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Final Phase I–Phase II Interim Report: Expedited Site Characterization, Morrill, Kansas

Environmental
Research Division

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ANL/ER/TR-04/001

Final Phase I–Phase II Interim Report: Expedited Site Characterization, Morrill, Kansas

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Notation

AGEM	Applied Geosciences and Environmental Management
AMSL	above mean sea level
BGL	below ground level
°C	degrees Celsius
CCC	Commodity Credit Corporation
CLP	Contract Laboratory Program
COC	chain of custody
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ESC	expedited site characterization
ft	foot (feet)
gal	gallon(s)
GPS	global positioning system
in.	inch(es)
KDHE	Kansas Department of Health and Environment
MCL	maximum contaminant level
µg/kg	microgram(s) per kilogram
µg/L	microgram(s) per liter
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
mi	mile(s)
µS/cm	microsiemen(s) per centimeter
mV	millivolt(s)
PWS	public water supply
QA	quality assurance
QC	quality control
RPD	relative percent difference
SDG	sample delivery group
TOC	total organic carbon
USDA	U.S. Department of Agriculture
VOC	volatile organic compound

Executive Summary

The Environmental Research Division of Argonne National Laboratory is performing a Phase I–Phase II investigation at Morrill, Kansas, on behalf of the Commodity Credit Corporation of the U.S. Department of Agriculture (CCC/USDA). The primary goals of this investigation are (1) to verify any association of carbon tetrachloride with the former CCC/USDA facility; (2) to verify the contaminant migration pathway from the former facility; and (3) to identify any domestic wells located outside the Morrill city limits that are downgradient from and within 1 mi of the former CCC/USDA facility and thus are potential receptors of groundwater contamination. The field work for the Phase I–Phase II investigation at Morrill was conducted in October 2003. This interim report presents the findings of the field investigation and outlines ongoing and planned activities associated with this investigation.

To satisfy the first goal, discrete near-surface and shallow subsurface soil samples were collected at 16 locations at the former CCC/USDA facility. Near-surface soil samples were collected at depths of approximately 2 ft and 5 ft below ground level (BGL). Shallow subsurface soil samples were collected at depths of 10 ft BGL and approximately 15 ft or bedrock, whichever was encountered first. The soil samples were analyzed for carbon tetrachloride and chloroform by EPA Methods 5030B and 8260B.

Neither carbon tetrachloride nor chloroform was detected in the near-surface or shallow subsurface soil samples collected. According to the Tier 2 risk-based standards for carbon tetrachloride and chloroform presented in *Risk-Based Standards for Kansas* (*RSK Manual*; KDHE 2003), the soils at the former CCC/USDA facility pose no identifiable human health risk. Additionally, the soils pose no threat of contamination to groundwater.

To satisfy the second goal, to verify the contaminant migration pathway from the former facility, depth-to-groundwater elevation measurements and groundwater samples were collected from the six existing KDHE monitoring wells. Groundwater samples were collected from the five KDHE wells completed in the upper impacted aquifer zone (MW1S–MW5S) and the single KDHE well completed in the lower aquifer zone (MW1D). The samples were analyzed for VOCs, including carbon tetrachloride and chloroform, and for inorganic geochemical properties, including anions, cations, and nitrate, to aid in the characterization of the contaminated aquifer zone and migration pathway.

A carbon tetrachloride plume, extending south-southeasterly from the former CCC/USDA facility toward Terrapin Creek, was identified in the upper of the two aquifer zones. A maximum carbon tetrachloride concentration of 89 μg/L was detected at MW3S, located on the former CCC/USDA facility. Nitrate levels above the MCL of 10 mg/L were detected in all five KDHE monitoring wells completed in the upper aquifer zone. No carbon tetrachloride, chloroform, or nitrate was detected in the sample (MW1D) from the deeper aquifer zone. The sample from the deeper aquifer also exhibited significantly higher sulfate content than the samples from the shallow aquifer.

Analysis of the depth-to-groundwater measurements indicates a south-southeasterly groundwater gradient of approximately 0.008 ft/ft in the vicinity of the former CCC/USDA facility. The most likely migration pathway is inferred to be as follows: (1) vertical infiltration of carbon tetrachloride from the land surface through the vadose zone to the water table, followed by (2) subhorizontal south-southeastward lateral migration within the Grenola limestone–Roca shale of the upper aquifer zone in response to the prevailing hydraulic gradient.

The upgradient and eastern lateral extent of the contaminated zone are adequately delineated by data from the existing monitoring wells, however, additional wells are needed to delineate the western lateral and the southern (downgradient) extent of the carbon tetrachloride plume at Morrill. Based on these findings, the installation of three additional monitoring wells (MW6S–MW8S) is recommended.

Although the former public wells in Morrill are no longer used for municipal supply and the city of Morrill and its residents have obtained their water by pipeline from the Sabetha municipal water supply since 1991, a program is underway to identify any potential receptors of the contaminated groundwater not receiving city water. Utility and water usage records are being collected and reviewed to identify residences within the city limits that are located downgradient from the former CCC/USDA facility and that do not appear to be using city water. Results of this review will be confirmed by conducting a door-to-door survey within the plume area. Any wells identified will be sampled.

Two domestic wells located downgradient from and within 1 mi of the former CCC/USDA facility were identified by using the Kansas Geological Survey Water Well Database. These two domestic wells are located outside the Morrill city limits, south of

Terrapin Creek, approximately 1.0 mile south of Morrill. These wells will also be sampled early in the monitoring program.

Results of monitoring and other planned studies will be issued as an addendum to the Final Phase I–Phase II report.

1 Introduction

The city of Morrill, Kansas, is located in Brown County, in the northeastern corner of the state. The town lies about 7 mi east of Sabetha and about 10 mi northwest of Hiawatha (Figure 1.1). The population of Morrill as of the 2000 census was approximately 277.

The Commodity Credit Corporation (CCC), an agency of the U.S. Department of Agriculture (USDA), operated a grain storage facility in the northwestern section of Morrill from 1950 until 1971. The property continued to be used for grain storage after 1971. Fourteen of the original 21 CCC/USDA circular bin structures remain today. Prior to 1986, commercial grain fumigants containing carbon tetrachloride were commonly used by the CCC/USDA and the grain storage industry to preserve grain.

Contamination with carbon tetrachloride, also known as tetrachloromethane, was initially identified in groundwater at Morrill in October 1985 in public water supply well PWS5, during statewide testing of public water supply wells for volatile organic compounds (VOCs). A preliminary assessment was completed by the Kansas Department of Health and Environment (KDHE) in 1989 to obtain background information on the Morrill public water supply and to identify potential sources of the detected carbon tetrachloride contamination (KDHE 1989).

Since 1991 the city of Morrill has obtained its water by pipeline from the municipal water supply of Sabetha. Water supplied through the Sabetha system comes from a surface reservoir. Former public wells in Morrill are no longer used for municipal supply. Wells PWS3, PWS4, and PWS5 were plugged in 1993. Wells PWS1 and PWS2 are no longer in active production, but they continue to be available for non-drinking purposes such as bulk hauling for agricultural uses, fire fighting, and road work (Hansen 2001).

Because the KDHE found carbon tetrachloride in the groundwater at the former CCC/USDA facility at Morrill that could, in part, be linked to historical use of carbon tetrachloride-based grain fumigants at the facility, the CCC/USDA is conducting an environmental site investigation at Morrill.

The investigation at Morrill is being performed by the Environmental Research Division of Argonne National Laboratory. Argonne is a nonprofit, multidisciplinary research center operated by the University of Chicago for the U.S. Department of Energy (DOE). The CCC/USDA has entered into an interagency agreement with DOE, under which Argonne provides technical assistance to the CCC/USDA with environmental site characterization and remediation at its former grain storage facilities.

The primary goals of this investigation were (1) to verify any association of carbon tetrachloride with the former CCC/USDA facility; (2) to verify the contaminant migration pathway from the former facility; and (3) to identify any domestic wells located outside the Morrill city limits that are downgradient from and within 1 mi of the former CCC/USDA facility and thus are potential receptors of groundwater contamination.

To meet the information needs discussed above, the investigation identified the following technical objectives:

1. Verify whether soils at the former CCC/USDA facility are contaminated with carbon tetrachloride.

2. Assess the nature and continuity of the geologic units composing the aquifer in the vicinity of the former CCC/USDA facility.

3. Verify the direction and magnitude of the groundwater gradient in the aquifer at the former CCC/USDA facility.

4. Verify the contaminant migration pathway at the former CCC/USDA facility.

5. Identify potential receptor wells outside the Morrill city limits.

6. Determine needs for additional monitoring wells.

These objectives were described in the Phase I *Work Plan* (Argonne 2003). After the issuance of the *Work Plan*, all parties, including KDHE, agreed on the desirability of combining Phase I and Phase II work to expedite the characterization process. This interim report is being issued to avoid delaying the release of available data. A Phase I–Phase II report, incorporating the results of long-term monitoring and the results from the sampling of private wells identified within and downgradient of the plume, will be prepared at a later date.

The field work for the Phase I–Phase II investigation at Morrill was conducted in October 2003.

This interim report presents the findings of the field investigation and outlines ongoing and planned activities associated with the investigation at Morrill. Section 1 provides a brief history of the area, technical objectives of the investigation, and a brief description of the sections contained in this report. Section 2 describes investigative methods. Section 3 presents all the data obtained during the investigation. Section 4 describes the interpretation of the pertinent data used to meet the technical objectives of the investigation. Section 5 presents the conclusions of the investigation relative to the technical objectives and outlines further recommendations and planned activities.

To streamline the reporting process, material from the site-specific *Work Plan* for the investigation at Morrill (Argonne 2003) is not repeated in detail in this report. The *Work Plan* may be consulted to obtain the complete details of the background and the investigative program at Morrill.

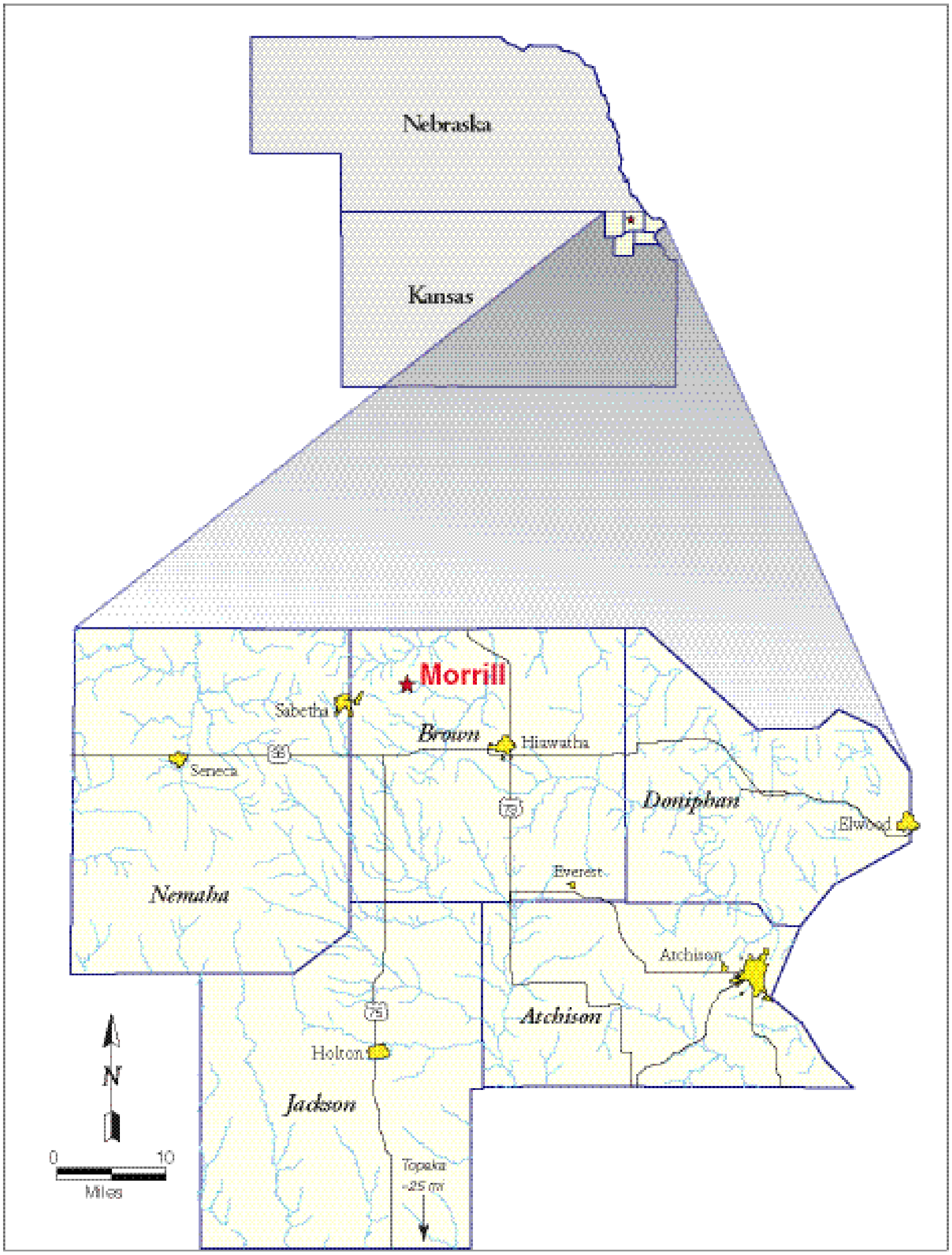

FIGURE 1.1 Location of Brown County and Morrill, Kansas.

2 Investigative Methods

The Phase I–Phase II investigation at Morrill is being performed by using an iterative process of data collection, evaluation, and interpretation during the field program to ensure the collection of necessary and sufficient data to achieve the specific technical objectives defined in Section 1. Throughout the field program, a comprehensive quality assurance/quality control (QA/QC) program was implemented to confirm the reliability of all information as it was accumulated.

The specific technical objectives and the investigative program developed for the investigation at Morrill were presented and discussed in Section 5 of the site-specific *Work Plan* (Argonne 2003). Procedures for the individual techniques employed by Argonne at this site are in the *Master Work Plan* (Argonne 2002). This section provides a brief overview of the methods used to implement the investigation at Morrill.

2.1 Methods to Verify Whether Soils at the Former CCC/USDA Facility Are Contaminated with Carbon Tetrachloride

Sampling of near-surface and shallow subsurface soils was conducted at the 16 locations, SB01–SB16, shown in Figure 2.1. All soil borings were continuously cored, by using a GeoProbe Model 540MT direct-push sampling tool, from the surface to a depth of approximately 15 ft below ground level (BGL), or to the point of refusal if bedrock was encountered. The depths of the borings ranged from approximately 13 ft to 15 ft BGL. At each location, discrete near-surface soil samples were collected at depths of approximately 2 ft and 5 ft BGL. Discrete subsurface soil samples were collected at depths of 10 ft BGL and 15 ft BGL or at the point of refusal, whichever came first.

Upon collection, the samples were placed in jars. The jars were sealed, placed on dry ice, and transported to the Applied Geosciences and Environmental Management (AGEM) Laboratory at Argonne, in accordance with procedures in the *Master Work Plan* (Argonne 2002, Sections 6.1.1.1 and 6.2). Upon receipt at the laboratory, the soil samples were analyzed for carbon tetrachloride and chloroform by purge-and-trap sample preparation with analysis by gas chromatography–mass spectrometry (EPA Methods 5030B and 8260B; Argonne 2002, Section 6.3.1.1).

A description of the continuous core collected from location SB12 is presented in Appendix A and discussed briefly in Section 3.1. Descriptions of all recovered shallow subsurface cores are also presented in Appendix A. Sample descriptions and results of the soil analyses for VOCs are presented in Section 3.3 and are discussed in relation to this technical objective in Section 4.1.

2.2 Methods to Assess the Nature and Continuity of the Geologic Units Composing the Aquifer in the Vicinity of the Former CCC/USDA Facility

A field reconnaissance was conducted along Terrapin Creek south of the former CCC/USDA facility in an attempt to locate bedrock outcrops downgradient of the former facility and identify characteristic fracturing or jointing within the units.

To aid in the recognition of the aquifer zones at Morrill, groundwater samples for geochemical analysis were collected. The two aquifer zones identified at Morrill are (1) the Grenola limestone and the Roca shale and (2) the deeper, Long Creek limestone member of the Foraker limestone. Regional water quality and hydrogeochemical data (Denne et al. 1998) indicate that groundwater from these Permian bedrock units is of the calcium sulfate type. Concentrations of sulfate have been noted to increase with depth, with water from the Foraker limestone exhibiting higher sulfate levels than waters within the overlying Roca shale and Grenola limestone. Regionally, nitrate concentrations above the MCL (> 10 mg/L [milligrams per liter]) have been detected in wells completed in the Grenola limestone and Roca shale (Bayne and Schoewe 1967).

