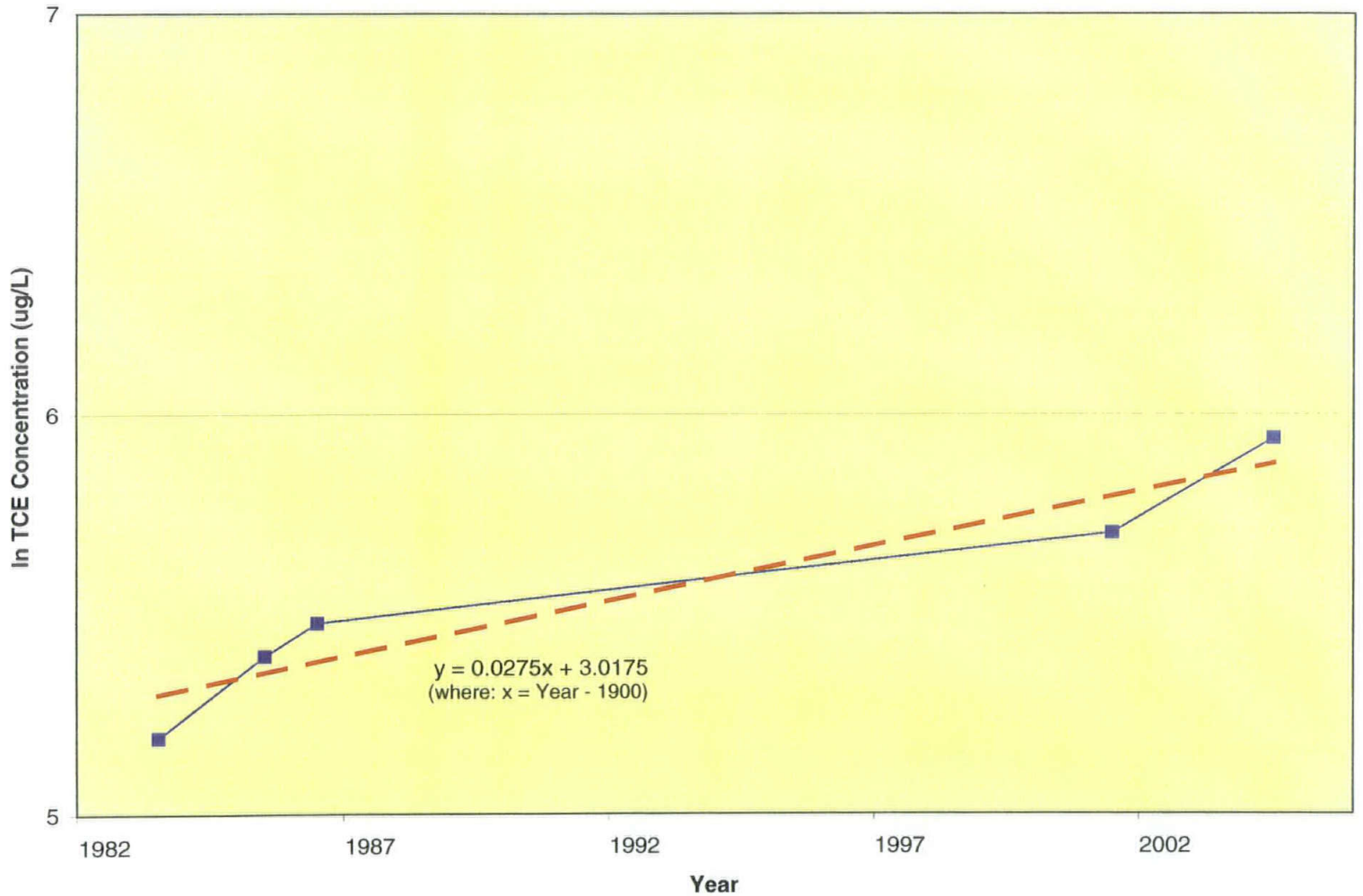


FIGURE E.2-7. TEMPORAL GROUND WATER DATA FOR WELL 01-22
TRICHLOROETHENE

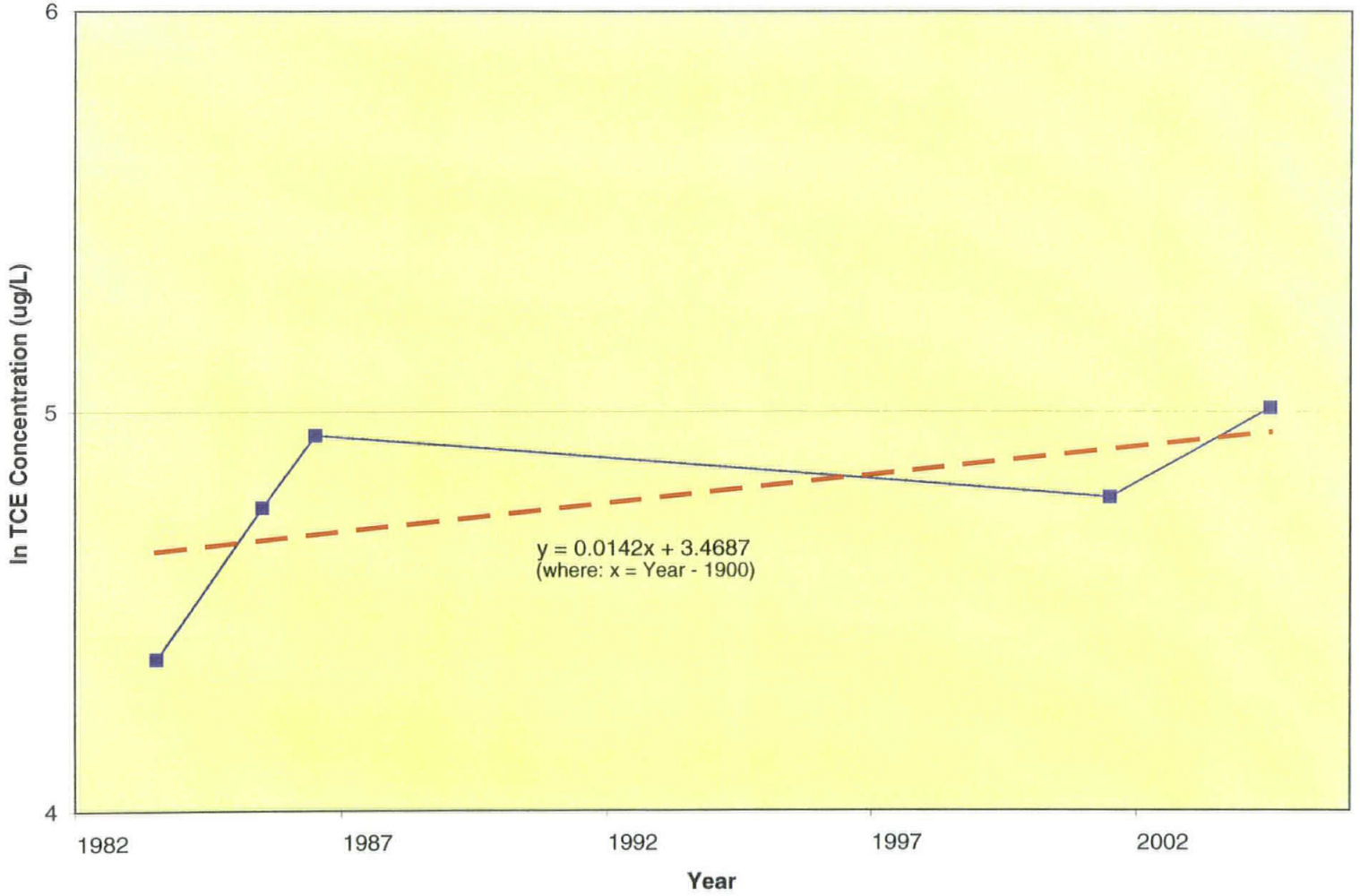


FIGURE E.2-8. TEMPORAL GROUND WATER DATA FOR WELL 01-25
TRICHLOROETHENE

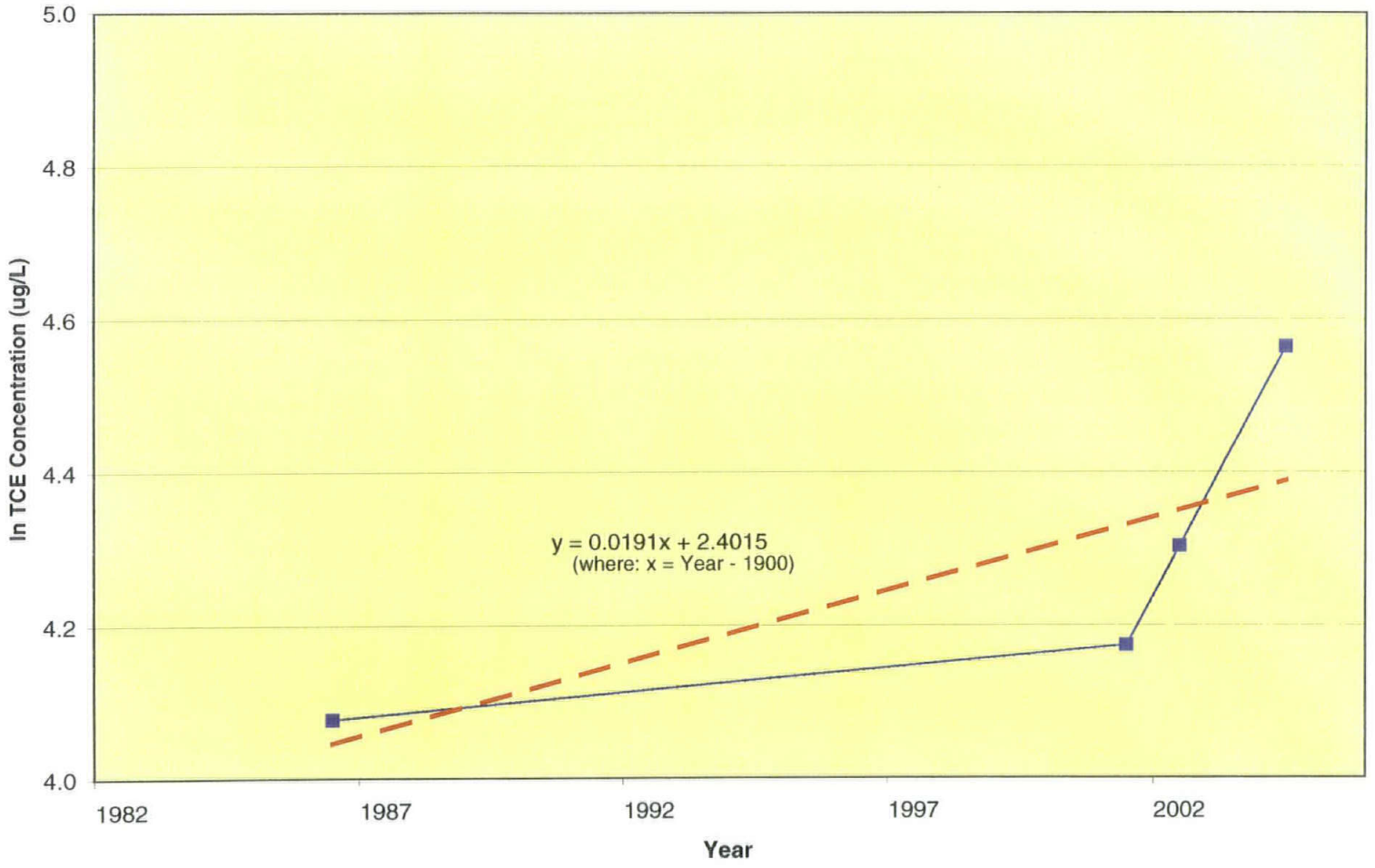


FIGURE E.2-9. RATE CONSTANT CALCULATIONS FOR TRICHLOROETHENE ATTENUATION IN GROUND WATER

Well No.	Attenuation Rate Constant[1] ($year^{-1}$)
01-02	-0.2657
01-05	-0.0467
01-11	-0.1538
01-12	-0.0728
01-15	0.0102
01-19	0.0275
01-22	0.0142
01-25	0.0191

1 Assumes first order decay model.
Constants computed from linear least squares fit of decay data.

Slope value statistics for boxed values to left:

minimum= -0.2657
maximum= 0.0275
median= -0.05975 $t_{1/2}$ = 11.6 years

Decay Model: **First order; uses median decay rate to compute C_{MCS}.**

$C_t = C_0 \cdot e^{-kt}$ where C_t = concentration at time = t.
and C_0 = initial concentration (at t=0)

Time, t_{RBCL}, required to reach RBCL without treatment
Using maximum concentration and median slope:

C_t = MCS = 5 ug/L C_0 = 660 ug/L = maximum concentration in 2004
-k = -0.05975 $t_{MCS} = [Ln(C_t/C_0)]/(-k)$
t = LN(5/660)/(-0.05975) = 80 years

Using Median concentration and median slope:

C_t = MCS = 5 ug/L C_0 = 30 ug/L = median concentration in 2004
-k = -0.05975 $t_{MCS} = [Ln(C_t/C_0)]/(-k)$
t = LN(5/30)/(-0.05975) = 30 years

% TCE Concentration Reduction to Achieve Cleanup Goals or PRGs:

(Med-MCS)/Med 0.96 where Med = median concentration

Calculations by: J. Schubert, TtNUS
Checked by: T. Johnston, TtNUS

APPENDIX E.3

CHLOROFORM

TABLE E.3-1. DATA FOR RATE CONSTANT CALCULATIONS FOR CHLOROFORM ATTENUATION IN GROUND WATER

Well	Date Sampled	Concentration	Validation Qualifier	Units	ln conc
01-02	10/5/1982	2000		UG/L	7.60
01-02	11/18/1982	1	U	UG/L	0.00
01-02	1/8/1985	1	U	UG/L	0.00
01-02	9/18/01	840	J	UG/L	6.73
01-02	6/27/02	1		UG/L	0.00
01-02	2/3/04	1.5		UG/L	0.41
01-05	10/5/1982	1	U	UG/L	0.00
01-05	1/7/1985	1	U	UG/L	0.00
01-05	2/4/04	1	U	UG/L	0.00
01-05	10/3/01	1	BU	UG/L	0.00
01-05	6/27/02	1	U	UG/L	0.00
01-11	1/7/1985	1	U	UG/L	0.00
01-11	1/29/1986	20		UG/L	3.00
01-11	8/30/01	15		UG/L	2.71
01-11	6/25/02	1	J	UG/L	0.00
01-11	2/3/04	1	U	UG/L	0.00
01-12	1/25/1983	53		UG/L	3.97
01-12	1/7/1985	13		UG/L	2.56
01-12	1/29/1986	5		UG/L	1.61
01-12	9/18/01	9	BJ	UG/L	2.20
01-12	1/29/04	9	BJ	UG/L	2.20
01-15	2/15/1983	39		UG/L	3.66
01-15	4/20/1983	8		UG/L	2.08
01-15	1/7/1985	13.8		UG/L	2.62
01-15	6/27/02	6		UG/L	1.79
01-15	2/2/04	1		UG/L	0.00
01-19	6/27/1983	15		UG/L	2.71
01-19	1/8/1985	10		UG/L	2.30
01-19	1/28/1986	14		UG/L	2.64
01-19	10/3/01	27	J	UG/L	3.30
01-19	2/3/04	2	J	UG/L	0.69
01-22	7/14/1983	4		UG/L	1.39
01-22	1/8/1985	4.4		UG/L	1.48
01-22	1/28/1986	8		UG/L	2.08
01-22	10/3/01	15	J	UG/L	2.71
01-22	2/2/04	15		UG/L	2.71
01-25	1/28/1986	5	U	UG/L	1.61
01-25	9/19/01	7	J	UG/L	1.95
01-25	6/25/02	6		UG/L	1.79
01-25	1/28/04	7		UG/L	1.95