To verify the geochemical characteristics of the two aquifer zones at Morrill, groundwater samples derived from existing KDHE monitoring wells were analyzed. Analyses included those for inorganic geochemical properties including anions, cations, and nitrate, as well as those for VOCs including carbon tetrachloride and chloroform.

Groundwater sampling and analysis were conducted in accordance with procedures described in the *Master Work Plan* (Argonne 2002, Sections 6.1.2, 6.2, and 6.3.2). Results are presented in Section 3.4 and discussed in Section 4.2.

2.3 Methods to Verify the Direction and Magnitude of the Groundwater Gradient in the Aquifer at the Former CCC/USDA Facility

Depths to groundwater were measured in all six of the existing KDHE monitoring wells (MW1S–MW5S and MW1D; Figure 2.2). These data were used to establish a baseline gradient and to verify previous determinations. Results are presented in Section 3.5.

2.4 Methods to Verify the Contaminant Migration Pathway at the Former CCC/USDA Facility

A suite of groundwater samples was collected from the six existing KDHE monitoring wells to quantify groundwater chemistry and contaminant concentrations within water-saturated units (Figure 2.2). Groundwater sampling was conducted in accordance with procedures described in the *Master Work Plan* (Argonne 2002, Sections 6.1.2 and 6.2). All samples were analyzed for cations and anions and for VOCs including carbon tetrachloride and chloroform.

A reconnaissance of the creek was conducted in an attempt to identify visible groundwater seeps. Although no groundwater seeps were identified along the northern flank of Terrapin Creek, surface water samples were collected from Terrapin Creek itself (Figure 2.2). Surface water sampling was conducted in accordance with procedures described in the *Master Work Plan* (Argonne 2002, Section 6.1.3). All samples were analyzed for cations and anions and for VOCs including carbon tetrachloride and chloroform. Results are presented in Section 3.4.

2.5 Methods to Identify Potential Receptor Wells outside the Morrill City Limits

Argonne attempted to identify any domestic wells outside the Morrill city limits that are downgradient from and within 1 mi of the former CCC/USDA facility. Records maintained by the Kansas Geological Survey were reviewed to identify any permitted wells within the area of interest. In addition, a presentation was made to the Morrill city council requesting assistance in identifying the presence and location of any private and domestic wells. Forms to help document the nature of identified wells were left with the city clerk. These activities are being augmented by a review of utility and water usage records, which will be followed by a door-to-door survey. Results to date are presented and discussed in Section 4.5.

2.6 Methods to Determine the Need for Additional Monitoring Wells

The results obtained through monitoring and sampling of the existing KDHE monitoring wells at Morrill were used to assess the degree to which the current monitoring wells adequately delineate the carbon tetrachloride contamination. Data used in this assessment are presented in Sections 3.4 and 3.5. The need for additional monitoring wells is discussed in Section 4.6.

2.7 Quality Control for Sample Collection, Handling, and Analysis

The QA/QC procedures for sample collection, handling, and analysis followed during Morrill Phase I–Phase II activities are described in detail in the *Master Work Plan* (Argonne 2002). Significant points include the following:

- Sample integrity was preserved throughout the collection, shipping, and analysis activities by the use of custody seals and chain-of-custody records.

- The QA/QC samples collected included a background near-surface soil sample, equipment rinsates, and trip blanks. Blind field replicate samples were collected, and samples were selected for duplicate analyses as a measure of analytical precision.

- Trip blanks were used to verify that samples collected for organic analyses were not contaminated during shipment.

- Subsurface soil samples taken to yield vertical contaminant profiles were analyzed for carbon tetrachloride and chloroform at the AGEM Laboratory with the purge-and-trap method, by following a modification of the protocol in EPA Method 8260B. Calibration checks were run with each sample delivery group to ensure proper calibration of the gas chromatograph throughout the analyses.

- Duplicate soil analyses were conducted at the AGEM Laboratory and at Severn-Trent Laboratory in Colchester, Vermont, as an indication of analytical precision.

- Groundwater samples were analyzed for carbon tetrachloride and chloroform at the AGEM Laboratory by using EPA Method 524.2. Replicate samples were sent to Clayton Laboratory in Novi, Michigan, for verification analyses with the Contract Laboratory Program (CLP) methodology of the U.S. Environmental Protection Agency (EPA).

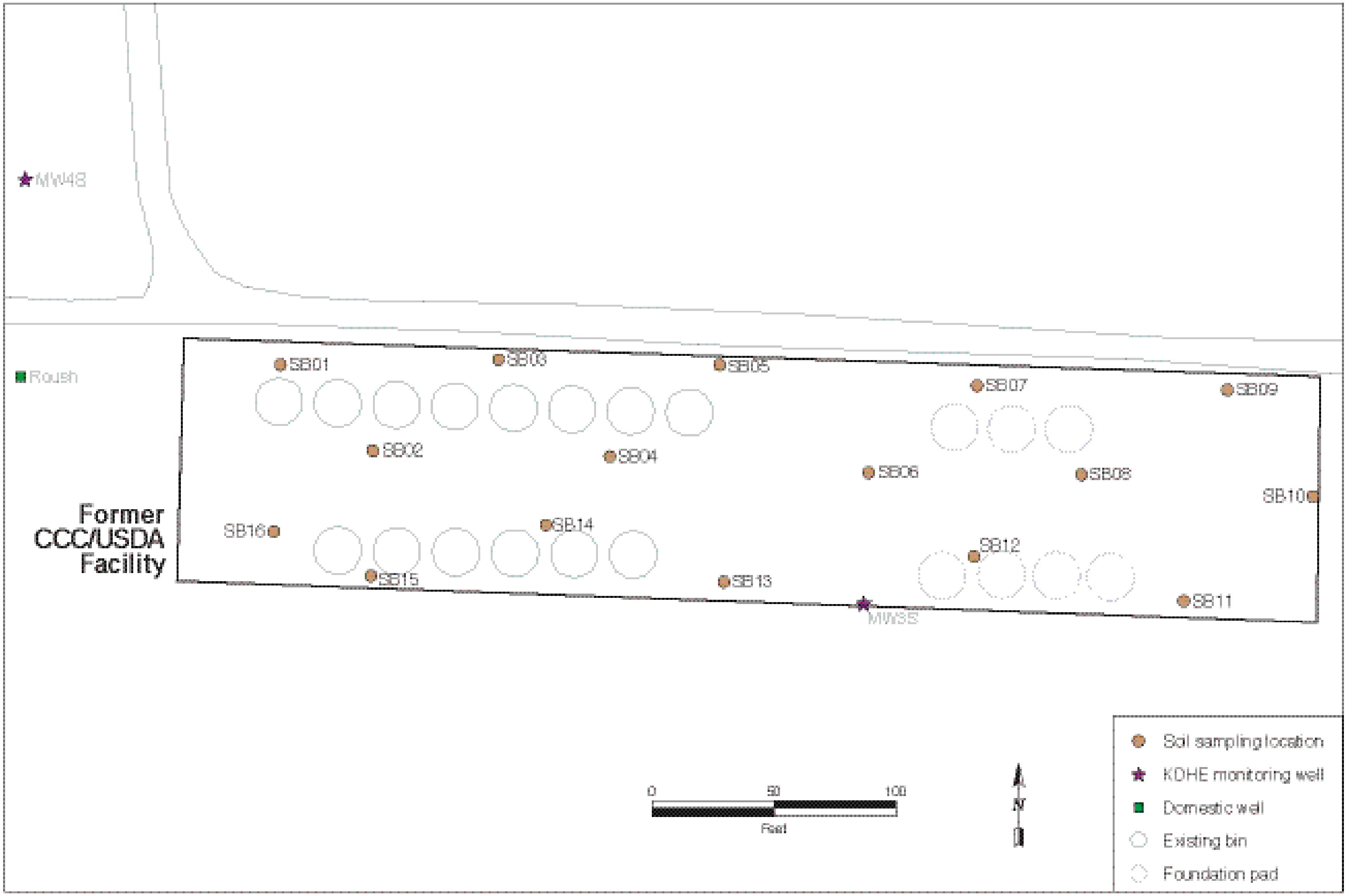

FIGURE 2.1 Locations of near-surface and shallow subsurface soil sampling activities at the former CCC/USDA facility at Morrill in October 2003.

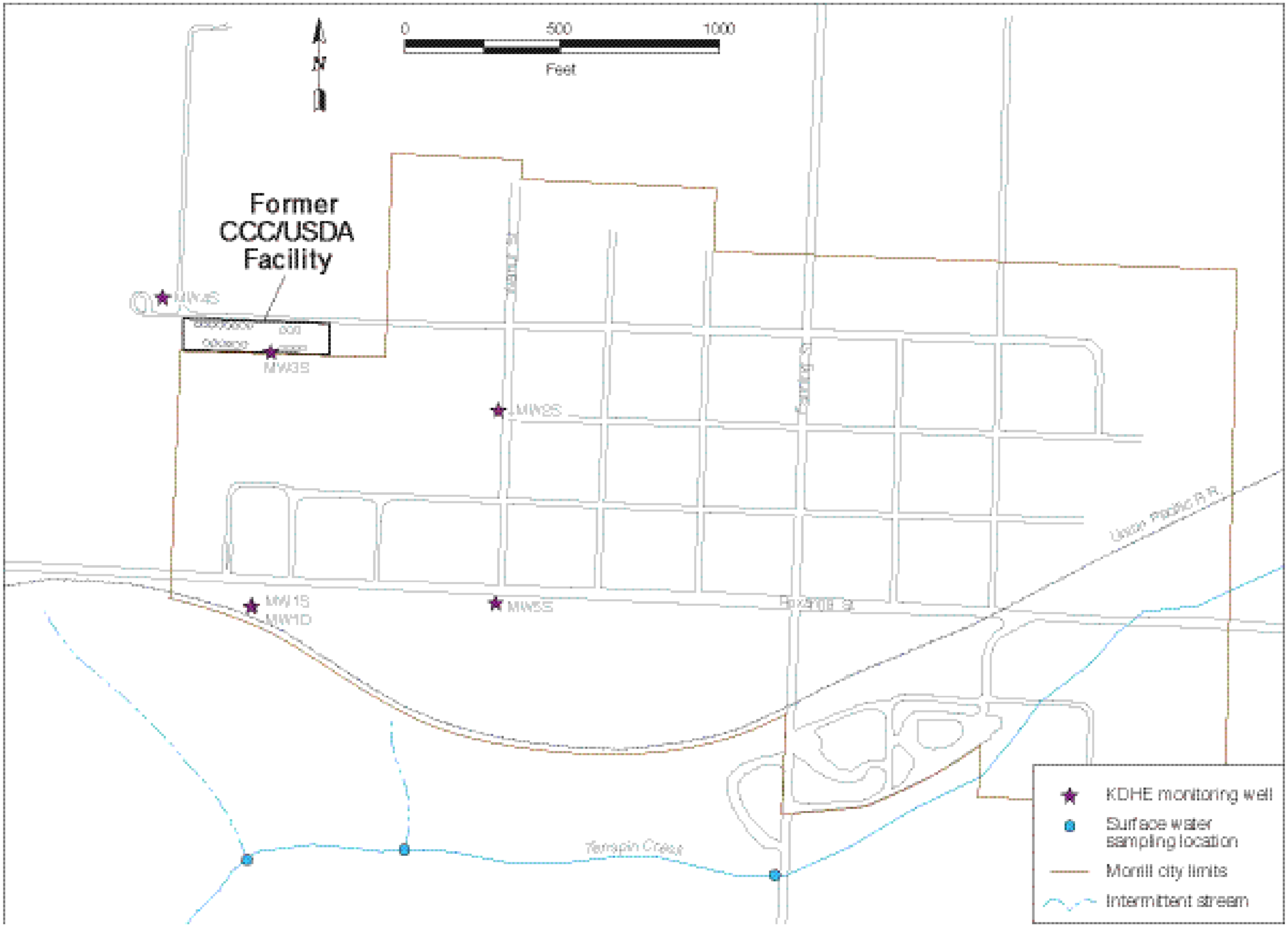

FIGURE 2.2 Locations of groundwater and surface water sampling activities in the investigation area at Morrill in October 2003.

3 Field and Laboratory Data

This section summarizes the field and laboratory data generated during the Phase I–Phase II investigation at Morrill. The general techniques and procedures followed are described in detail in the *Master Work Plan* (Argonne 2002). The data are summarized in this section according to the type of media investigated and the activities performed. These data are interpreted in Section 4 in the context of the specific technical objectives presented in Section 1.

3.1 Soil Boring Data

Continuous core samples were collected from soil boring SB12 (Figure 3.1). These data confirmed the generally fine grained, heterogeneous nature of the vadose zone soils identified by GeoCore (1996) at MW3S, at the former CCC/USDA facility. These soils were interpreted as representing the glacial till and outwash deposits of the Pleistocene age Upper Independence Formation. The descriptions of the samples from boring SB12 are in Appendix A, as are additional core samples from selected intervals.

3.2 Coordinates Survey Data

The six existing KDHE monitoring wells at Morrill (MW1D and MW1S–MW5S) were surveyed by Schwab-Eaton, P.A., Manhattan, Kansas, to provide horizontal and vertical control for water level monitoring. Soil sampling locations SB01 and SB10 were also surveyed to serve as on-site reference points. The coordinates of other sampling locations were measured by Argonne personnel using a hand-held differential global positioning system (GPS). Coordinates survey data are in Appendix B, Table B.1.

3.3 Analytical Data for Soils

Discrete near-surface and subsurface soil samples were collected at each of the 16 investigative locations at the former CCC/USDA facility (see Figure 2.1). Near-surface soil samples were collected at depths of approximately 2 ft and 5 ft BGL. Subsurface soil samples were collected every 5 ft, starting at a depth of 10 ft BGL and continuing to approximately 15 ft or bedrock, whichever was encountered first. The soil samples were analyzed for carbon tetrachloride and chloroform by purge-and-trap sample preparation with analysis by gas chromatography–mass spectrometry (EPA Methods 5030B and 8260B; Argonne 2002, Section 6.3.1.1). Sample descriptions are in Table C.1, Appendix C.

Contaminant Data for Soils

No carbon tetrachloride or chloroform was detected in any of the near-surface soil samples or in any of the shallow subsurface soil samples above the method quantitation limit of 10 μg/kg (Figure 3.2). Complete analytical results for VOCs in subsurface soil samples are in Table C.2, Appendix C.

3.4 Analytical Data for Groundwater and Surface Water

The six KDHE monitoring wells (MW1D and MW1S–MW5S) were purged and sampled October 21–23, 2003. All wells were sampled in accordance with procedures presented in the *Master Work Plan* (Argonne 2002), Section 6.1.2.4.

Surface water samples were collected from three locations in Terrapin Creek. Although a reconnaissance of the creek was conducted in an attempt to identify visible groundwater seeps, no such seeps were observed near or along the creek bed.

The analytical results of groundwater and surface water samples collected are summarized in Table D.1, Appendix D.

3.4.1 Field Measurements

Field measurements of temperature, pH, and electrical conductivity taken during collection of groundwater samples are presented in Table D.2, Appendix D.

3.4.2 Contaminant Data

Carbon tetrachloride was detected above the quantitation limit of 1 μg/L in three of the six wells sampled: MW1S, MW3S, and MW5S (Figure 3.3). These are the three wells in which carbon tetrachloride has historically been detected (Argonne 2003). A maximum concentration of 89 μg/L was detected in MW3S; 33 μg/L was detected in MW1S; and 5.8 μg/L was detected in MW5S. Chloroform, a degradation product of carbon tetrachloride, was detected above the quantitation limit of 1 μg/L in MW1S (1.6 μg/L) and in MW3S (2.7 μg/L). Carbon tetrachloride and chloroform were not detected in any of the other monitoring wells or in any of the surface water samples collected along Terrapin Creek (Figure 3.3).

Complete results of organic analyses on monitoring well and surface water samples are in Table D.3 in Appendix D. These results are discussed in Section 4. The QA/QC results, including results for samples analyzed with EPA CLP methodology, are summarized in Section 3.6.

3.4.3 Major Elements

Results of inorganic analyses of the groundwater samples were used to characterize the groundwater geochemistry and the ionic compositions of waters. The analytical results for major cations and anions are discussed in Section 4.

Nitrate (as nitrogen) concentrations in groundwater ranged from 12.1 mg/L to 25.1 mg/L in the wells screened in the upper aquifer. No nitrate was detected above a quantitation limit of 0.2 mg/L in well MW1D, which is screened in the deeper aquifer zone. All inorganic analytical results are presented in Table D.4 in Appendix D.

3.5 Groundwater Level Data

The depth to groundwater was measured before the six existing KDHE monitoring wells were purged and sampled. The groundwater level data for the five wells in the shallow aquifer zone (MW1S–MW5S) and the one well in the deep aquifer (MW1D) are presented in Table E.1 in Appendix E.