FIGURE E.3-1. TEMPORAL GROUND WATER DATA FOR WELL 01-02
CHLOROFORM

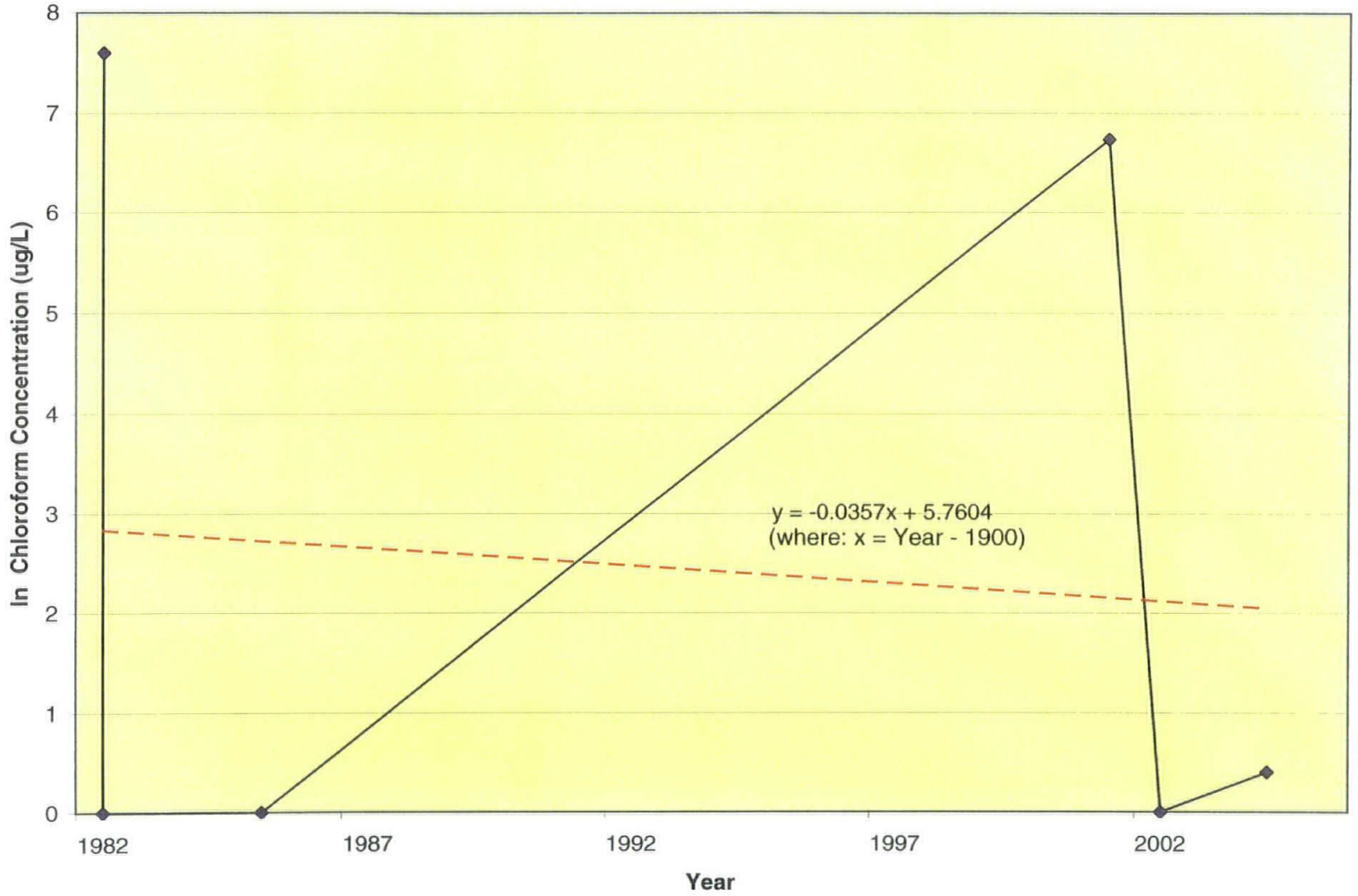


FIGURE E.3-2. TEMPORAL GROUND WATER DATA FOR WELL 01-05
CHLOROFORM

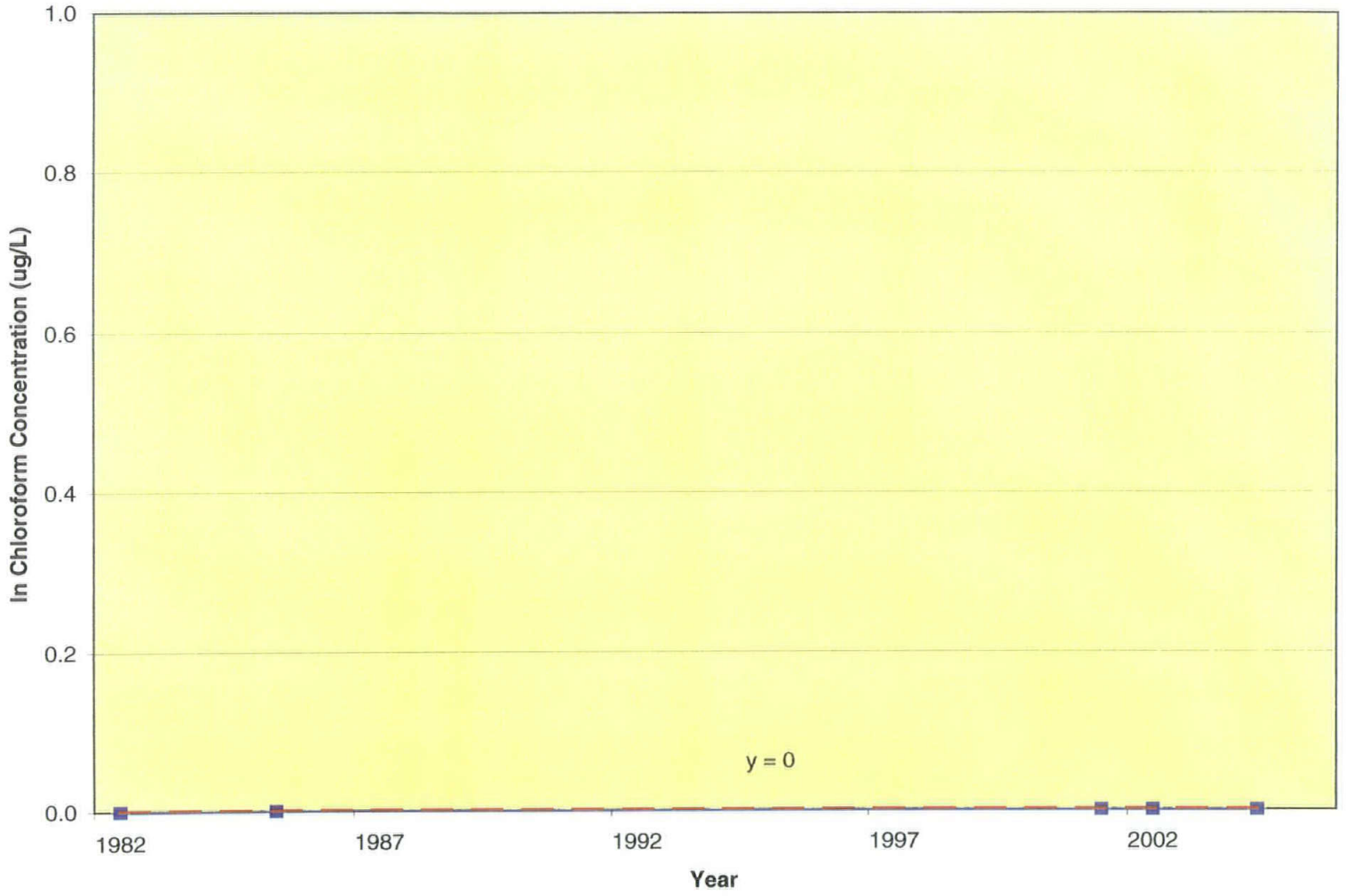


FIGURE E.3-3 TEMPORAL GROUND WATER DATA FOR WELL 01-11
CHLOROFORM

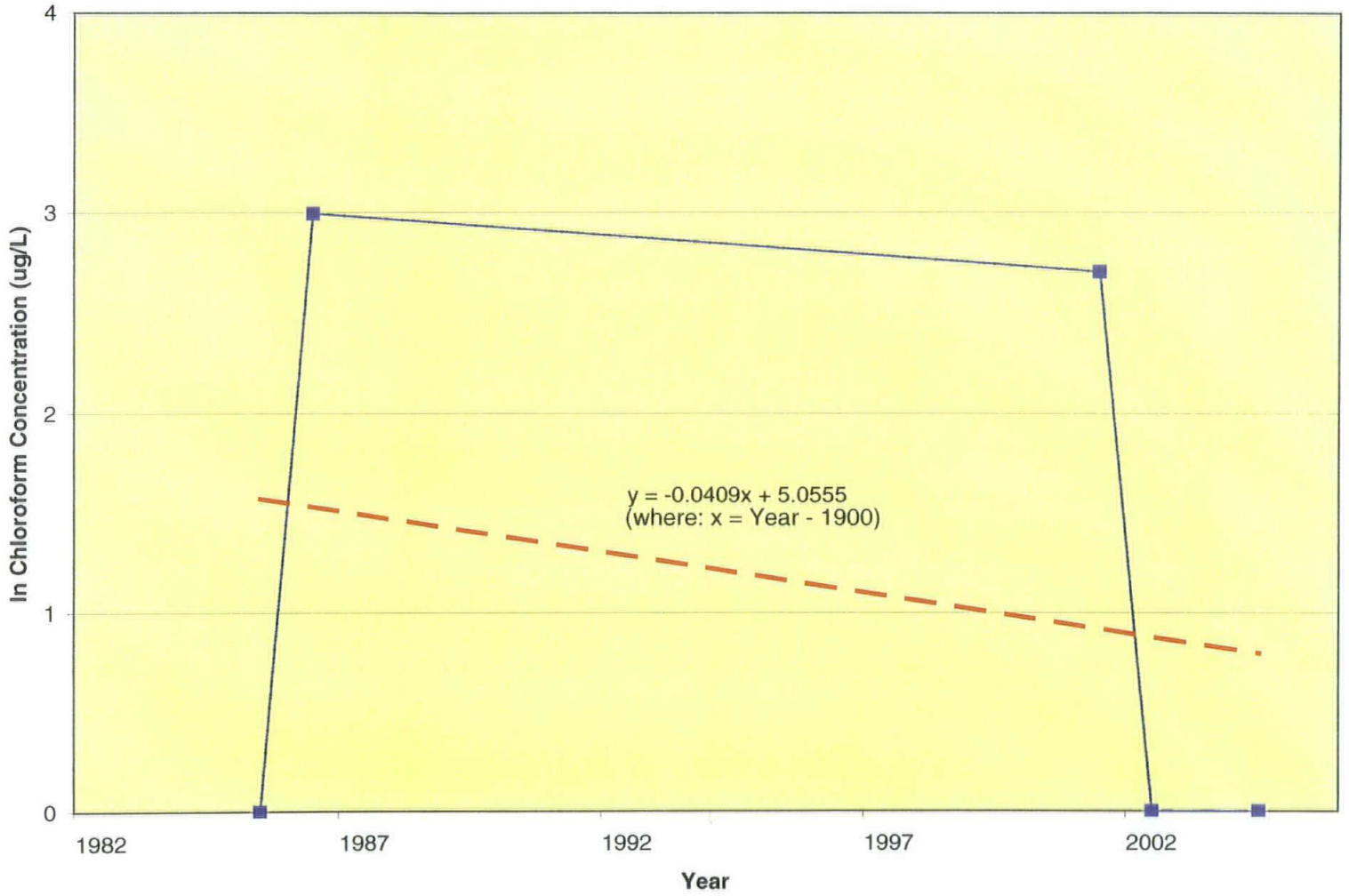


FIGURE E.3-4. TEMPORAL GROUND WATER DATA FOR WELL 01-12
CHLOROFORM

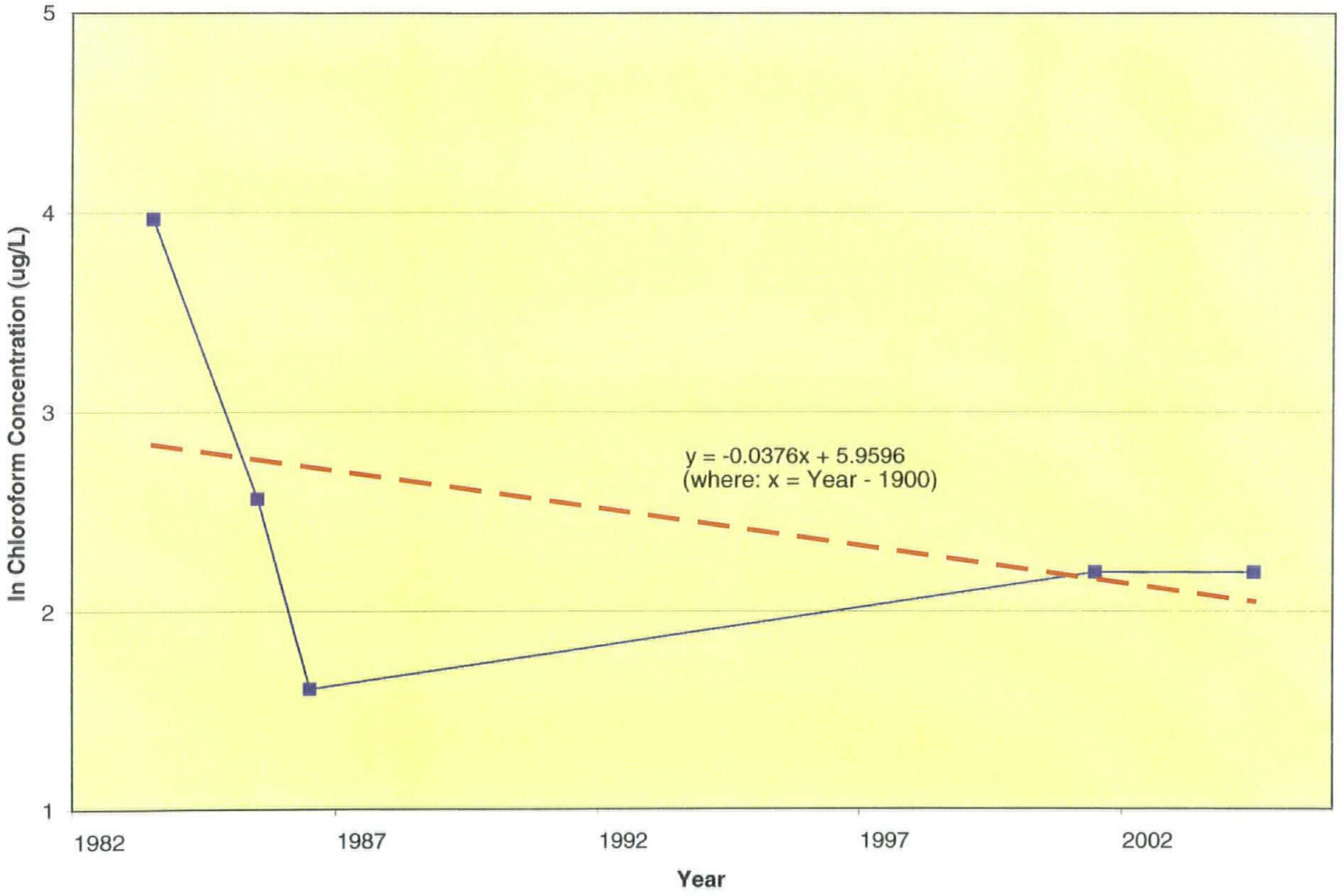


FIGURE E.3-5. TEMPORAL GROUND WATER DATA FOR WELL 01-15
CHLOROFORM

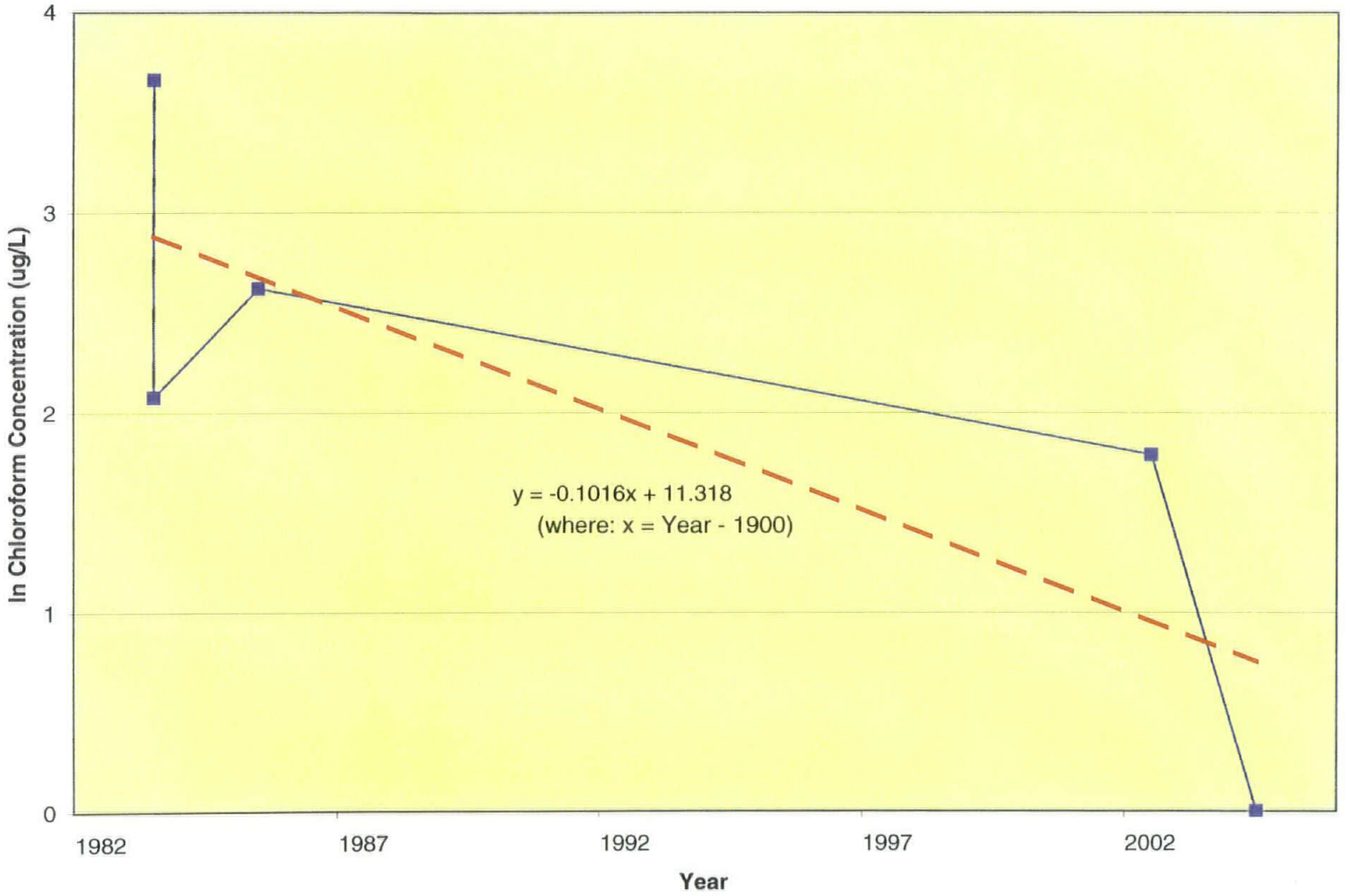


FIGURE E.3-6. TEMPORAL GROUND WATER DATA FOR WELL 01-19
CHLOROFORM

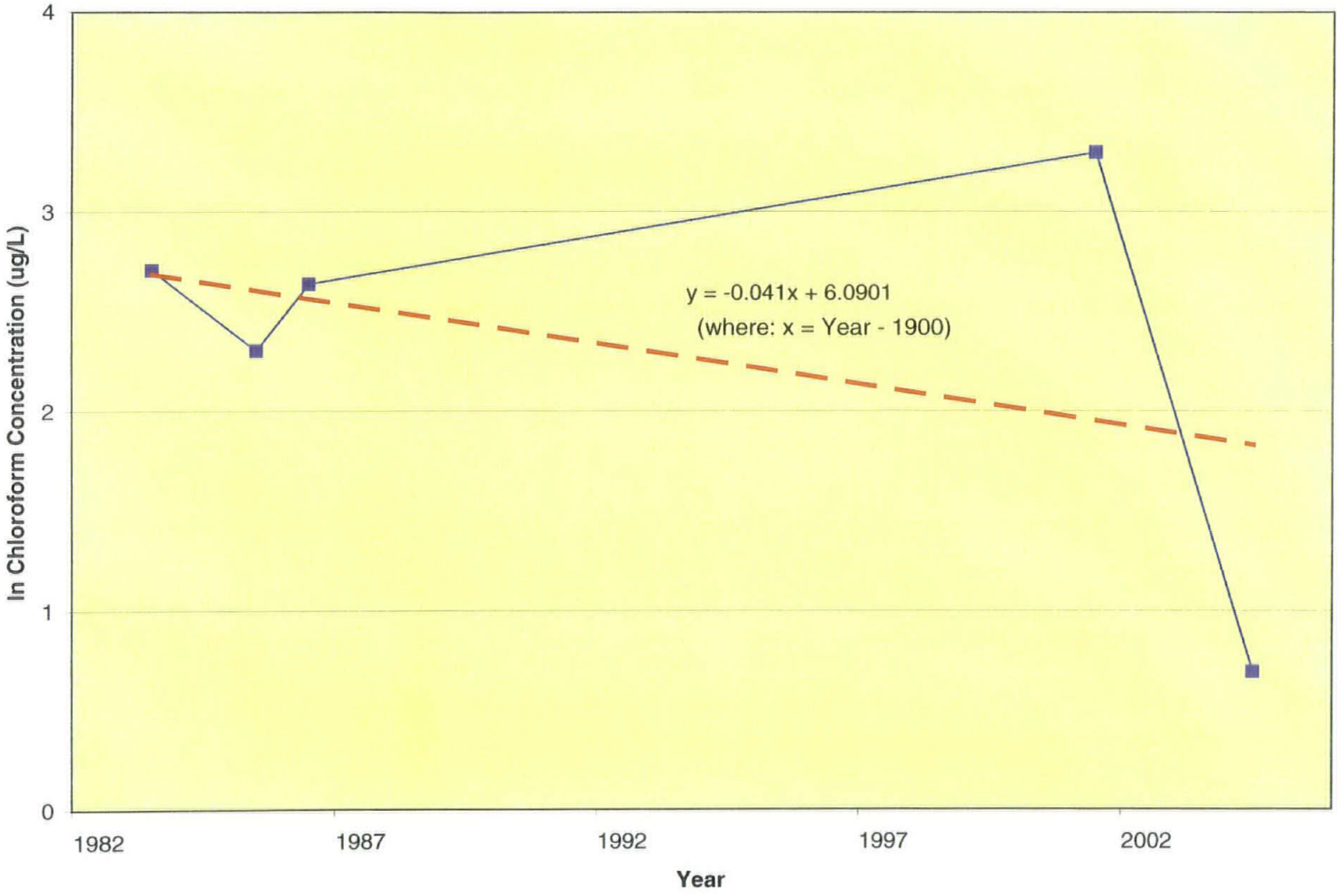


FIGURE E.3-7. TEMPORAL GROUND WATER DATA FOR WELL 01-22
CHLOROFORM

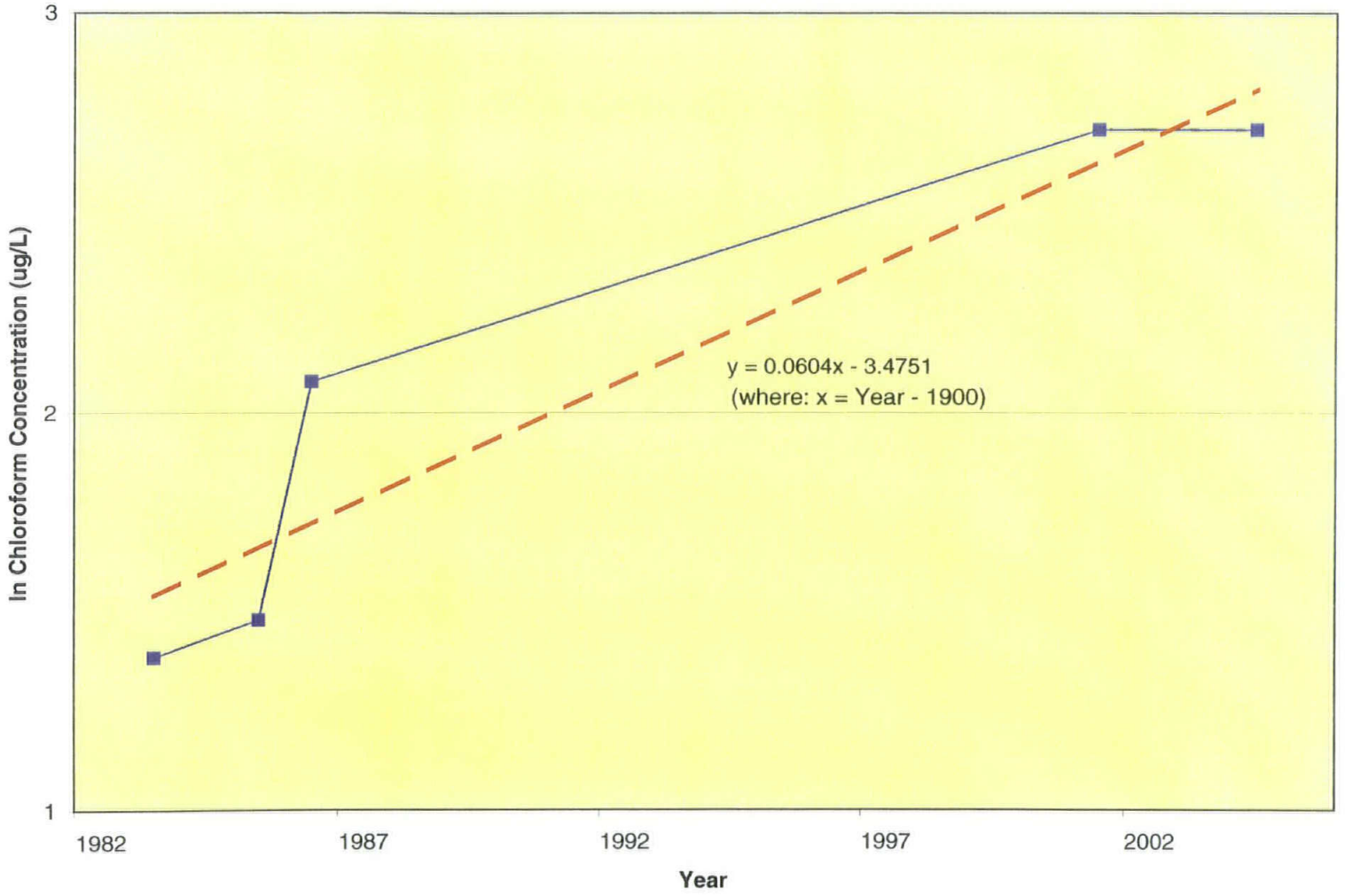


FIGURE E.3-8. TEMPORAL GROUND WATER DATA FOR WELL 01-25
CHLOROFORM

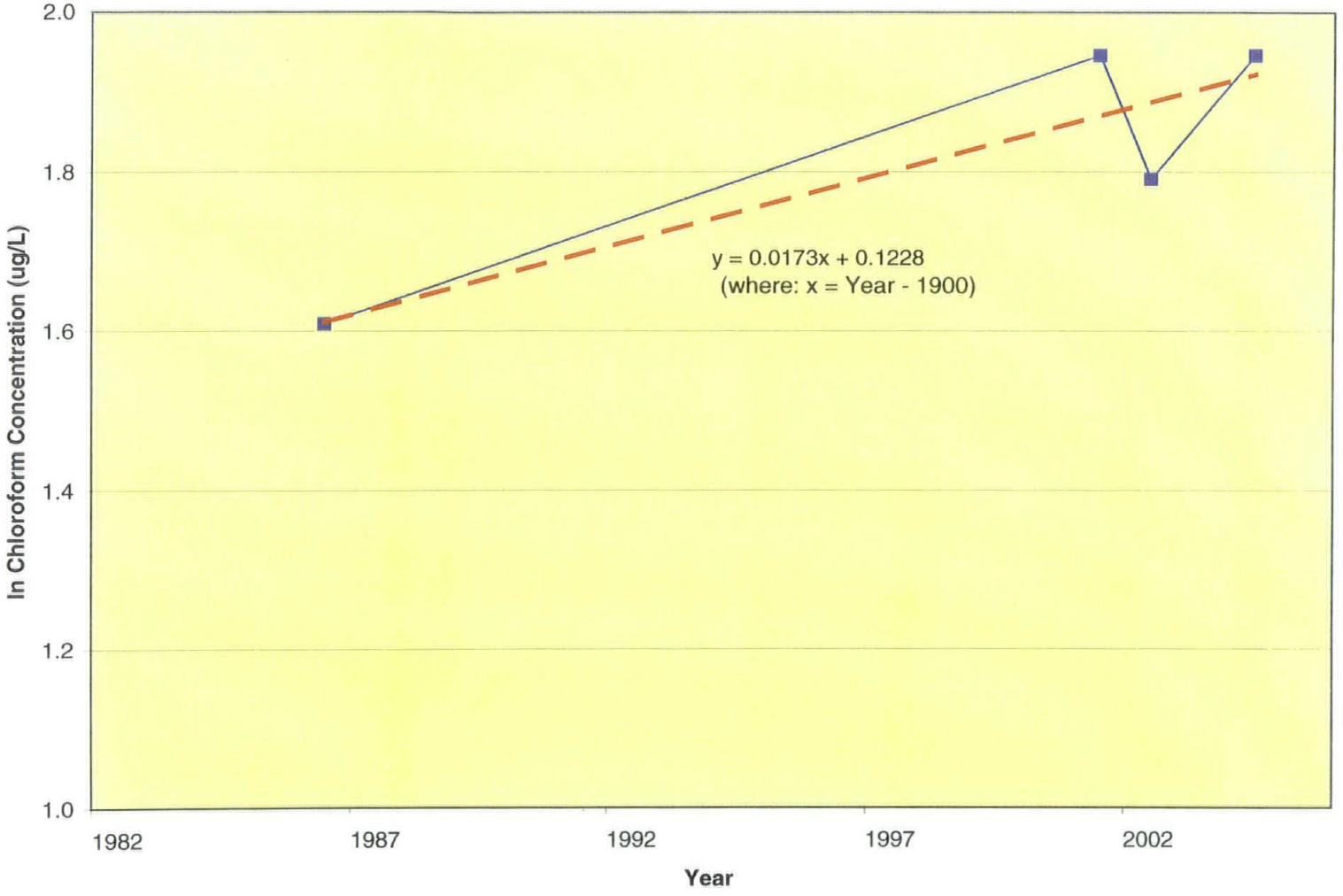


FIGURE E.3-9. RATE CONSTANT CALCULATIONS FOR CHLOROFORM ATTENUATION IN GROUND WATER

Well No.	Attenuation Rate Constant[1] ($year^{-1}$)
01-02	-0.0357
01-05	NA
01-11	-0.0409
01-12	-0.0376
01-15	-0.1016
01-19	-0.041
01-22	0.0604
01-25	-0.0173

1 Assumes first order decay model.
Constants computed from linear least squares fit of decay data.

Slope value statistics for boxed values to left:

minimum=	-0.1016			
maximum=	-0.0357			
median=	-0.0409	$t_{1/2}$=	16.9	years

Decay Model: **First order; uses median decay rate to compute C_{prg}.**

$C_t = C_0 \cdot e^{-kt}$ where C_t = concentration at time = t.
and C_0 = initial concentration (at t=0)

Time, t_{RBCL}, required to reach RBCL without treatment
Using Maximum Conncetration and median slope:

C_t = MCS = 80 ug/L C_0 = 790 ug/L = maximum concentration in 2004
-k = -0.0409 $t_{MCS} = [Ln(C_t/C_0)]/(-k)$
t = LN(80/790)/(-0.0409) = 60 years

Using Median concentration and median slope:
Does not apply because median concentration is 2 ug/L, which is already less than the MCS (80 ug/L).

Calculations by: J. Schubert, TtNUS
Checked by: T. Johnston, TtNUS

TABLE E.1-1. DATA FOR RATE CONSTANT CALCULATIONS FOR 1,1,2,2-TETRACHLOROETHANE ATTENUATION IN GROUND WATER

Well	Date Sampled	Concentration	Validation Qualifier	Units	ln conc
01-02	10/5/1982	36000		UG/L	10.49
01-02	11/18/1982	589000		UG/L	13.29
01-02	1/8/1985	525		UG/L	6.26
01-02	1/29/1986	66000		UG/L	11.10
01-02	9/18/01	38000		UG/L	10.55
01-02	6/27/02	30		UG/L	3.40
01-02	2/3/04	59		UG/L	4.08
01-05	10/5/1982	58		UG/L	4.06