3.6 Quality Control Data for Soil and Water Analyses

The QA/QC procedures followed during Morrill Phase I–Phase II work for collection, handling, and analysis of soil and water samples are described in detail in the *Master Work Plan* (Argonne 2002). A detailed report of the QA/QC activities is in Appendix F. Results of the QA/QC activities are summarized as follows:

- Sample integrity was maintained successfully throughout the collection, shipping, and analysis activities by the use of custody seals and chain-of-custody records. Transcription errors in sample identities as listed on one chain-of-custody record and one analytical data report, described in detail in the QC Report in Appendix F, were resolved during review of shipping and handling documentation.

- All samples shipped to the AGEM Laboratory for organic analysis and all soil samples shipped to Severn-Trent Laboratory for verification organic analysis were received with custody seals intact and at the appropriate temperature. However, water samples shipped to Clayton Laboratory for verification organic analysis were received at a temperature of 14°C. All samples were analyzed within required holding times. The low relative percent difference between results reported by Clayton Laboratory and AGEM Laboratory (9%, i.e., within the expected analytical error) indicates that excessive volatilization during shipment did not occur.

- Because of an instrument error, analysis of sample MRSB11-S-16371 at the AGEM Laboratory was not successful. A replicate of the sample was sent to Severn-Trent Laboratory for verification organic analysis. That result is reported as the primary analytical result (Table C.2, Appendix C), as opposed to a QC analysis.

- Carbon tetrachloride and chloroform were not detected in trip blanks accompanying soil and water samples shipped to the AGEM Laboratory for organic analysis, or in the trip blank shipped with water samples to Clayton Laboratory for verification organic analysis. Chloroform, methylene chloride, and 1,1,1-trichloroethane were detected at low concentrations in the blank of the methanol used for extraction of the soil samples shipped to Severn-Trent Laboratory for verification organic analysis. Therefore, the chloroform concentrations reported from that laboratory are qualified (Table F.6 in Appendix F).

- Carbon tetrachloride and chloroform were not detected in laboratory method blanks analyzed with the samples or in sampling equipment rinsates.

- For the purge-and-trap analyses of near-surface and subsurface soil samples for carbon tetrachloride and chloroform at the AGEM Laboratory with EPA Methods 5030B and 8260B, calibration checks were run with each sample delivery group to verify proper calibration of the gas chromatograph throughout the analyses, and surrogate standard determinations were performed. Neither carbon tetrachloride nor chloroform was detected in the soil samples above the quantitation limit of 10 μg/kg. The analytical data from the AGEM Laboratory are acceptable for quantitative determination of contaminant distribution in soils and for risk analysis.

- Verification purge-and-trap analyses of replicate soil samples with EPA Methods 5030B and 8260B at Severn-Trent Laboratory showed no carbon tetrachloride contamination in the soil samples above the quantitation limit of 10 μg/kg, supporting the AGEM Laboratory data. Low detection of carbon tetrachloride in three verification samples is qualified due to high surrogate recovery in the QC sample associated with the samples and variable recovery in the spike/spike duplicate analysis. In addition, chloroform detected in the samples at concentrations < 19 μg/kg is attributed to the presence of chloroform at 14 μg/kg in the methanol used for sample extraction.

- Groundwater and surface water samples were analyzed for carbon tetrachloride and chloroform at the AGEM Laboratory by using EPA Method 524.2 (the purge-and-trap method). The QC limits were met for the analyses. Results for a blind replicate groundwater sample and blind replicate surface water sample indicate excellent analytical precision. The relative percent differences between the detected concentrations of carbon tetrachloride and chloroform in the groundwater sample and its associated replicate were 1.1% and 0.0%, respectively. No contamination was detected in the surface water sample or its associated replicate. The analytical data from AGEM Laboratory for groundwater and surface water samples are acceptable for quantitative determination of contaminant distribution.

- The QC limits were met in verification analyses of replicate groundwater samples for carbon tetrachloride and chloroform with EPA CLP methodology at Clayton Laboratory. The results support the AGEM Laboratory data.

- The QC parameters were met for inorganic analyses of groundwater samples, including instrument calibration through analysis of spiked calibration check standards and the verification of interelement and background correction factors through the analysis of interference check samples for inductively coupled plasma procedures. The inorganic data from Severn-Trent Laboratory are accepted on the basis of the accuracy achieved in the analysis of QC samples.

3.7 Waste Handling

Purge water generated from wells MW1S and MW3S, previously identified as containing carbon tetrachloride concentrations above the maximum contaminant level (MCL) of 5 μg/L (micrograms per liter), was placed in containers for proper disposal at an approved facility at Sabetha, Kansas. Purge water generated from the other four wells was discharged to the ground, as indicated in Section 6.1.5 of the Master *Work Plan* (Argonne 2002) and by prior agreement with the KDHE.

3.8 Summary

The following are the key analytical results of the Phase I–Phase II field investigation at Morrill:

- No carbon tetrachloride or chloroform was detected in near-surface or subsurface soils (maximum depth approximately 15 ft BGL) at the former CCC/USDA facility.

- Carbon tetrachloride was detected in three of the KDHE monitoring wells completed in the shallow aquifer above the MCL of 5 µg/L. A maximum concentration of 89 µg/L was detected in MW3S; 33 µg/L was detected in MW1S; and 5.8 µg/L was detected in MW5S.

- Chloroform, a degradation product of carbon tetrachloride, was detected at low concentrations in MW1S (1.6 µg/L) and in MW3S (2.7 µg/L).

- Carbon tetrachloride and chloroform were not detected in MW1D, MW2S, and MW4S or in any of the surface water samples collected along Terrapin Creek.

- Nitrate levels above the MCL of 10 mg/L were detected in all five monitoring wells completed in the shallow aquifer.

- Nitrate was not detected in monitoring well MW1D, completed in the deeper aquifer.

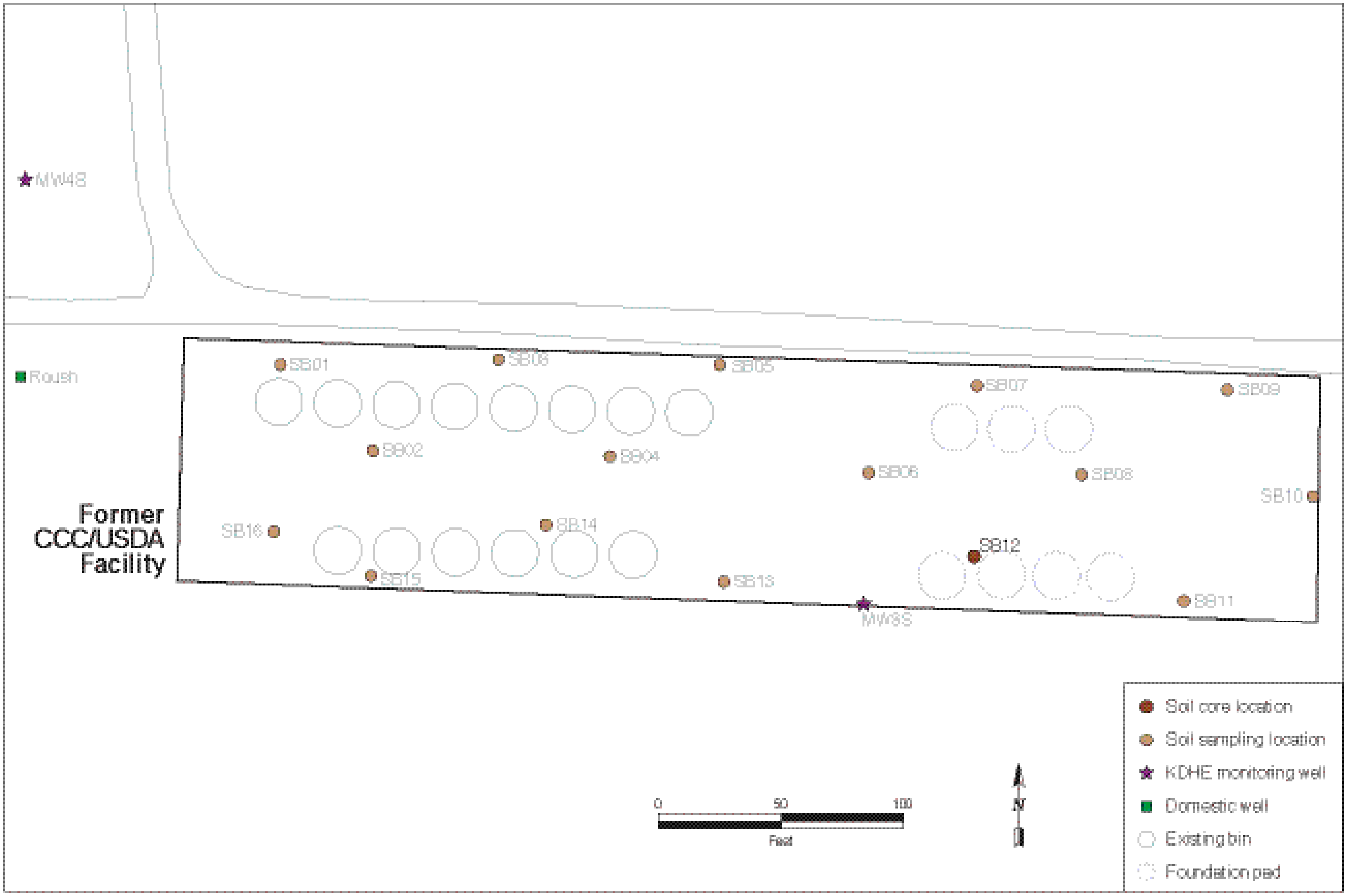

FIGURE 3.1 Location of continuously cored boring SB12 at the former CCC/USDA facility at Morrill.

FIGURE 3.2 Results of analyses for volatile organic compounds in the near-surface and shallow subsurface soil samples collected at the former CCC/USDA facility at Morrill in October 2003.

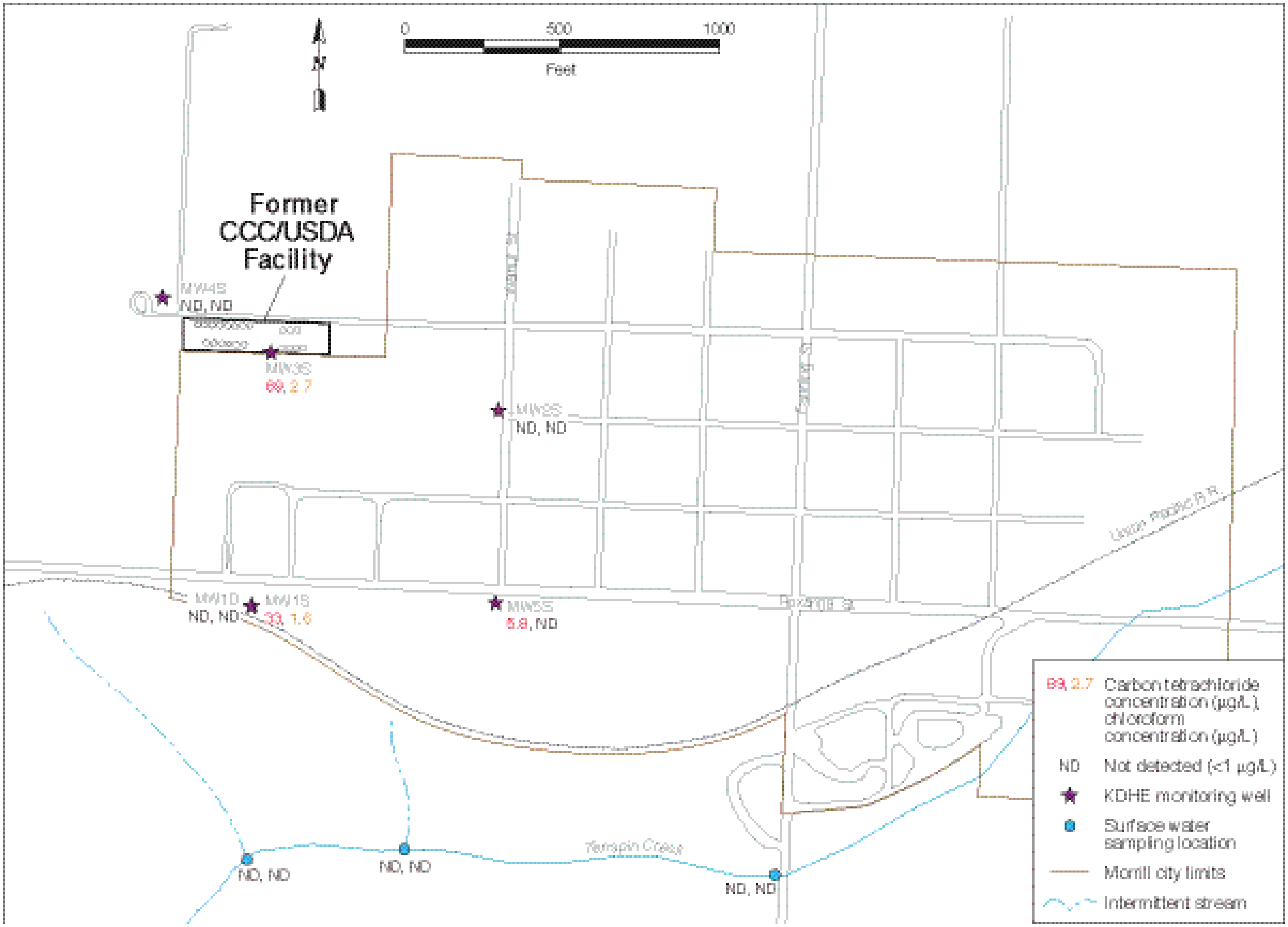

FIGURE 3.3 Results of analyses for volatile organic compounds in groundwater and surface water samples collected in the investigation area at Morrill in October 2003.

4 Interpretation of Results

The primary goals of this investigation were (1) to verify any association of carbon tetrachloride with the former CCC/USDA facility; (2) to verify the contaminant migration pathway from the former facility; and (3) to identify any domestic wells located outside the Morrill city limits that are downgradient from and within 1 mi of the former CCC/USDA facility and thus are potential receptors of groundwater contamination. To generate the information needed to accomplish these goals, the investigation had the following technical objectives:

1. Verify whether soils at the former CCC/USDA facility are contaminated with carbon tetrachloride.
2. Assess the nature and continuity of the geologic units composing the aquifer in the vicinity of the former CCC/USDA facility.
3. Verify the direction and magnitude of the groundwater gradient in the aquifer at the former CCC/USDA facility.
4. Verify the contaminant migration pathway at the former CCC/USDA facility.
5. Identify potential receptor wells outside the Morrill city limits.
6. Determine needs for additional monitoring wells.

4.1 Verify Whether Soils at the Former CCC/USDA Facility Are Contaminated with Carbon Tetrachloride

The methodology presented in Section 2.1 was used to collect near-surface and subsurface soil samples to assess whether soils at the former CCC/USDA facility are contaminated with carbon tetrachloride. The soil samples were analyzed for carbon tetrachloride and chloroform by purge-and-trap sample preparation with analysis by gas chromatography–mass spectrometry with a method quantitation limit of 10 μg/kg (EPA Methods 5030B and 8260B; Argonne 2002, Section 6.3.1.1).

4.1.1 Contamination in Soils

Sixty-four soil samples were collected for analysis of VOCs at 16 locations at depths ranging from 2–15 ft BGL. No carbon tetrachloride or chloroform was detected in any of the soil samples (Figure 3.2).

4.1.2 Human Health Risks Associated with Exposure to Soils

Results obtained from the sampling and analysis of near-surface and subsurface soils were compared against the Tier 2 risk-based standards for carbon tetrachloride and chloroform presented in *Risk-Based Standards for Kansas* (*RSK Manual*; KDHE 2003). In deriving the presented concentrations for soil, the KDHE evaluated exposure pathways including incidental ingestion of soil, inhalation of airborne particulates, inhalation of chemical volatilizing from soil, and direct dermal contact with soil. The KDHE standards are based on risk to human health, for residential and nonresidential land use settings.

The risk-based standards listed in the Tier 2 Risk-Based Summary Table (Appendix A in *RSK Manual*; KDHE 2003) for carbon tetrachloride are 2.5 mg/kg or 2,500 μg/kg for a residential setting and 7.0 mg/kg or 7,000 μg/kg for a nonresidential setting. The corresponding risk-based standards for chloroform are 3.9 mg/kg (3,900 μg/kg) and 6.0 mg/kg (6,000 μg/kg).

The absence of detectable concentrations of either carbon tetrachloride or chloroform in soils to a depth of 13–15 ft BGL indicates that no identifiable human heath risk is associated with either carbon tetrachloride or chloroform in shallow soils at the former CCC/USDA facility.

4.2 Assess the Nature and Continuity of the Geologic Units Composing the Aquifer in the Vicinity of the Former CCC/USDA Facility

A field reconnaissance was conducted along Terrapin Creek south of the former CCC/USDA facility in an attempt to locate bedrock outcrops anticipated to occur downgradient of the former facility and identify any characteristic fracturing, jointing, or both within the units. The reach of Terrapin Creek examined was highly vegetated and overgrown. No outcrops were readily visible in the banks along Terrapin Creek immediately downgradient of the former

CCC/USA facility. The absence of visible outcrops precluded the identification of any characteristic fractures or joints in the limestone units.

The two aquifer zones identified at Morrill have been shown to be geochemically distinguishable. Anion and cation data collected for the six KDHE monitoring wells were analyzed by using two graphical techniques: the Stiff diagram, which plots the major ion compositions in milliequivalents per liter, and the Piper trilinear plot, which represents the concentrations as percentages of total equivalents per liter. Figure 4.1 presents the Stiff diagrams for the six wells sampled. Figure 4.2 presents the Piper trilinear plot of the same data. Both of these figures show that the water sample from the deeper aquifer (MW1D) exhibits a significantly higher sulfate content than the samples from the shallow aquifer (MW1S–MW5S) and is readily distinguishable from the shallow aquifer samples. The two aquifer zones were also distinguished by a lack of detectable nitrate in the sample from the deeper aquifer (Figure 4.3 and Table D.4, Appendix D).

4.3 Verify the Direction and Magnitude of the Groundwater Gradient in the Aquifer at the Former CCC/USDA Facility

The potentiometric surface of the upper aquifer in the investigation area is depicted in Figure 4.4. The contours presented are based on manual readings taken in October 2003 (Table E.1, Appendix E). The resulting contour pattern indicates a south-southeasterly gradient of approximately 0.008 ft/ft in the vicinity of the former CCC/USDA facility, consistent with the gradient depicted by GeoCore in 1994 and 1995 (GeoCore 1994, 1996; see Argonne 2003, Figure 3.10).

4.4 Verify the Contaminant Migration Pathway at the Former CCC/USDA Facility

The preliminary geologic/hydrogeologic model as presented in the site-specific Phase I *Work Plan* (Argonne 2003) was updated on the basis of the results of the October 2003 investigation. The purpose was to integrate the current understanding of the geology and hydrogeology and thus predict the potential contaminant migration pathway from the former CCC/USDA facility. The most likely migration pathway is inferred to be as follows: (1) vertical infiltration of carbon tetrachloride from the land surface through the vadose zone to the water table, followed by (2) subhorizontal south-southeastward lateral migration within the Grenola limestone–Roca shale in response to the prevailing hydraulic gradient. This contaminant migration pathway is shown in Figure 4.5.

During periods of high groundwater levels, groundwater could possibly discharge into Terrapin Creek, though no such discharge was observed during the October 2003 investigation.

4.5 Identify Potential Receptor Wells Outside the Morrill City Limits

Three domestic wells situated downgradient from and within 1 mi of the former CCC/USDA facility have been identified outside the Morrill city limits. The Kent Grimm well and the Rodney Grimm well, located south of Terrapin Creek, are approximately 1.0 mile south of Morrill. They are reported as having been constructed in 2000 and are designated as domestic wells in the Kansas Geological Survey Water Well Database. The Avis Miller well was found to lie approximately 600 ft south of Terrapin Creek. Additionally, two previously unidentified wells, the James Stone well and the Ernest Moravec well, were discovered within the city limits (Figure 4.6).

Water usage records for residents within the city of Morrill are being reviewed. A door-to-door survey of the presumed plume area will be conducted following completion of the records review to ensure that all residents have an uncontaminated water source.

4.6 Determine Needs for Additional Monitoring Wells

The distribution of carbon tetrachloride in groundwater at Morrill, as detected during sampling in October 2003, is shown in Figure 4.7. Historic carbon tetrachloride data (1988–2003) are shown in Figure 4.8. A carbon tetrachloride plume is identified as extending south-southeasterly from the former CCC/USDA facility, toward Terrapin Creek. Review of the data indicates that although the upgradient and eastern lateral extent of the contaminated zone is adequately delineated by the existing monitoring wells, additional wells are needed to delineate the western lateral and the southern (downgradient) extent of the carbon tetrachloride plume at Morrill.

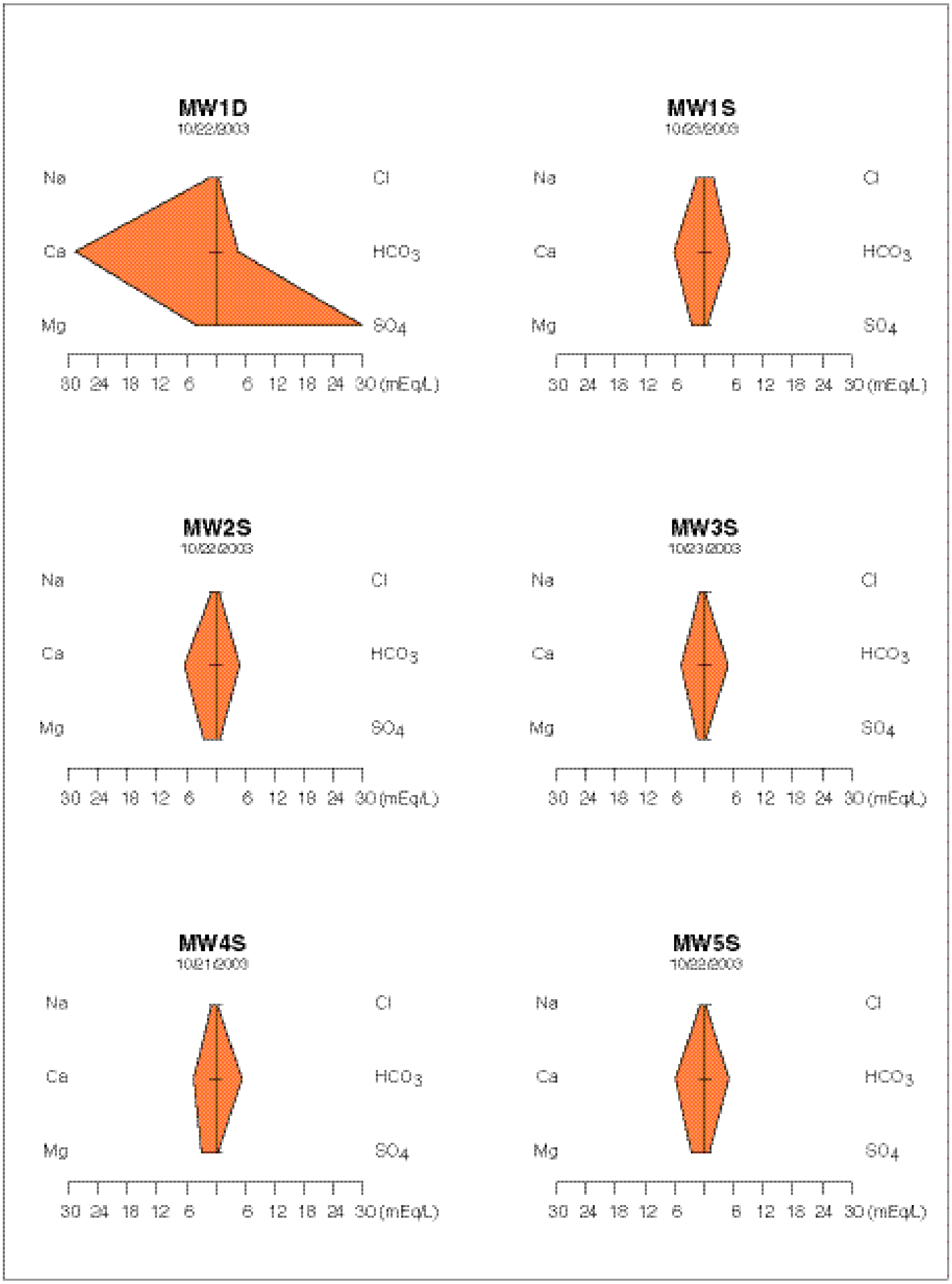

FIGURE 4.1 Major ion compositions (milliequivalents per liter) for groundwater samples collected at Morrill in October 2003, displayed as Stiff diagrams.

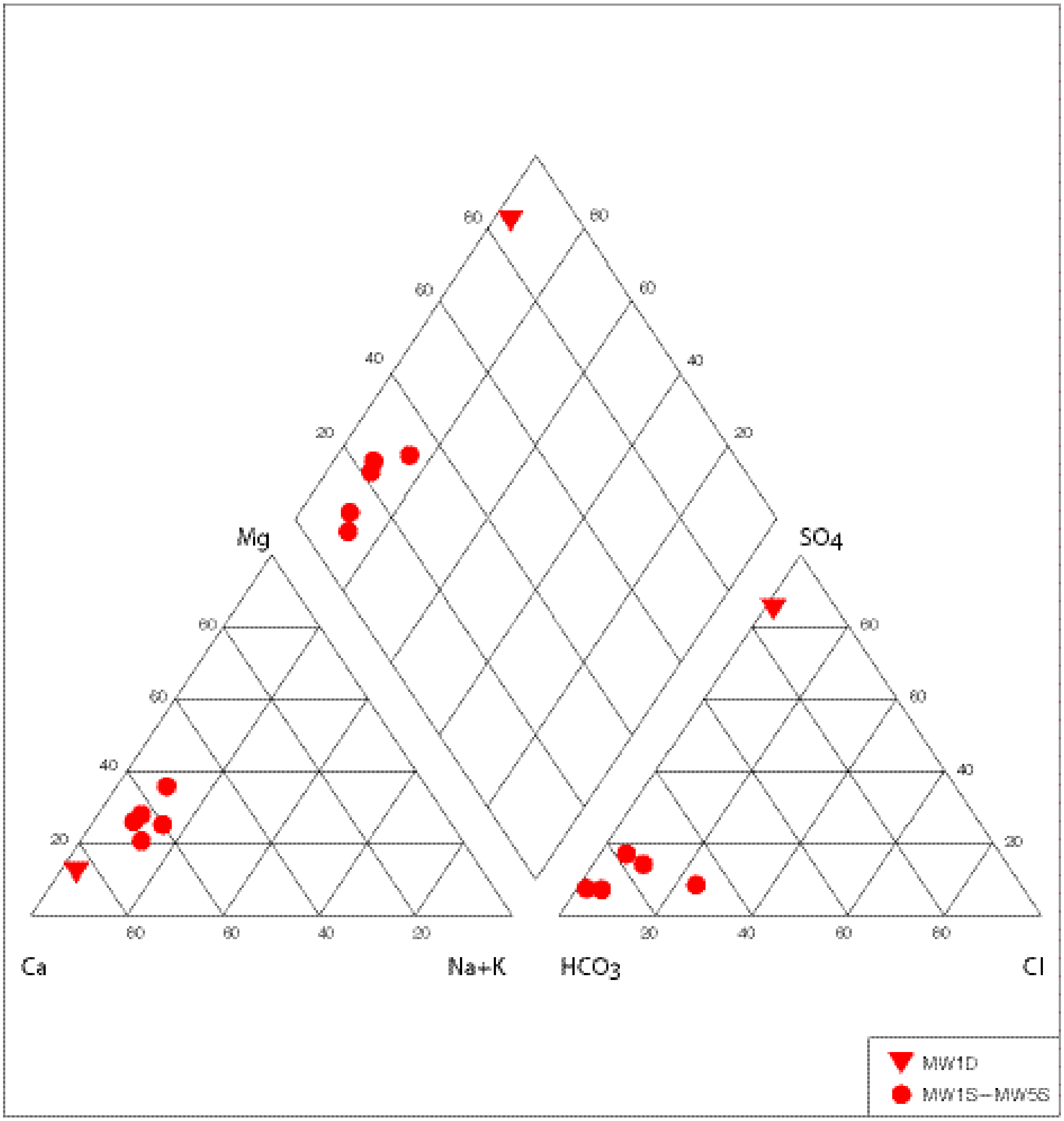

FIGURE 4.2 Major ion compositions (percent of total equivalents per liter) for groundwater samples collected at Morrill in October 2003, displayed as a Piper trilinear plot.

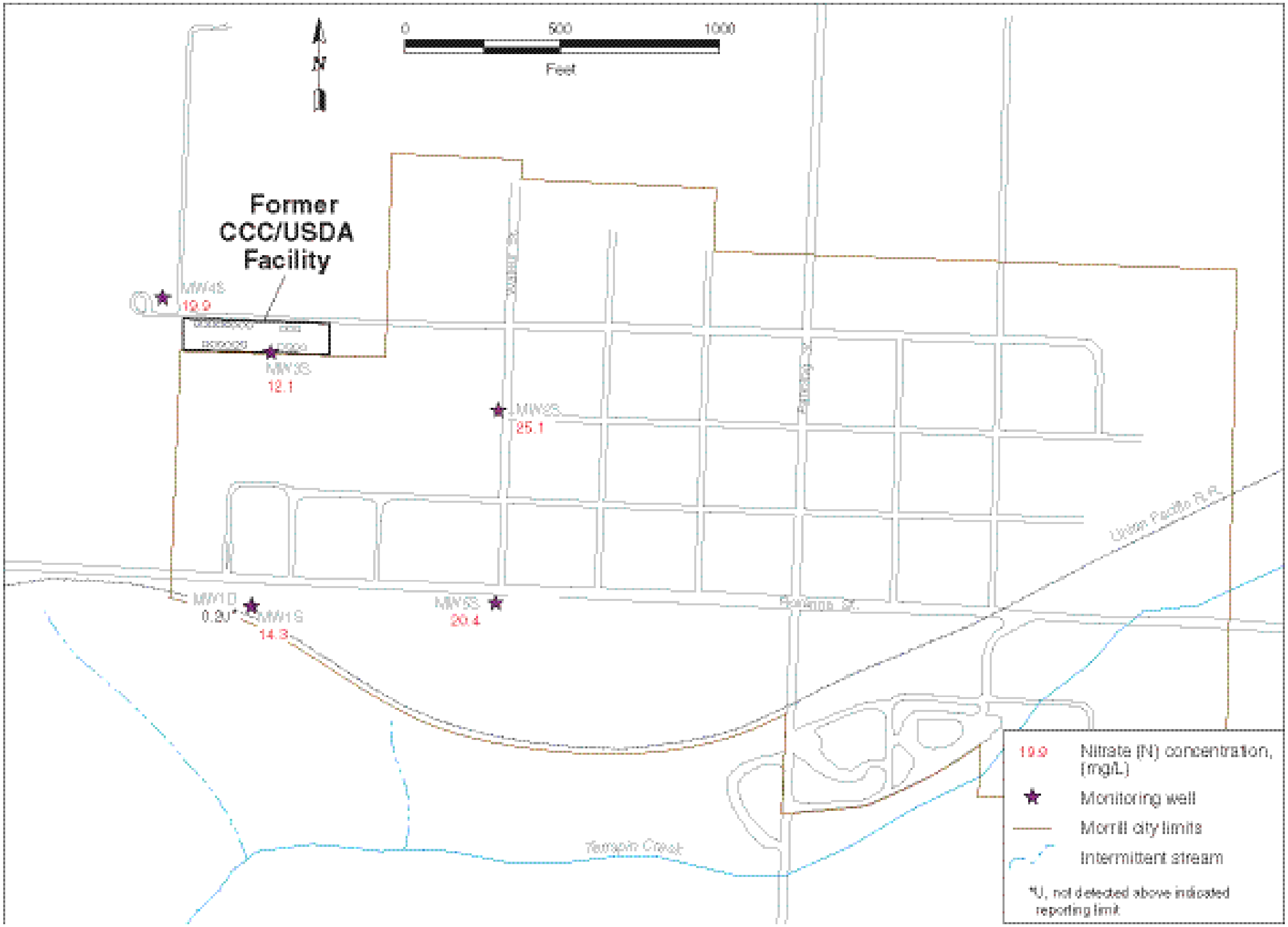

FIGURE 4.3 Nitrate concentrations for groundwater samples collected at Morrill in October 2003.