01-05	1/7/1985	85.9		UG/L	4.45
01-05	1/29/1986	7		UG/L	1.95
01-05	10/3/01	9	J	UG/L	2.20
01-05	6/27/02	8		UG/L	2.08
01-05	2/4/04	6		UG/L	1.79
01-11	1/7/1985	138		UG/L	4.93
01-11	1/29/1986	760		UG/L	6.63
01-11	8/30/01	170		UG/L	5.14
01-11	6/25/02	1		UG/L	0.00
01-11	2/3/04	1	U	UG/L	0.00
01-12	1/25/1983	6000		UG/L	8.70
01-12	1/7/1985	518		UG/L	6.25
01-12	1/29/1986	280		UG/L	5.63
01-12	9/18/01	230		UG/L	5.44
01-12	1/29/04	320		UG/L	5.77
01-15	2/15/1983	1500		UG/L	7.31
01-15	4/20/1983	1450		UG/L	7.28
01-15	1/7/1985	230		UG/L	5.44
01-15	1/28/1986	27		UG/L	3.30
01-15	09/17/01	250		UG/L	5.52
01-15	06/27/02	230		UG/L	5.44
01-15	02/02/04	49		UG/L	3.89
01-19	1/8/1985	146		UG/L	4.98
01-19	1/28/1986	300		UG/L	5.70
01-19	10/03/01	270		UG/L	5.60
01-19	02/03/04	280		UG/L	5.63
01-22	7/14/1983	50		UG/L	3.91
01-22	1/8/1985	65.3		UG/L	4.18
01-22	1/28/1986	120		UG/L	4.79
01-22	10/9/01	150	J	UG/L	5.01
01-22	2/2/04	71		UG/L	4.26
01-25	1/28/86	42		UG/L	3.74
01-25	9/19/01	32		UG/L	3.47
01-25	6/25/02	24		UG/L	3.18
01-25	1/28/04	29		UG/L	3.37

FIGURE E.4-1

DISSOLVED TCE MASS PROJECTED INTO FUTURE

NSWC CRANE
CRANE, INDIANA

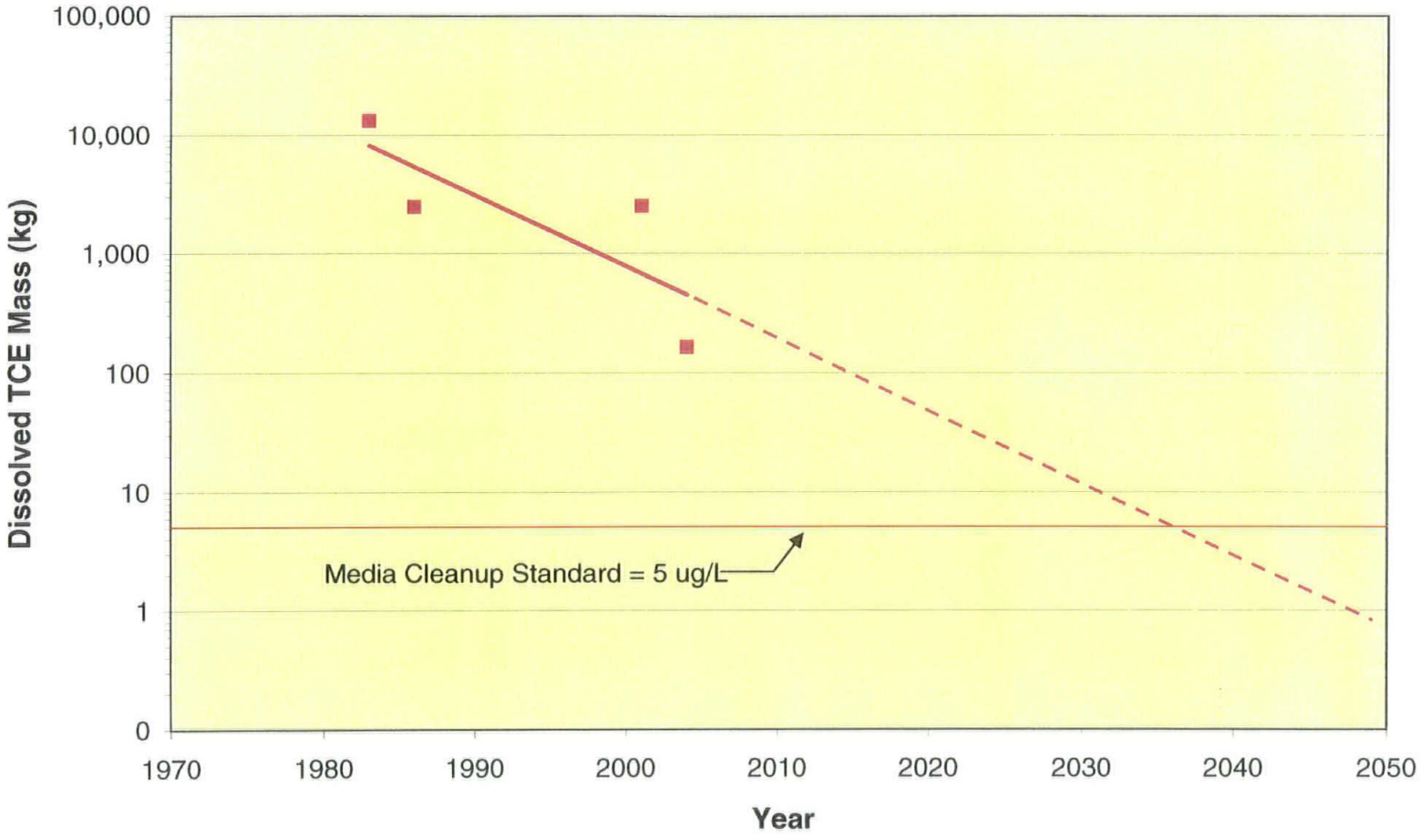
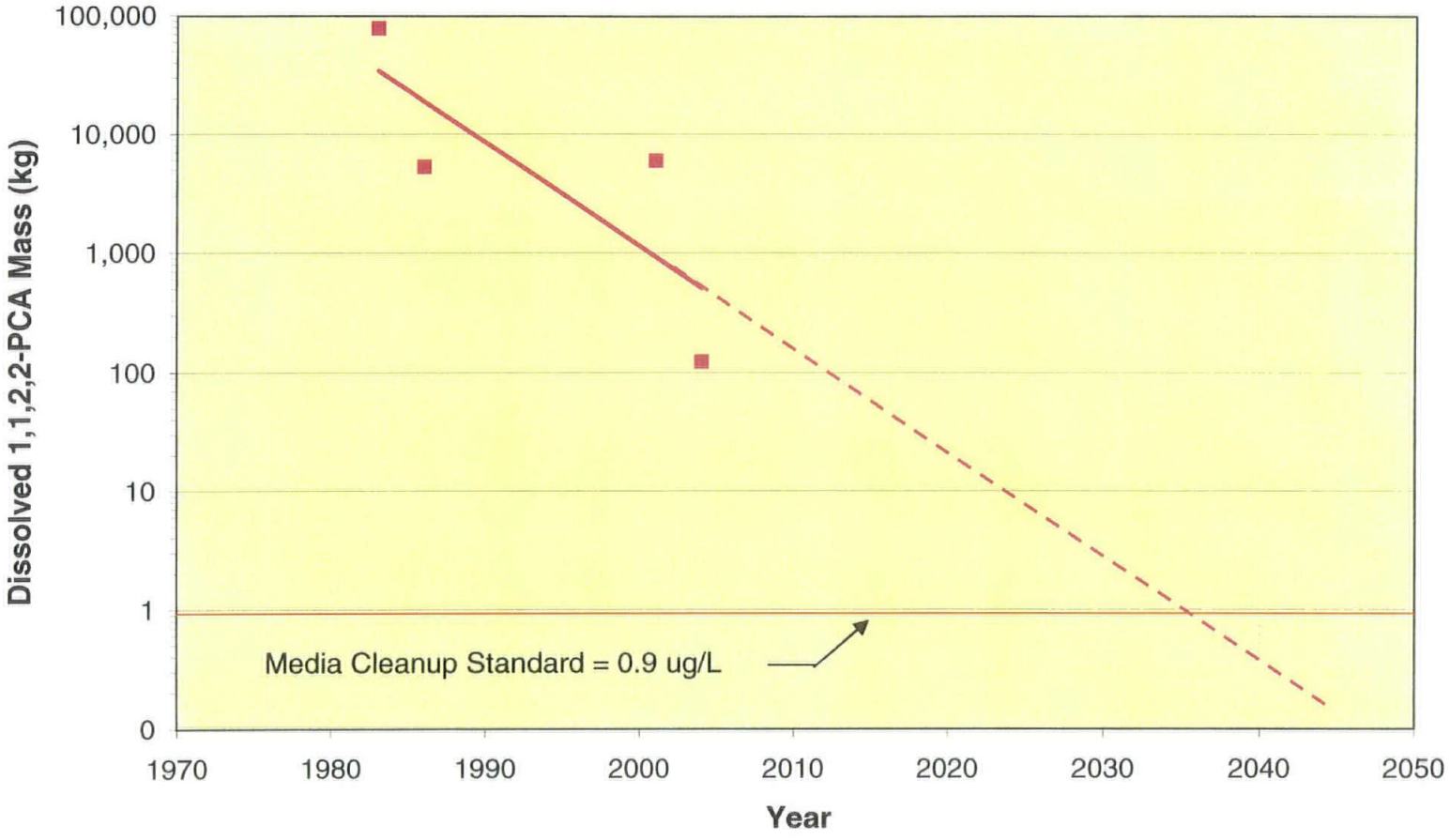