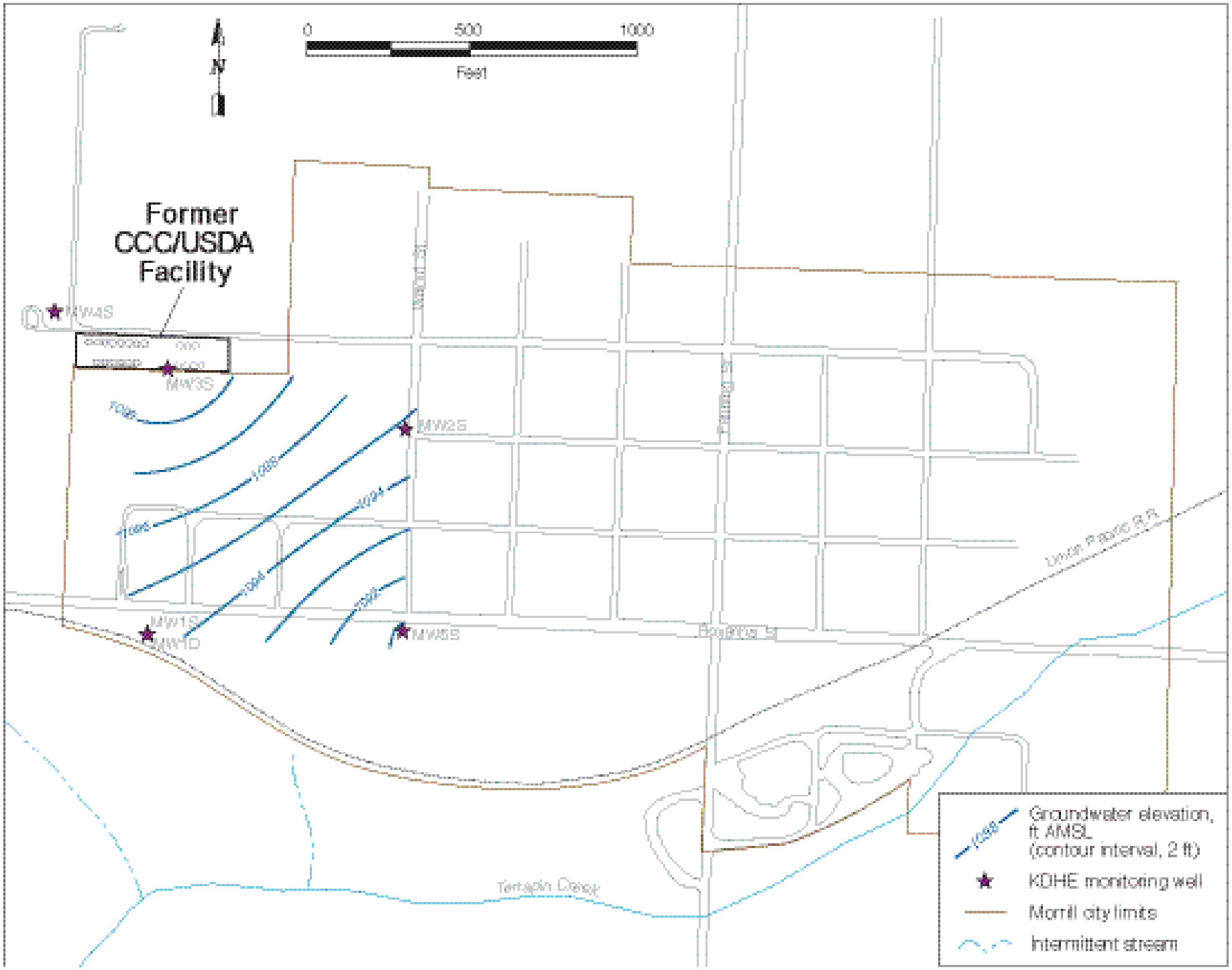

FIGURE 4.4 Potentiometric surface of the upper aquifer in the investigation area at Morrill, as measured manually in October 2003

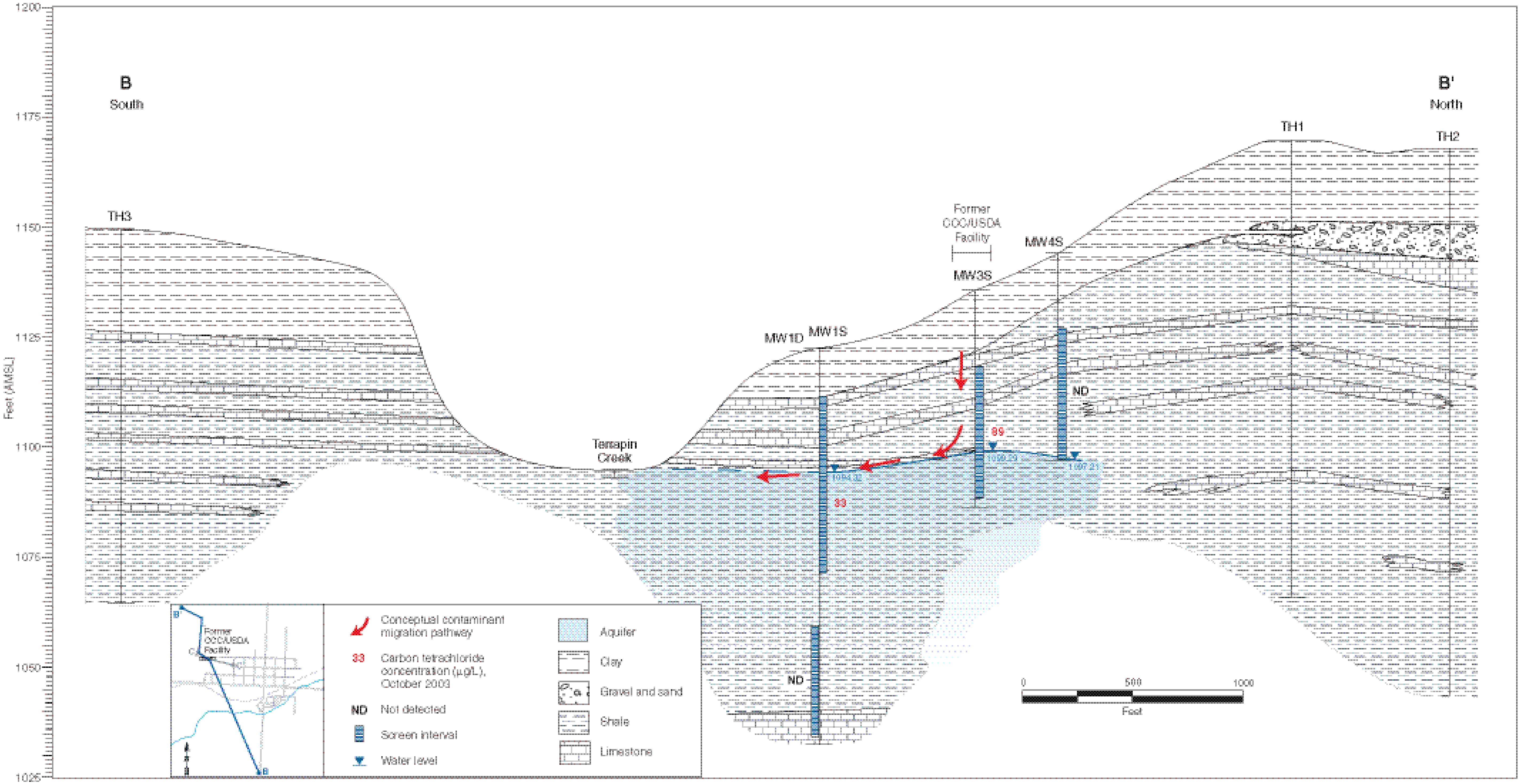

FIGURE 4.5 Inferred contaminant migration pathway at the former CCC/USDA facility at Morrill, displayed on interpretive geologic cross section B-B´ (vertically exaggerated; Figure 3.8 in Argonne 2003).

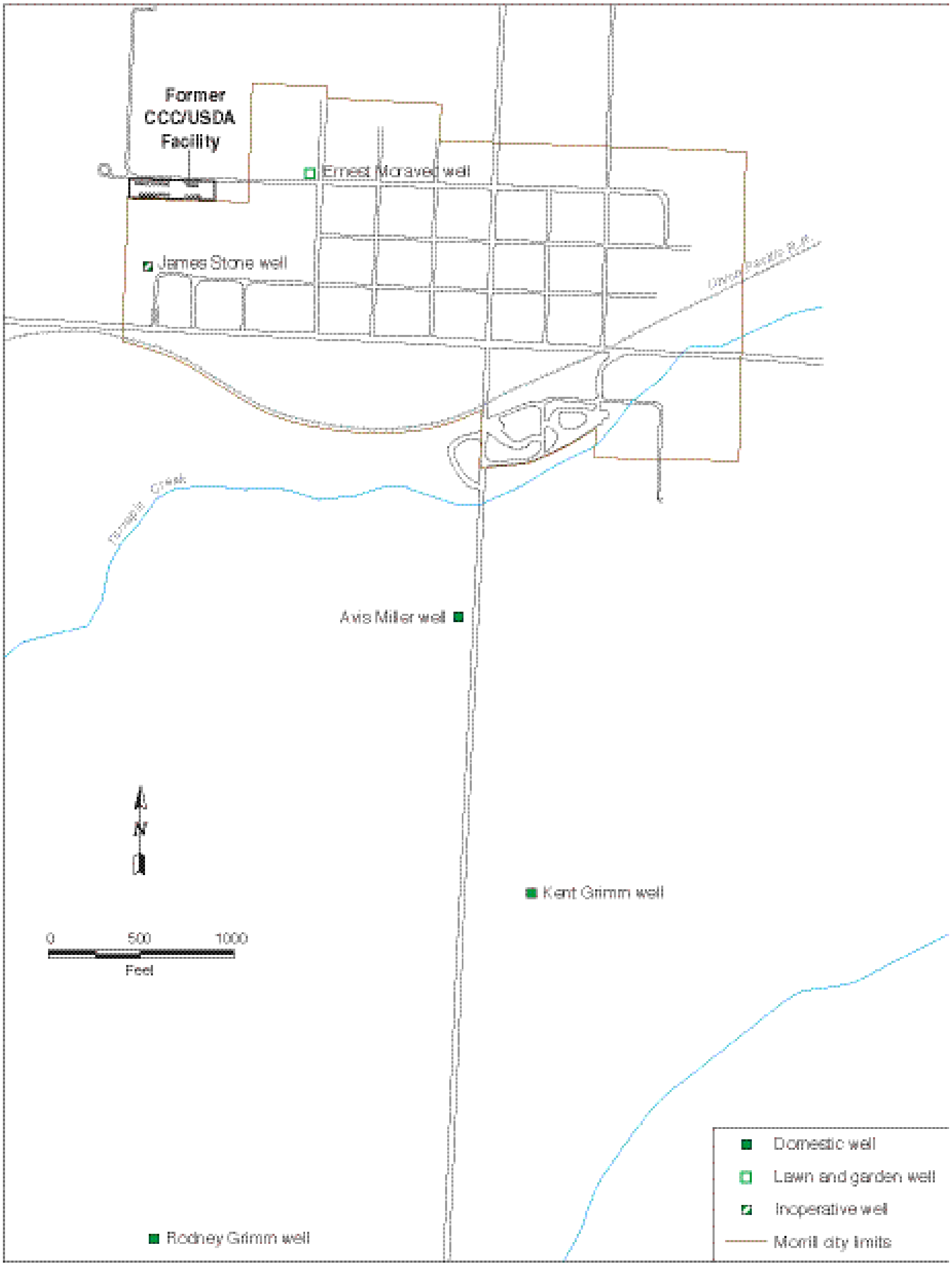

FIGURE 4.6 Locations of newly identified potential receptor wells at Morrill, downgradient and within 1 mi of the former CCC/USDA facility.

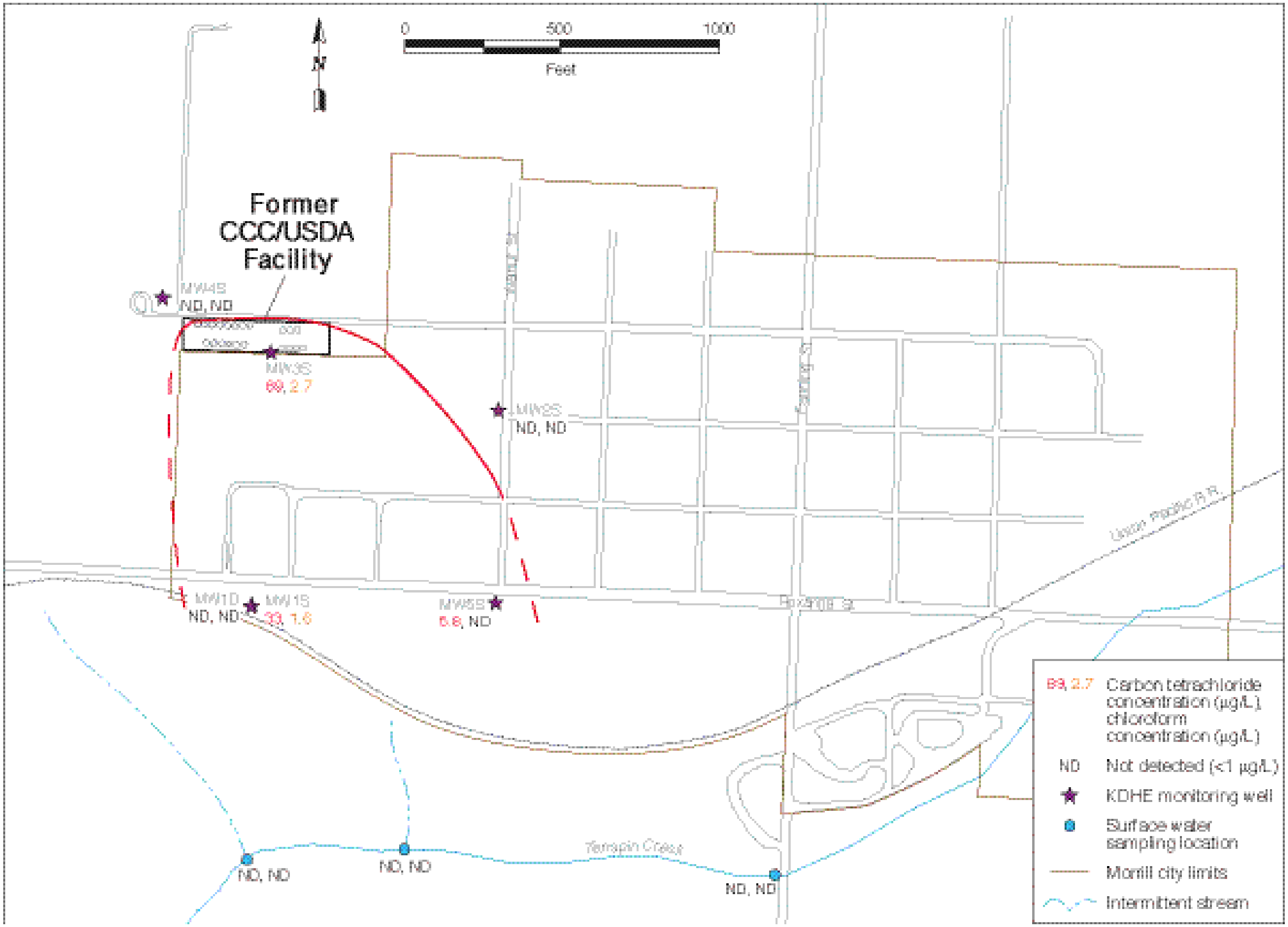

FIGURE 4.7 Interpreted distribution of carbon tetrachloride in groundwater at Morrill in October 2003.

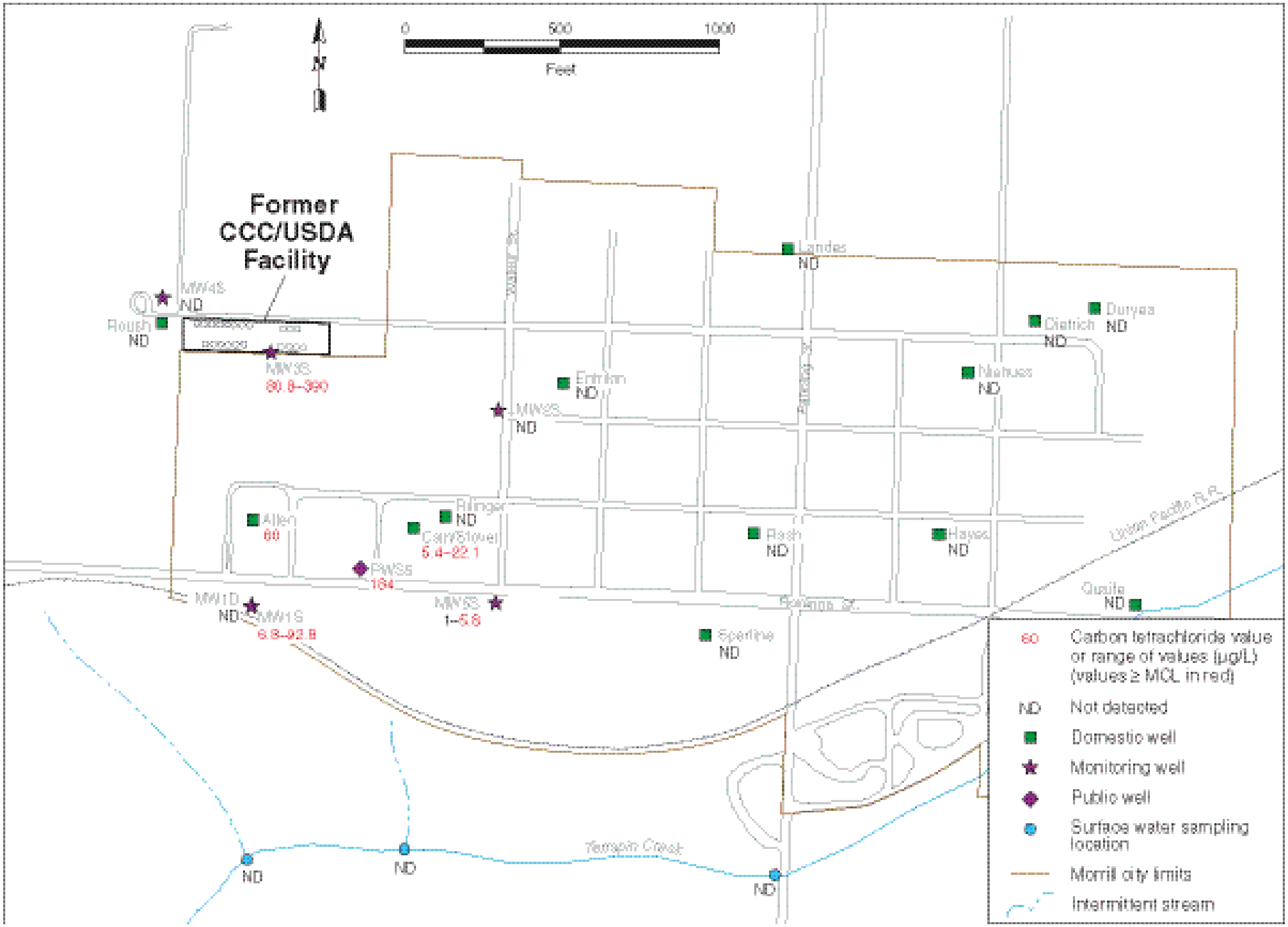

FIGURE 4.8 Carbon tetrachloride concentration data, 1988–2003, at Morrill.