FIGURE E.4-2

DISSOLVED 1,1,2,2-TETRACHLOROETHANE MASS PROJECTED INTO FUTURE

NSWC CRANE
CRANE, INDIANA



E.4 TEMPORAL TRENDS IN CONTAMINANT MASS

FIGURE E.4-1

DISSOLVED TCE MASS PROJECTED INTO FUTURE

NSWC CRANE
CRANE, INDIANA

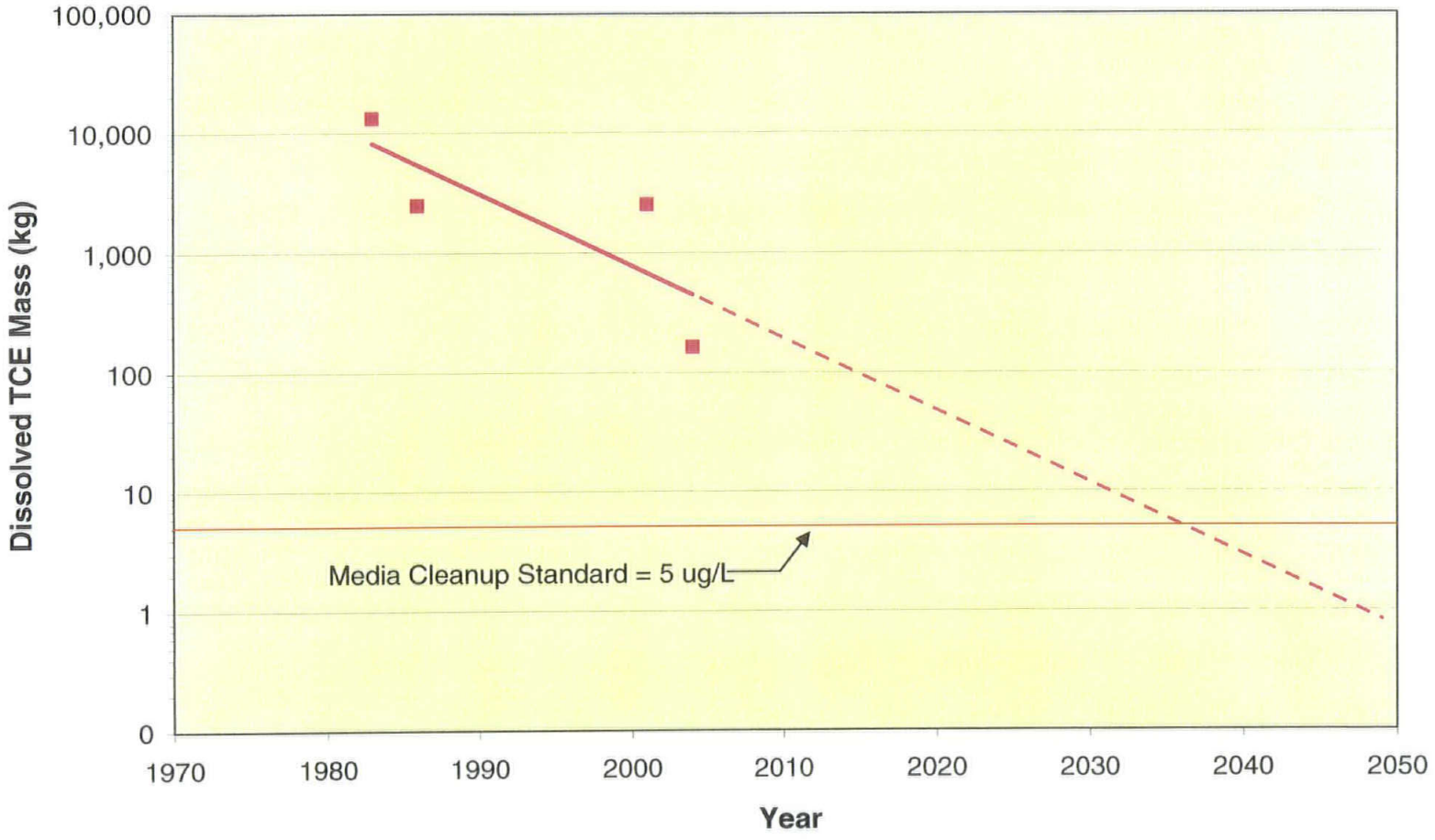
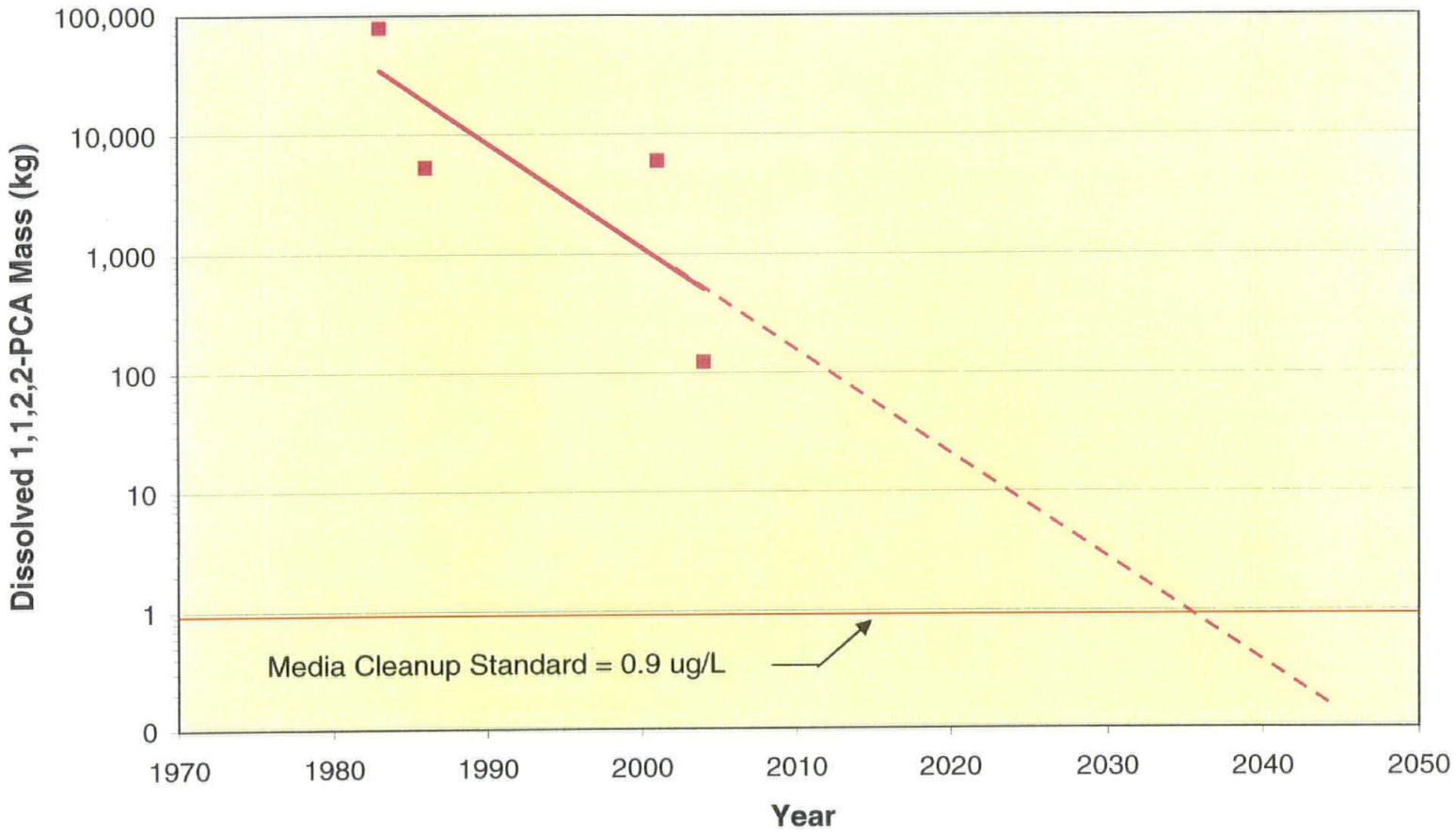


FIGURE E.4-2

DISSOLVED 1,1,2,2-TETRACHLOROETHANE MASS PROJECTED INTO FUTURE

NSWC CRANE
CRANE, INDIANA



APPENDIX F

CONCEPTUAL DESIGN CALCULATIONS

Prepared By: J.P. Kumar

CONCEPTUAL PROCESS DESIGN
CMS-ALTERNATIVE 3
MGBG, CRANE

August 6, 2004

Year 1 Treatment for 12 months

PBA (sq ft)	12,000 sq ft
Injection well spacing:	15 ft
Number of Injection Points:	53
Plume Area (sq ft)	277,000 sq ft
Injection well spacing:	15 ft
Number of Injection Points:	1231

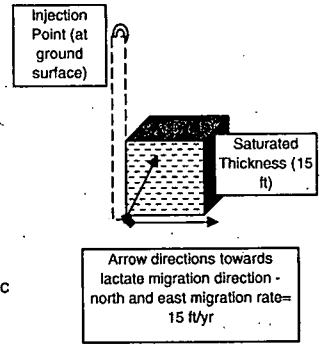
Treatment in Years 6 and 11 would cover 50 percent and 25 percent of the injection points

Process Requirements (lactate and dilution water feed rate):

Target Conc in PBA: 4000 mg/L

Soluble lactate migration rate (assume) 15 ft/yr

Estimated volume of sat zone influenced in treatment duration:
(15 ft tall rectangular wedge, east and north of each injection point x within 15 ft distance)
338 cu ft
2525 gal
(See conceptual sketch of sat zone influenced by injection depicted to the right)



Volume of saturated zone to be influenced in 12 months per location:
2525 gal
Mass of lactate required (at 60%) strength per location:
Target conc x Vol of water x1/60%
140 lb/location as 60% strength

Assume injection frequency:	2 months			
Injected mass per location each event:	23.4	lb as 60 %	14.0	lb 100%
Injected volume per loc each event:	2.1	gal as 60%		
Dilution water per loc each event:	21.4	gal (for 10:1 dilution)		
Total dilute lactate:	23.6	gal (diluted product)	71553.8	mg/L conc
(per injection point per location)			7%	

Outer Plume Area injection points:
Target Conc in aquifer: 1000 mg/L
Volume of saturated zone to be influenced in 12 months per location:
2525 gal
Mass of lactate required (at 60%) strength per location:
Target conc x Vol of water x1/60%
35 lb/location as 60% strength

Assume injection frequency:	2 months			
Injected mass per location each event:	5.8	lb as 60 %	3.5	lb 100%
Injected volume per loc each event:	0.54	gal as 60%		
Dilution water per loc each event:	5	gal (for 10:1 dilution)		
Total dilute lactate:	5.9	gal (diluted product)	71553.8	mg/L conc
(per injection point per location)			7%	

Estimate injection duration:
Estimate duration for one well volume to disperse at the rate of groundwater flow rate in PBA

Migration rate per year=	15 ft	
One well injection surface area=	11.8 sq ft	(15 ft x 3 inch dia hole)
Dispersion rate per one well volume=	176.7	cu ft/yr
	0.5	cu ft/day
Duration for dispersion in source area:	6.5	days

yellow highlights indicate key assumptions or parameters.