5 Conclusions and Recommendations

5.1 Conclusions

The conclusions for the technical objectives of the Phase I–Phase II investigation at Morrill are as follows:

1. *Verify whether soils at the former CCC/USDA facility are contaminated with carbon tetrachloride*. Soils at the former CCC/USDA facility have not been found to be contaminated with carbon tetrachloride. Neither carbon tetrachloride nor chloroform was detected in near-surface soils or in subsurface soils collected to bedrock or to a depth of approximately 15 ft BGL. No identifiable human health risk is associated with either carbon tetrachloride or chloroform in the shallow soils at the former CCC/USDA facility. Additionally, the soils pose no threat of contamination to groundwater.

2. *Assess the nature and continuity of the geologic units composing the aquifer in the vicinity of the former CCC/USDA facility*. The two aquifer zones identified in the vicinity of the former facility — (1) the Grenola limestone and the Roca shale above (1,065 ft AMSL) and (2) the deeper Long Creek limestone member of the Foraker limestone below (1,065 ft AMSL) — have been shown to be geochemically distinguishable based on variations in sulfate and nitrate content.

3. *Verify the direction and magnitude of the groundwater gradient in the aquifer at the former CCC/USDA facility*. The potentiometric surface indicates a south-southeasterly gradient of 0.008 ft/ft in the vicinity of the former CCC/USDA facility, consistent with the contours depicted by GeoCore in 1994 and 1995 (see Argonne 2003, Figure 3.10).

4. *Verify the contaminant migration pathway at the former CCC/USDA facility*. The most likely contaminant pathway is inferred to be as follows: (1) vertical infiltration of carbon tetrachloride from the land surface through the vadose zone to the water table, followed by (2) subhorizontal south-southeastward

lateral migration within the Grenola limestone–Roca shale in response to the prevailing hydraulic gradient. During periods of high groundwater levels, groundwater could possibly discharge into Terrapin Creek.

5. *Identify potential receptor wells outside the Morrill city limits*. Three domestic wells have been identified outside the Morrill city limits that are situated downgradient from and within 1 mi of the former CCC/USDA facility. These wells, south of Terrapin Creek, are the Avis Miller well, the Kent Grimm well, and the Rodney Grimm well. Additionally, two previously unidentified wells, the James Stone well and the Ernest Moravec well, were identified within Morrill city limits.

6. *Determine needs for additional monitoring wells*. Groundwater monitoring data indicate that although the upgradient and eastern lateral extent of the contaminated zone is adequately delineated by the existing monitoring wells, additional wells are needed to delineate the western lateral and the southern (downgradient) extent of the carbon tetrachloride plume at Morrill.

5.2 Recommendations and Planned Activities

On the basis of the findings and conclusions of the Phase I–Phase II investigations at Morrill to date, the following activities are recommended:

- Install three additional monitoring wells, MW6S, MW7S, and MW8S, at the locations shown in Figure 5.1. To ensure comparability of monitoring data, all three wells should be installed in the same (shallow) aquifer zone. A supplemental monitoring well installation work plan has been approved by KDHE.

- After installation of the three additional monitoring wells, sample all nine monitoring wells. KDHE will be notified prior to the sampling event.

- Complete a survey of Morrill residences within the plume area (south of Hanson St. and west of Fanning St.). Sample any previously unidentified wells and all other domestic wells located within 1 mi downgradient of the former CCC/USDA facility. KDHE will be notified of the sampling schedule when finalized.

- Following installation and sampling of the proposed monitoring wells and all identified domestic wells, issue a report documenting the activities and results, together with a preliminary list of remedial action objectives and potential corrective action alternatives, to the KDHE.

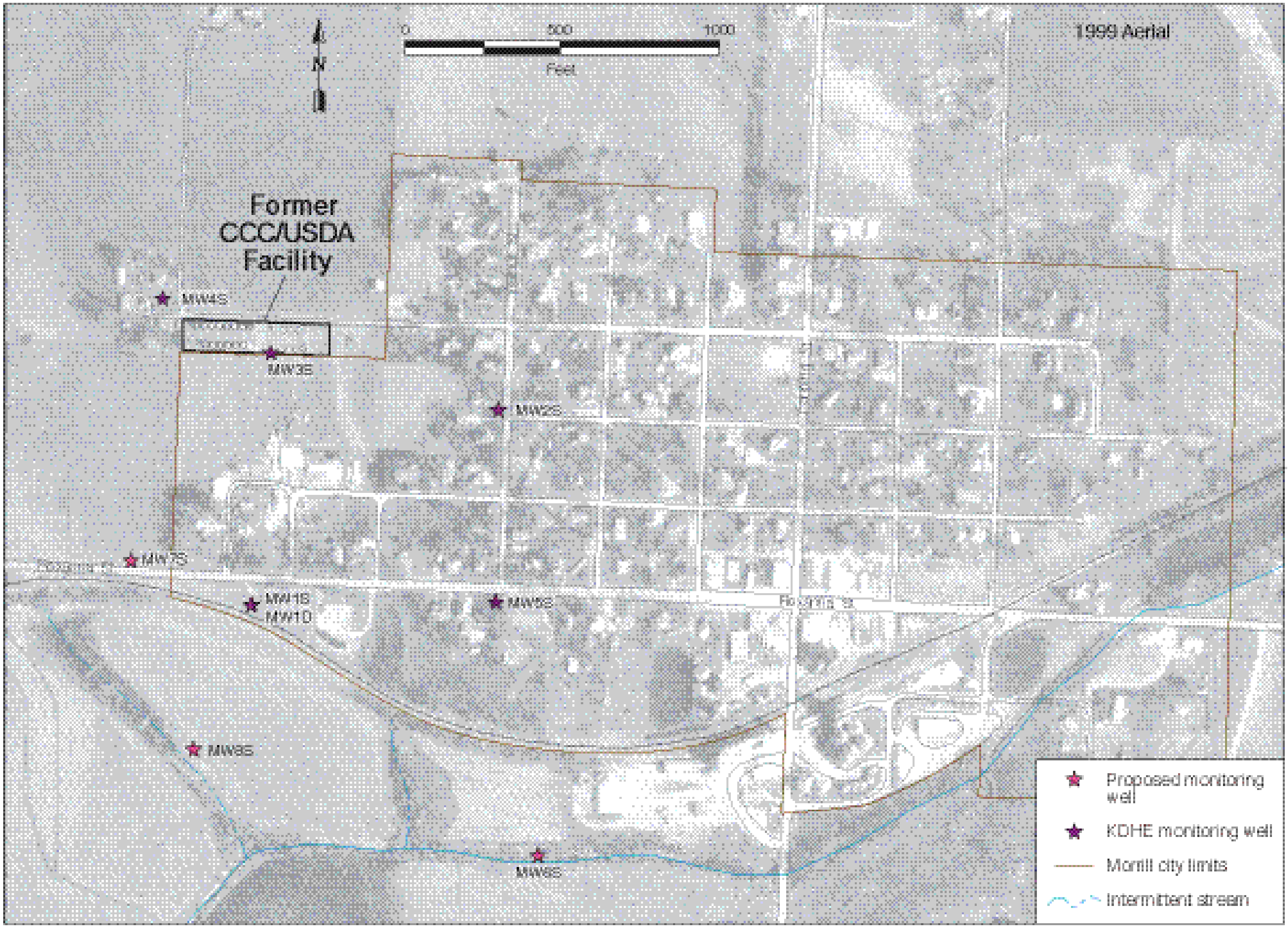

FIGURE 5.1 Proposed locations for new monitoring wells MW6S, MW7S, and MW8S at Morrill.

6 References

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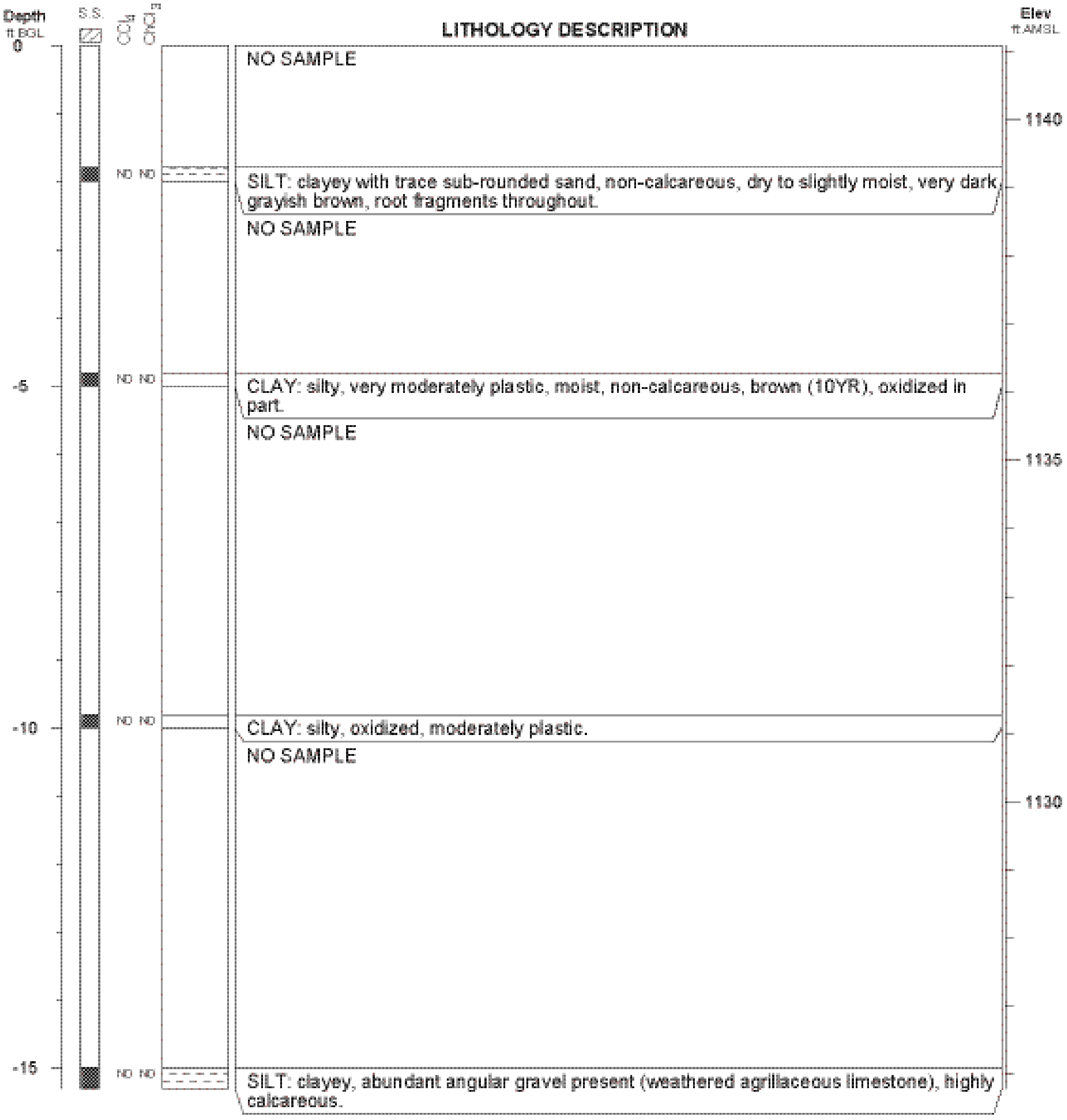
Appendix A:

Geologic Logs

Argonne National Laboratory

Boring ID: SB01

Project: Morrill Phase I/II
Geologist: L. LaFreniere
Elevation: 1141.09
Total Depth: 15.3 ft
Core Description: 0 to 15.3 ft
Log Date: 10/22/2003
Plot Date: 3/22/2004
Driller: Daryl Biere
Company: Argonne
Rig: Geoprobe



LITHOLOGY DESCRIPTION

NO SAMPLE

SILT: clayey with trace sub-rounded sand, non-calcareous, dry to slightly moist, very dark grayish brown, root fragments throughout.

NO SAMPLE

CLAY: silty, very moderately plastic, moist, non-calcareous, brown (10YR), oxidized in part.

NO SAMPLE

CLAY: silty, oxidized, moderately plastic.

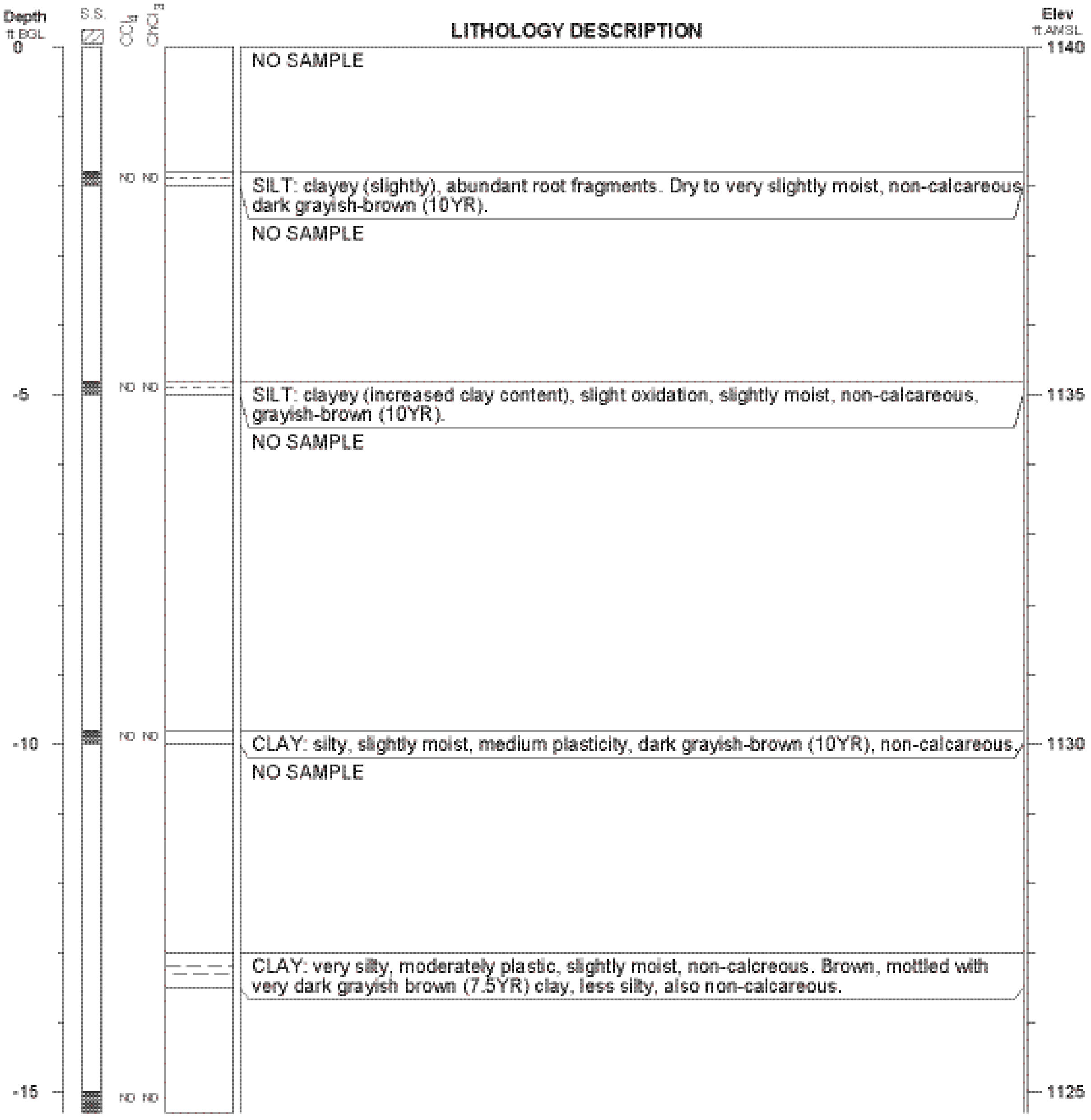
NO SAMPLE

SILT: clayey, abundant angular gravel present (weathered agrillaceous limestone), highly calcareous.

Carbon tetrachloride in soil sample = µg/kg

Argonne National Laboratory **Boring ID: SB02**

Project: Morrill Phase I/II **Elevation:** 1140 (Est.) **Log Date:** 10/22/2003 **Company:** Argonne
Geologist: L. LaFreniere **Total Depth:** 13.5 ft **Plot Date:** 3/22/2004 **Rig:** Geoprobe
Core Description: 0 to 13.5 ft **Driller:** Daryl Biere



NO SAMPLE

SILT: clayey (slightly), abundant root fragments. Dry to very slightly moist, non-calcareous dark grayish-brown (10YR).

NO SAMPLE

SILT: clayey (increased clay content), slight oxidation, slightly moist, non-calcareous, grayish-brown (10YR).

NO SAMPLE

CLAY: silty, slightly moist, medium plasticity, dark grayish-brown (10YR), non-calcareous.

NO SAMPLE

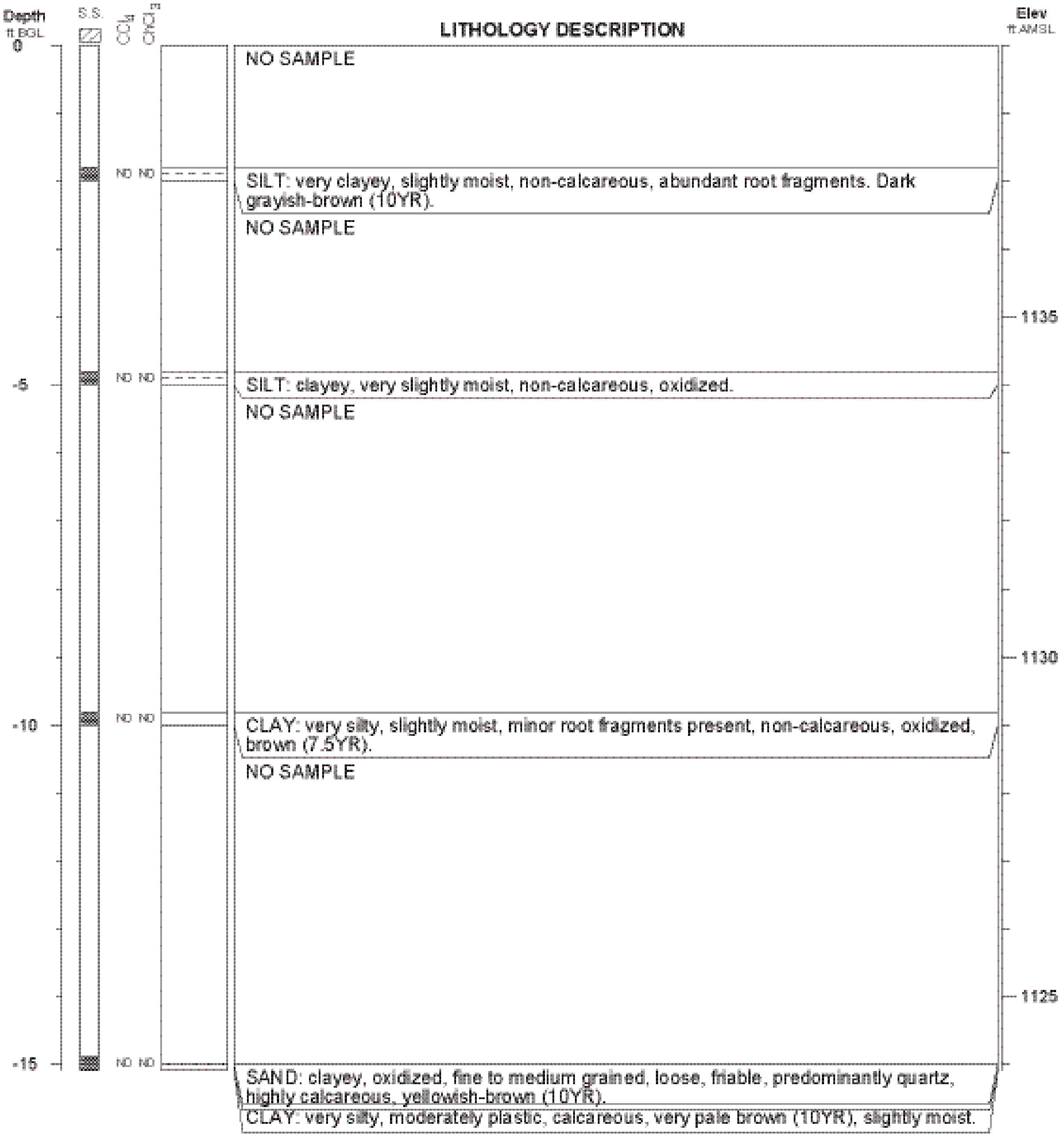
CLAY: very silty, moderately plastic, slightly moist, non-calcreous. Brown, mottled with very dark grayish brown (7.5YR) clay, less silty, also non-calcareous.

Carbon tetrachloride in soil sample = µg/kg

Argonne National Laboratory

Boring ID: SB03

Project: Morrill Phase I/II
Geologist: L. LaFreniere
Elevation: 1139 ft (Est.)
Total Depth: 15.1 ft
Core Description: 0 to 15.1 ft
Log Date: 10/22/2003
Plot Date: 3/22/2004
Driller: Daryl Biere
Company: Argonne
Rig: Geoprobe



NO SAMPLE

SILT: very clayey, slightly moist, non-calcareous, abundant root fragments. Dark grayish-brown (10YR).

NO SAMPLE

SILT: clayey, very slightly moist, non-calcareous, oxidized.

NO SAMPLE

CLAY: very silty, slightly moist, minor root fragments present, non-calcareous, oxidized, brown (7.5YR).

NO SAMPLE

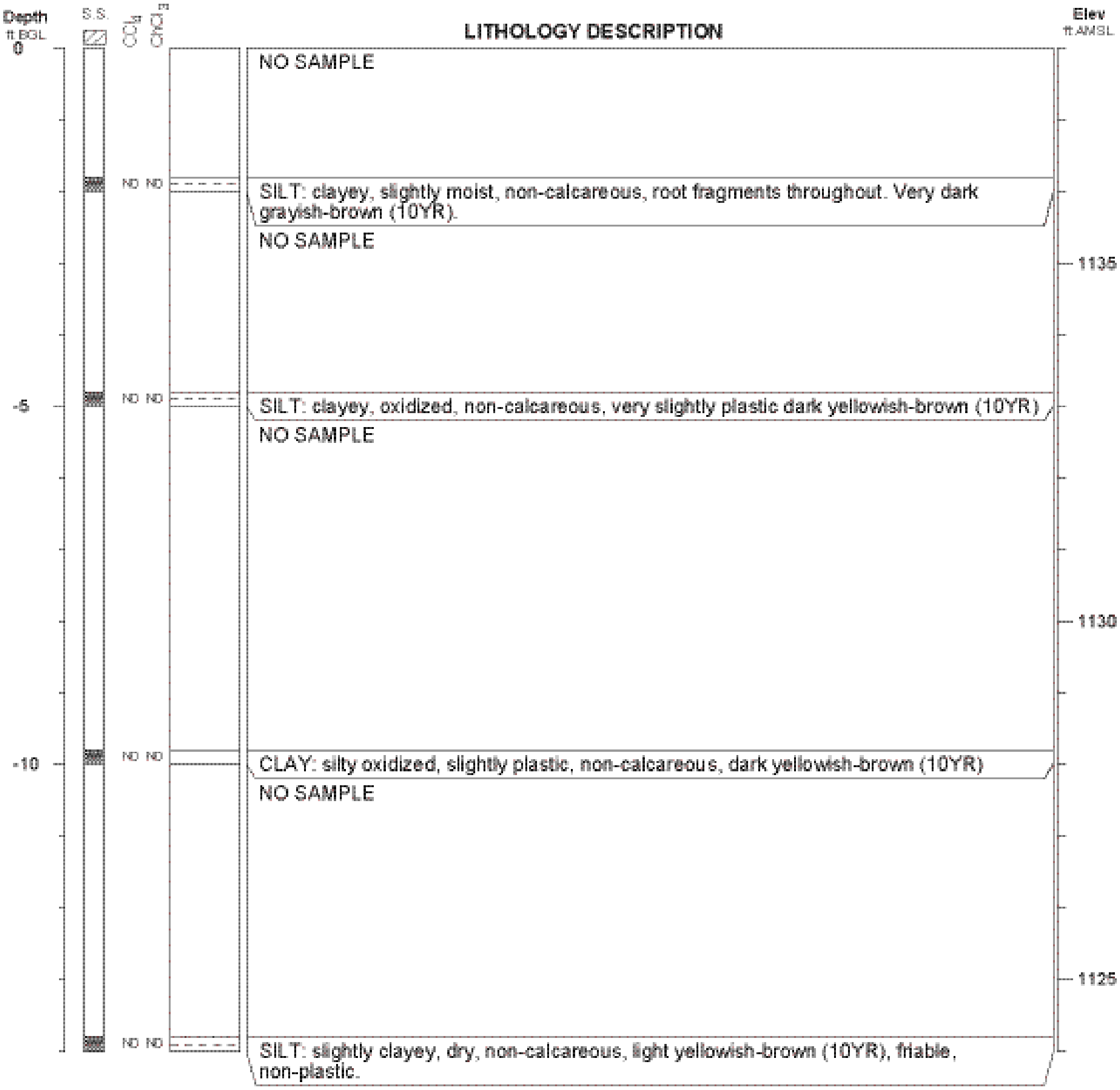
SAND: clayey, oxidized, fine to medium grained, loose, friable, predominantly quartz, highly calcareous, yellowish-brown (10YR).

CLAY: very silty, moderately plastic, calcareous, very pale brown (10YR), slightly moist.

Carbon tetrachloride in soil sample = µg/kg

Argonne National Laboratory Boring ID: SB04

Project: Morrill Phase I/II
Elevation: 1138 (Est.)
Log Date: 10/21/2003
Company: Argonne
Geologist: L. LaFreniere
Total Depth: 14.01
Plot Date: 3/22/2004
Rig: Geoprobe
Core Description: 0 to 14.01
Driller: Daryl Biere



LITHOLOGY DESCRIPTION

NO SAMPLE

SILT: clayey, slightly moist, non-calcareous, root fragments throughout. Very dark grayish-brown (10YR).

NO SAMPLE

SILT: clayey, oxidized, non-calcareous, very slightly plastic dark yellowish-brown (10YR)

NO SAMPLE

CLAY: silty oxidized, slightly plastic, non-calcareous, dark yellowish-brown (10YR)

NO SAMPLE

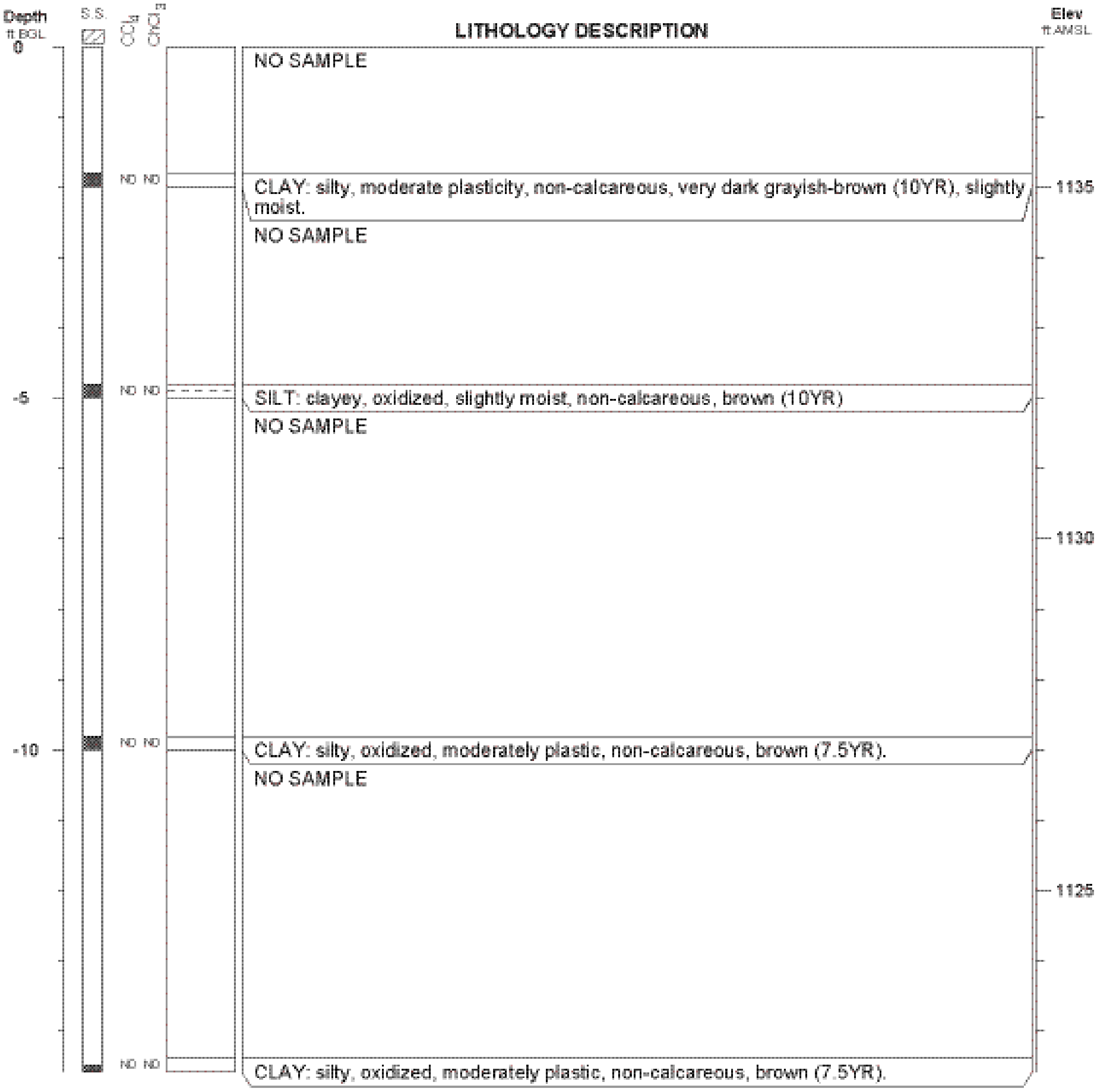
SILT: slightly clayey, dry, non-calcareous, light yellowish-brown (10YR), friable, non-plastic.

Carbon tetrachloride in soil sample = µg/kg

Argonne National Laboratory

Boring ID: SB05

Project: Morrill Phase I/II
Geologist: L. LaFreniere
Elevation: 1137 (Est.)
Total Depth: 14.6 ft
Core Description: 0 to 14.6 ft
Log Date: 10/21/2003
Plot Date: 3/22/2004
Driller: Daryl Biere
Company: Argonne
Rig: Geoprobe



NO SAMPLE

CLAY: silty, moderate plasticity, non-calcareous, very dark grayish-brown (10YR), slightly moist.

NO SAMPLE

SILT: clayey, oxidized, slightly moist, non-calcareous, brown (10YR)

NO SAMPLE

CLAY: silty, oxidized, moderately plastic, non-calcareous, brown (7.5YR).