Prepared By: J.P. Kumar

SUMMARY OF PROCESS REQUIREMENTS
CMS-ALTERNATIVE 3
MGBG, CRANE

Aug 6, 2004

Cost Item	Source Area (Year 1)	Outer Plume (Year 1)
Mass of Na-Lactate (lb)	7,486	43,200
Drums of Na-Lactate (total)	12	72
Potable Water Volume for 10:1 dilution (gal)	6,862	39,600

Mass of lacatate and volume of water are assumed to be 50 percent of the above in Year 6 treatment and 25 percent of the above in Year 11 treatment.

			Comments
Number of Injection Points	53	1231	Number of injection points will reduce to 50 percent in Year 6 and 25 percent in Year 11
Duration for drilling (days)	27	616	Assume 2 locations per day, one drill rig
Duration for injection (days)	6.5		Source area injection controls duration
Number of Injection Events	6	6	Number of injection events will remain the same in Year 6 and Year 11
Drums of Na-Lactate per injection event	2	12	Number of drums will reduce proportionally in Years 6 and 11
Potable water volume per injection event (gal)	1,144	6,600	Volume of water will reduce proportionally in Years 6 and 12
Total volume per injection event(gal)	1,258	7,260	Total volume of water will reduce proportionally in Years 6 and 12
Volume per point per event(gal)	23.6	5.9	Volume per point per event will remain the same in all treatment years
Diluted lactate feed rate (average required over 7 days @ 10 hr operation/day) (gph):	17.97	103.72	Diluted lactate feed rate will reduce in Years 6 and 11
Ave pump feed rate for all injection points (gpm):	0.30	1.73	Pump feed rate will reduce in Years 6 and 11, can use the same equipment and throttle or reduce volumes per batch

APPENDIX G

COST ESTIMATES

Alternative 2

Every Other Year

water - collect 16 samples from 14 wells, labor - say 2 people for 6 days
1 day - prep, collect supplies, forms, etc., 1 day travel

total: 2 people 8 days, 12 hour days

cost item	number	cost/hr	hours	cost/day	days	total cost
supervisor	1	$40	96			$3,840
laborer	1	$32	96			$3,072
cars & gas	1			$70	6	$420
ship, supplie	1			$300	6	$1,800
TOTAL COST PER ROUND						**$9,132**

Analysis/Water - per round

parameter	medium	unit cost
TCL VOCs	water	$ 185.00
anions (chloride, sulfate, nitrate, niti	water	$ 60.00
methane, ethene, ethane	water	$ 125.00
field test kit		$ 50.00
bubble strip sampler		$ 33.00
Total per sample		$ 453.00

$453 x 16 = $ 7,248 per round

ORP/DO (2)	$ 600.00
Water Level (2)	$ 60.00
2-Way Radio (2)	$ 100.00
Total per round	$ 760.00

$ 7,248.00 + $ 760 = **$ 8,008**

NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA
SWMU 1
ALTERNATIVE 2: MONITORED NATURAL ATTENUATION AND INSTITUTIONAL CONTROLS
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$57,169		$57,169	1.000	$57,169
1				0.935	
2		$19,140	$19,140	0.873	$16,709
3		$0	$0	0.816	$0
4		$19,140	$19,140	0.763	$14,604
5		$40,175	$40,175	0.713	$28,645
6		$19,140	$19,140	0.666	$12,747
7		$0	$0	0.623	$0
8		$19,140	$19,140	0.582	$11,139
9		$0	$0	0.544	$0
10	$114,323	$59,315	$173,638	0.508	$88,208
11		$0	$0	0.475	$0
12		$19,140	$19,140	0.444	$8,498
13		$0	$0	0.415	$0
14		$19,140	$19,140	0.388	$7,426
15		$40,175	$40,175	0.362	$14,543
16		$19,140	$19,140	0.339	$6,488
17		$0	$0	0.317	$0
18		$19,140	$19,140	0.296	$5,665
19		$0	$0	0.277	$0
20	$114,323	$59,315	$173,638	0.258	$44,799
21		$0	$0	0.242	$0
22		$19,140	$19,140	0.226	$4,326
23		$0	$0	0.211	$0
24		$19,140	$19,140	0.197	$3,771
25		$59,315	$59,315	0.184	$10,914
26		$19,140	$19,140	0.172	$3,292
27		$0	$0	0.161	$0
28		$19,140	$19,140	0.150	$2,871
29		$0	$0	0.141	$0
30		$59,315	$59,315	0.131	$7,770
				TOTAL PRESENT WORTH	$349,586

$135,625 ERN Funded LTM

Activity Funded ERN $290,370

AL SURFACE WARFARE CENTER CRANE
RANE, INDIANA
SWMU 1
ALTERNATIVE 2: MONITORED NATURAL ATTENUATION AND INSTITUTIONAL CONTROLS
CAPITAL COST - YEAR 0

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	100	hr			$35.00		$0	$0	$3,500	$0	$3,500
2 MOBILIZATION/DEMOBILIZATION											
2.1 Mobilize/Demobilize Drill Rig	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000
3 DECONTAMINATION											
3.1 Decontamination of Drill Rig	1	ls	$500.00				$500	$0	$0	$0	$500
4 MONITORING WELL INSTALLATION											
4.1 Overburden Drilling, 15 ft per hole, 1 hole	15	lf	$40.00				$600	$0	$0	$0	$600
4.2 Bedrock Coring, 15 ft per hole, 1 hole	15	lf	$50.00				$750	$0	$0	$0	$750
4.3 2" PVC Monitoring Well, 1 @ 30 ft	30	ft	$21.00				$630	$0	$0	$0	$630
4.4 Well Casing, 1 @ 15 ft	15	ft	$48.00				$720	$0	$0	$0	$720
4.5 Flush-mount Cover with Roadbox	1	ea	$500.00				$500	$0	$0	$0	$500
4.6 Well Development, 4 hr per well	4	hr	$150.00				$600	$0	$0	$0	$600
4.7(a) Install Bladder Pump	32	ea		$926.00			$0	$29,632	$0	$0	$29,632
4.7(b) Teflon Tubing	32	ea		$200.00			$0	$6,400	$0	$0	$6,400
4.7(c) Pump controller & accessory	2	ea		$2,792.00			$0	$5,584	$0	$0	$5,584
4.8 Overnight Geologists	2	ea			$600.00		$0	$0	$1,200	$0	$1,200
							$9,300	$41,616	$4,700	$0	$55,616
Local Area Adjustments							100.0%	77.4%	95.9%	95.9%	
							$9,300	$32,211	$4,507	$0	$46,018
Overhead on Labor Cost @ 30%									$1,352		$1,352
G & A on Labor Cost @ 10%									$451		$451
G & A on Material Cost @ 10%								$3,221			$3,221
G & A on Subcontract Cost @ 10%							$930				$930
Total Direct Cost							$10,230	$35,432	$6,310	$0	$51,972
Indirects on Total Direct Cost @ 0%											$0
Profit on Total Direct Cost @ 10%											$5,197
Subtotal											$57,169
Health & Safety Monitoring @ 0%											$0
Total Field Cost											$57,169
Contingency on Total Field Costs @ 0%											$0
Engineering on Total Field Cost @ 0%											$0
TOTAL COST											**$57,169**

AL SURFACE WARFARE CENTER CRANE
RANE, INDIANA
SWMU 1
ALTERNATIVE 2: MONITORED NATURAL ATTENUATION AND INSTITUTIONAL CONTROLS
CAPITAL COST - YEARS 10 & 20

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 MOBILIZATION/DEMOBILIZATION											
1.1 Mobilize/Demobilize Drill Rig	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000
2 DECONTAMINATION											
2.1 Decontamination of Drill Rig	1	ls	$500.00				$500	$0	$0	$0	$500
3 MONITORING WELL INSTALLATION											
4.1 Overburden Drilling, 15 ft per hole, 4 holes	60	lf	$40.00				$2,400	$0	$0	$0	$2,400
4.2 Bedrock Coring, 15 ft per hole, 4 hole	60	lf	$50.00				$3,000	$0	$0	$0	$3,000
4.3 Protective Casing and Grouting, 15 ft per hole	60	lf	$20.00				$1,200	$0	$0	$0	$1,200
4.4 2" PVC Monitoring Well, 30 ft per hole, 4 holes	120	ft	$21.00				$2,520	$0	$0	$0	$2,520
4.5 Well Casing, 4 @ 15 ft	60	ft	$48.00				$2,880	$0	$0	$0	$2,880
4.6 Flush-mount Cover with Roadbox	4	ea	$500.00				$2,000	$0	$0	$0	$2,000
4.7 Well Development, 4 hr per well	16	hr	$150.00				$2,400	$0	$0	$0	$2,400
4.8 Overnight Geologists	2	ea			$900.00		$0	$0	$1,800	$0	$1,800
4.9 Install Bladder Pump & Teflon Tubing	32	ea		$1,126.00			$0	$36,032	$0	$0	$36,032
							$21,900	$36,032	$1,800	$0	$59,732
							100.0%	77.4%	95.9%	95.9%	
Local Area Adjustments							$21,900	$27,889	$1,726	$0	$51,515
Overhead on Labor Cost @ 30%									$518		$518
G & A on Labor Cost @ 10%									$173		$173
G & A on Material Cost @ 10%								$2,789			$2,789
G & A on Subcontract Cost @ 10%							$2,190				$2,190
Total Direct Cost							$24,090	$30,678	$2,417	$0	$57,184
Indirects on Total Direct Cost @ 30%											$17,155
Profit on Total Direct Cost @ 10%											$5,718
Subtotal											$80,058
Health & Safety Monitoring @ 2%											$1,601
Total Field Cost											$81,659
Contingency on Total Field Costs @ 20%											$16,332
Engineering on Total Field Cost @ 20%											$16,332
TOTAL COST											**$114,323**

NAVAL [illegible]CE WARFARE CENTER CRANE
CRANE, INDIANA
SWMU 1
ALTERNATIVE 2: MONITORED NATURAL ATTENUATION AND INSTITUTIONAL CONTROLS
Annual Cost

Item	Item Cost Every 2 Years for 30 Years	Item Cost Every 5 Years	Notes
Performance Sampling	$9,130	$15,800	Labor, field supplies for sampling 14 wells every 2 years plus 17 additional wells every 5th year.
Performance Analysis/Water	$8,010	$17,375	Analyze 14 wells plus 2 duplicates for TCL VOCs & natural attenuation parameters every 2years. Analyze 31 wells plus 4 duplicates for same parameters every 5th
Report	$1,000		Document sampling events and results.
Site Inspection	$1,000		One day annual inspection to verify continued implementation of institutional controls.
Site Review		$7,000	
TOTALS	$19,140	$40,175	

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Permitting	400	hr			$35.00		$0	$0	$14,000	$0	$14,000
2 SITE PREPARATION											
2.1 Construction Survey	6.5	ac	$294.00				$1,911	$0	$0	$0	$1,911
2.2 Cut & chip light Trees to 6" dia.	2.1	ac			$1,325.00	$995.00	$0	$0	$2,783	$2,090	$4,872
2.3 Selective Tree Removal, 400 trees/acre, hardwoods, 1:	2.1	ac			$830.00	$2,450.00	$0	$0	$1,743	$5,145	$6,888
2.4 Remove Selective Trees using Chain Saw, to 36" dia	20	ea			$166.00	$124.00	$0	$0	$3,320	$2,480	$5,800
2.5 Access Road Geotextile, 12' x 840'	1,120	sy		$1.83	$0.17		$0	$2,050	$190	$0	$2,240
2.6 Access Road Crushed Stone, 3/4', 6", 12' x 840'	10,080	sf		$5.20	$0.25	$0.48	$0	$52,416	$2,520	$4,838	$59,774
3 DECONTAMINATION											
3.1 Decontamination Services	8	mo	$3,400.00				$27,200	$0	$0	$0	$27,200
3.2 Temporary Equipment Decon Pad	1	ls		$1,500.00	$2,000.00	$200.00	$0	$1,500	$2,000	$200	$3,700
3.3 Decon Water	8,000	gal		$0.20			$0	$1,600	$0	$0	$1,600
3.4 Decon Water Storage Tank, 6,000 gallon	8	mo				$600.00	$0	$0	$0	$4,800	$4,800
3.5 Clean Water Storage Tank, 4,000 gallon	8	mo				$540.00	$0	$0	$0	$4,320	$4,320
3.6 PPE (2 p * 5 days * 34 weeks)	340	day		$30.90			$0	$10,506	$0	$0	$10,506
3.7 Disposal of Decon Waste (liquid & solid)	8	mo	$900.00				$7,200	$0	$0	$0	$7,200
4 INJECTION POINT INSTALLATION											
4.1 Drill Rig Mob/Demob	4	ls	$5,000.00				$20,000	$0	$0	$0	$20,000
4.2 Overburden Drilling, 15 ft per hole, 1284 holes	19,260	lf	$40.00				$770,400	$0	$0	$0	$770,400
4.3 Bedrock Coring, 15 ft per holes, 1284 holes	19,260	lf	$50.00				$963,000	$0	$0	$0	$963,000
4.4 Protective Casing and Grouting, 15 ft per hole	19,260	lf	$24.00				$462,240	$0	$0	$0	$462,240
4.5 PVC Riser, 30 ft per hole, 1284 holes	38,520	lf	$21.00				$808,920	$0	$0	$0	$808,920
4.6 Manhole (8" Cast Iron) w/Flush-Mount Cover	1,284	ea		$36.45			$0	$46,802	$0	$0	$46,802
5 PILOT-SCALE TEST											
5.1 Material Costs (assume 25% of full scale)	1	ls		$46,470.31			$0	$46,470	$0	$0	$46,470
5.2 Labor Costs (assume 25% of full scale)	1	ls			$66,000.00		$0	$0	$66,000	$0	$66,000
5.3 Injection Costs (assume 25% of full-scale costs)	21	drums		$448.00			$0	$9,408	$0	$0	$9,408
5.4 Reporting	1	ls	$10,000.00				$10,000	$0	$0	$0	$10,000
6 FULL-SCALE IMPLEMENTATION											
6.1 Pipe, 1" Dia. PE Lateral	21,200	lf		$0.48			$0	$10,070	$0	$0	$10,070
6.2 Pipe, 2" Dia. PVC Header	990	lf		$1.61			$0	$1,596	$0	$0	$1,596
6.3 Tee, 2" Dia. PVC	86	ea		$5.12			$0	$440	$0	$0	$440
6.4 Tee, 1" Dia. PVC	1,400	ea		$1.11			$0	$1,554	$0	$0	$1,554
6.5 Ball Valves, 1"	1,400	ea		$39.00			$0	$54,600	$0	$0	$54,600
6.6 Globe Valves, 2"	4	ea		$356.00			$0	$1,424	$0	$0	$1,424
6.7 Pressure Gages	86	ea		$259.00			$0	$22,274	$0	$0	$22,274
6.8 Tank, 2000 gal	1	ea		$2,233.00		$123.26	$0	$2,233	$0	$123	$2,356
6.9 Tank, 5000 gal	3	ea		$4,250.00		$156.87	$0	$12,750	$0	$471	$13,221
6.10 Tank Mixer (2 HP)	7	ea		$3,083.00			$0	$21,581	$0	$0	$21,581
6.11 Drum Pumps, 10 gpm @ 35 ft TDH	4	ea				$1,293.75	$0	$0	$0	$5,175	$5,175
6.12 Chemical Feed Pumps (0.25 HP)	4	ea				$221.95	$0	$0	$0	$888	$888
6.13 Flow Totalizers	4	ea		$695.00			$0	$2,780	$0	$0	$2,780
6.14 Gasoline Operated Generator, 10 KW	2	ea				$3,900.00	$0	$0	$0	$7,800	$7,800
6.15 Storage Shed (Prefab 20' x 20'), 4	1,600	sf		$5.05		$3.33	$0	$8,080	$0	$5,328	$13,408
6.16 Well Cap with Fitting	1,284	ea		$6.54			$0	$8,397	$0	$0	$8,397
6.17 Geologists (4), 30 weeks, 60 hr weeks	7,200	hr			$25.00		$0	$0	$180,000	$0	$180,000
6.18 Engineers (2), 8 weeks, 60 hr weeks	960	hr			$28.00		$0	$0	$26,880	$0	$26,880
6.19 Supervisor (1), 8 weeks, 40 hr weeks	320	hr			$35.00		$0	$0	$11,200	$0	$11,200

NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA
SWMU 1
ALTERNATIVE 3: IN-SITU ENHANCED BIOREMEDIATION - CLEAN-UP GOALS
Capital Cost

8/16/2004 1:57 PM

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
6.20 Electrician (1), 4 weeks, 40 hr weeks	160	hr			$39.40		$0	$0	$6,304	$0	$6,304
6.21 Plumber (1), 4 weeks, 40 hr weeks	160	hr			$39.60		$0	$0	$6,336	$0	$6,336
6.22 Laborers (4), 8 weeks, 40 hr weeks	1,280	hr			$26.00		$0	$0	$33,280	$0	$33,280
6.23 Na-Lactate, 6 events, 14 drums per event, incl freight	84	Drums		$448.00			$0	$37,632	$0	$0	$37,632
6.24 Potable Water, 6 events; 7,745 gal per event	46	kgal		$10.20			$0	$469	$0	$0	$469
7 SITE RESTORATION											
7.1 Topsoil, by Hand , say 2/3 of total area, or 4.3 acres	20,444	sy		$4.04	$1.36		$0	$82,596	$27,804	$0	$110,400
7.2 Fertilizer, Push Spreader	20,444	sy		$0.07	$0.01		$0	$1,431	$204	$0	$1,636
7.3 Hay, 1" Deep, Hand Spread	20,444	sy		$0.52	$0.44		$0	$10,631	$8,996	$0	$19,627
7.4 Grass Seed by Push Spreader	184	msf		$16.65	$1.16		$0	$3,064	$213	$0	$3,277
Subtotal							$3,070,871	$454,354	$393,774	$43,658	$3,962,657
Local Area Adjustments							100.0%	77.4%	95.9%	95.9%	
							$3,070,871	$351,670	$377,629	$41,868	$3,842,038
Overhead on Labor Cost @ 30%									$113,289		$113,289
G & A on Labor Cost @ 10%									$37,763		$37,763
G & A on Material Cost @ 10%								$35,167			$35,167
G & A on Subcontract Cost @ 10%							$307,087				$307,087
Total Direct Cost							$3,377,958	$386,837	$528,681	$41,868	$4,335,344
Indirects on Total Direct Cost @ 30%											$1,300,603
Profit on Total Direct Cost @ 15%											$650,302
Subtotal											$6,286,248
Health & Safety Monitoring @ 2%											$125,725
Total Field Cost											$6,411,973
Contingency on Total Field Costs @ 20%											$1,282,395
Engineering on Total Field Cost @ 20%											$1,282,395
TOTAL COST											**$8,976,763**

NA URFACE WARFARE CENTER CRANE
CRANE, INDIANA
SWMU 1
ALTERNATIVE 3: IN-SITU ENHANCED BIOREMEDIATION - CLEAN-UP GOALS
Annual Cost

Item	Item Cost Per Year (Years 1, 6, 11)	Item Cost Per Year (Years 5, 10)	Item Cost Per Year (Years 5, 10, 14)	Item Cost Per Year (Year 6)	Item Cost Per Year (Year 11)	Item Cost Per Year (Years 6, 11, 15)	Notes
Sampling	$43,200						Sample 10 wells (plus 2 duplicate samples) in rounds 1 through 3 and 32 wells (plus 4 duplicate samples) in round 4.
Sampling			$15,800				Sample 32 wells (plus 4 duplicate samples).
Analysis/Water	$36,420						Analyze groundwater samples from 10 monitoring wells (plus 2 duplicate samples) for VOCs and natural attenuation parameters in rounds 1 through 3 and analyze groundwater samples from 32 monitoring wells (plus 4 duplicate samples) in round 4.
Analysis/Water			$17,830				Analyze groundwater samples from 32 monitoring wells (plus 4 duplicate samples).
Injection System Repair		$148,555					Injection system repair is 10% of the initial installation cost.
Groundwater Treatment				$19,055	$9,525		Groundwater treatment is 50% of the intitial treatment cost in Year 6 and 25% of the initial treatment cost in Year 11.
Report						$5,000	Document sampling events and results.
TOTALS	$79,620	$148,555	$33,630	$19,055	$9,525	$5,000	

NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA
SWMU 1
ALTERNATIVE 3: IN-SITU ENHANCED BIOREMEDIATION - CLEAN-UP GOALS
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$8,976,763		$8,976,763	1.000	$8,976,763
1		$79,620	$79,620	0.935	$74,445
2		$0	$0	0.873	$0
3		$0	$0	0.816	$0
4		$0	$0	0.763	$0
5		$182,185	$182,185	0.713	$129,898
6		$103,675	$103,675	0.666	$69,048
7		$0	$0	0.623	$0
8		$0	$0	0.582	$0
9		$0	$0	0.544	$0
10		$182,185	$182,185	0.508	$92,550
11		$94,145	$94,145	0.475	$44,719
12		$0	$0	0.444	$0
13		$0	$0	0.415	$0
14		$33,630	$33,630	0.388	$13,048
15		$5,000	$5,000	0.362	$1,810
				TOTAL PRESENT WORTH	**$9,402,280**