NO SAMPLE

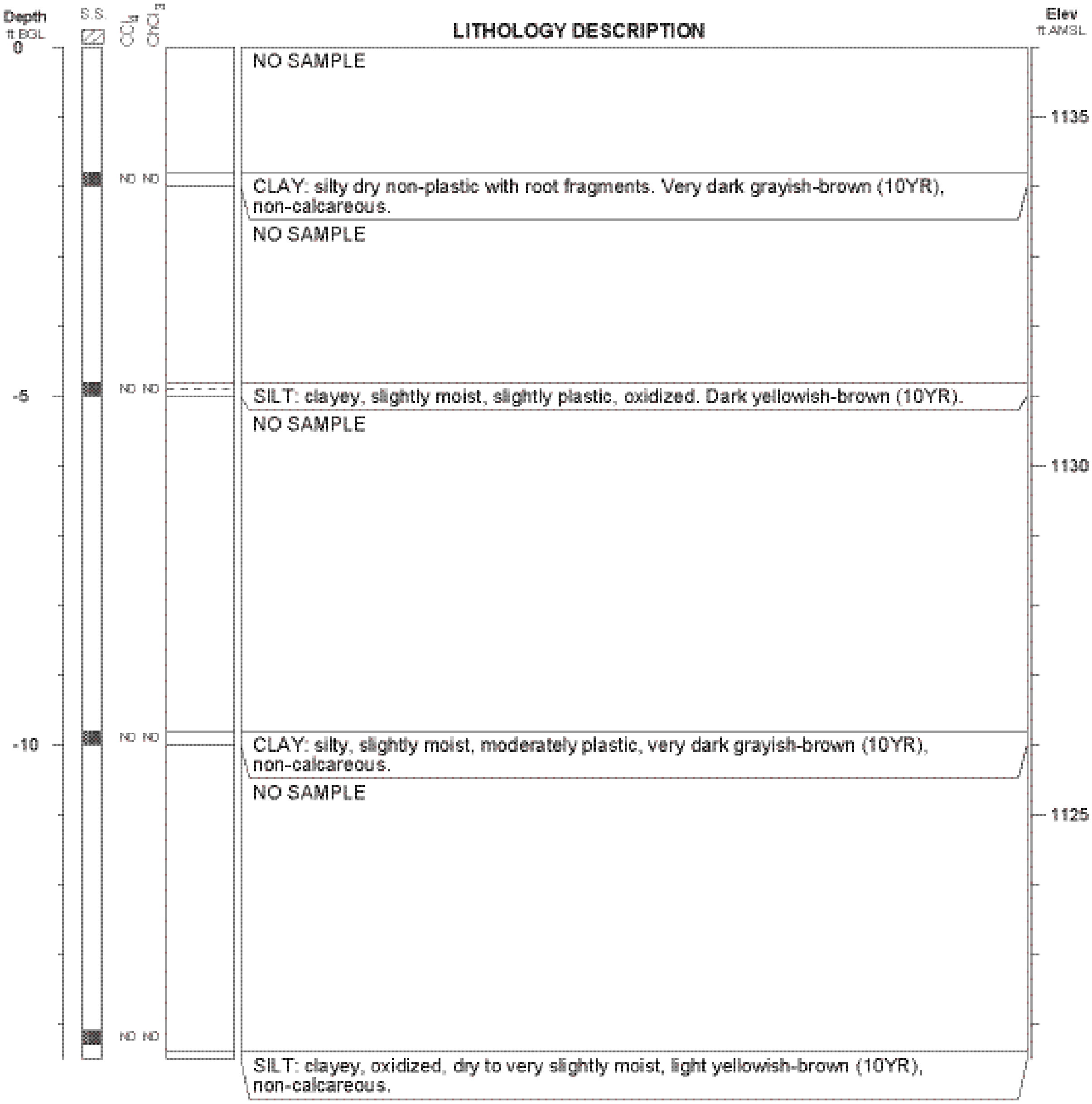
CLAY: silty, oxidized, moderately plastic, non-calcareous, brown (7.5YR).

Carbon tetrachloride in soil sample = µg/kg

Argonne National Laboratory

Boring ID: SB07

Project: Morrill Phase I/II
Geologist: L. LaFreniere
Elevation: 1136 ft (Est.)
Total Depth: 14.5 ft
Core Description: 0 to 14.5 ft
Log Date: 10/21/2003
Plot Date: 3/22/2004
Driller: Daryl Biere
Company: Argonne
Rig: Geoprobe



NO SAMPLE

CLAY: silty dry non-plastic with root fragments. Very dark grayish-brown (10YR), non-calcareous.

NO SAMPLE

SILT: clayey, slightly moist, slightly plastic, oxidized. Dark yellowish-brown (10YR).

NO SAMPLE

CLAY: silty, slightly moist, moderately plastic, very dark grayish-brown (10YR), non-calcareous.

NO SAMPLE

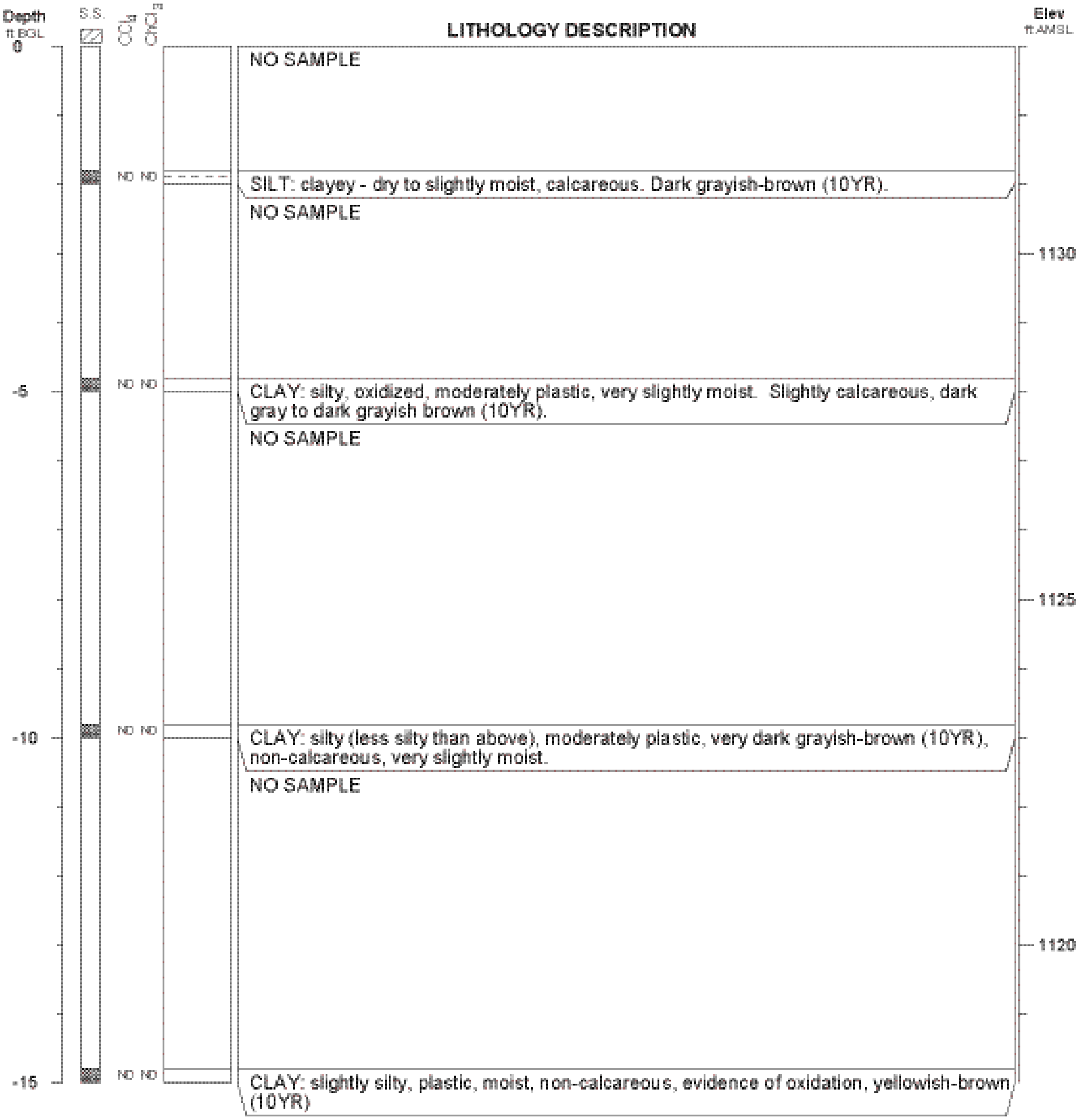
SILT: clayey, oxidized, dry to very slightly moist, light yellowish-brown (10YR), non-calcareous.

Carbon tetrachloride in soil sample = µg/kg

Argonne National Laboratory

Boring ID: SB09

Project: Morrill Phase I/II
Geologist: L. LaFreniere
Elevation: 1133 ft (Est.)
Total Depth: 15 ft
Core Description: 0 to 15 ft
Log Date: 10/21/2003
Plot Date: 3/22/2004
Driller: Daryl Biere
Company: Argonne
Rig: Geoprobe



NO SAMPLE

SILT: clayey - dry to slightly moist, calcareous. Dark grayish-brown (10YR).

NO SAMPLE

CLAY: silty, oxidized, moderately plastic, very slightly moist. Slightly calcareous, dark gray to dark grayish brown (10YR).

NO SAMPLE

CLAY: silty (less silty than above), moderately plastic, very dark grayish-brown (10YR), non-calcareous, very slightly moist.

NO SAMPLE

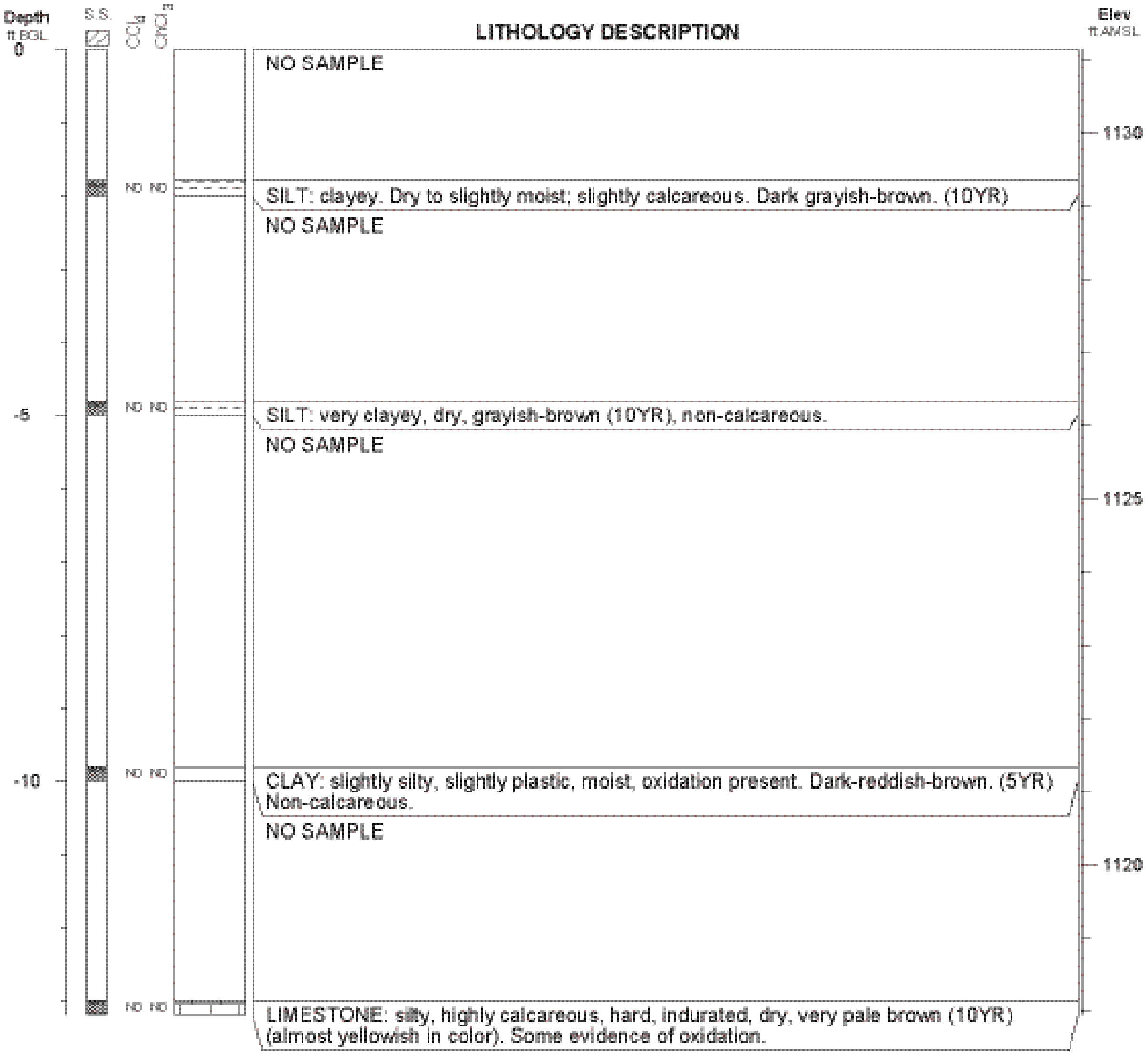
CLAY: slightly silty, plastic, moist, non-calcareous, evidence of oxidation, yellowish-brown (10YR)

Carbon tetrachloride in soil sample = µg/kg

Argonne National Laboratory

Boring ID: SB10

Project: Morrill Phase I/II
Geologist: L. LaFreniere
Elevation: 1131.15 ft
Total Depth: 13.2 ft
Core Description: 0 to 13.2 ft
Log Date: 10/21/2003
Plot Date: 3/22/2004
Driller: Daryl Biere
Company: Argonne
Rig: Geoprobe



LITHOLOGY DESCRIPTION

NO SAMPLE

SILT: clayey. Dry to slightly moist; slightly calcareous. Dark grayish-brown. (10YR)

NO SAMPLE

SILT: very clayey, dry, grayish-brown (10YR), non-calcareous.

NO SAMPLE

CLAY: slightly silty, slightly plastic, moist, oxidation present. Dark-reddish-brown. (5YR) Non-calcareous.

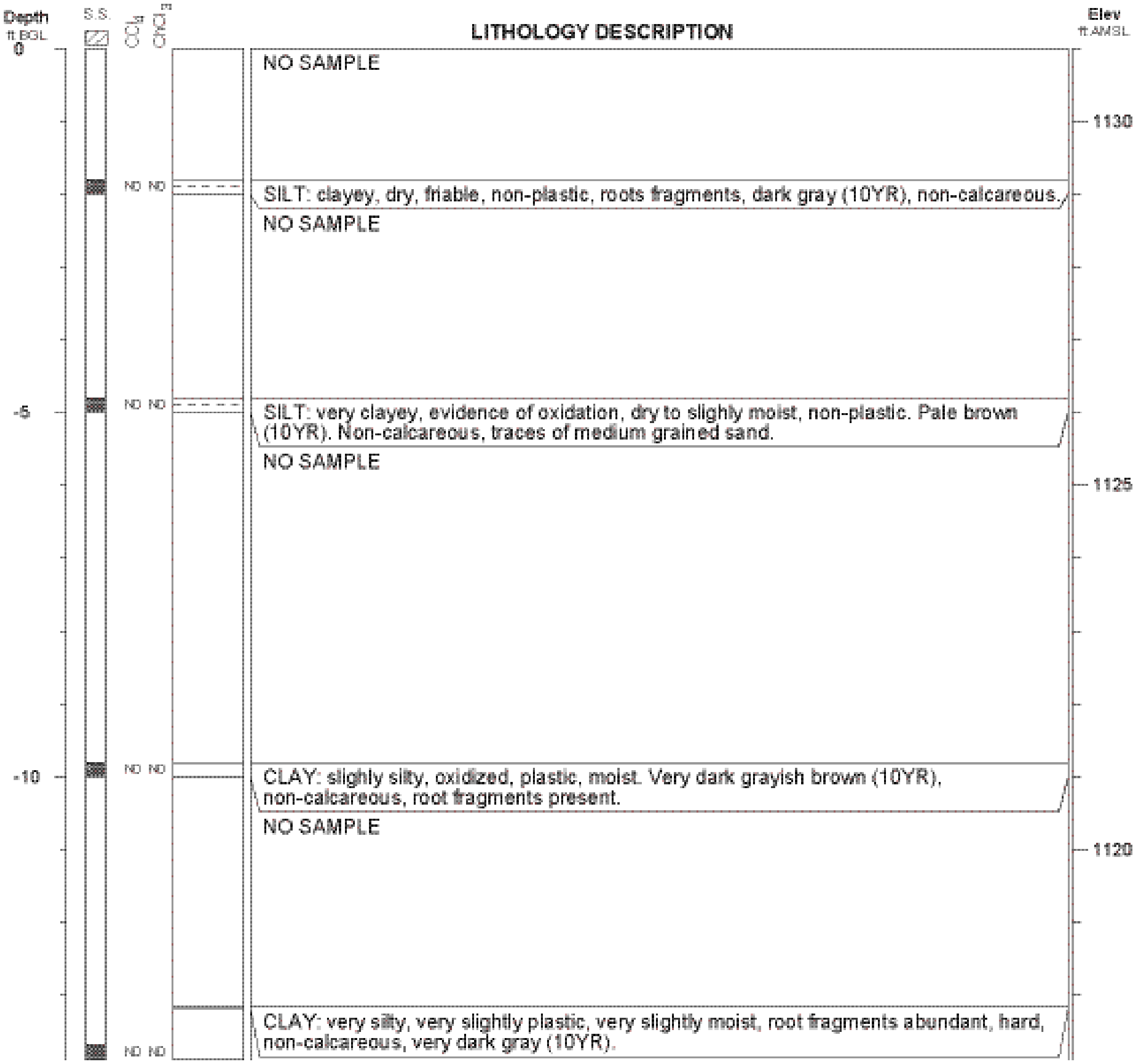
NO SAMPLE

LIMESTONE: silty, highly calcareous, hard, indurated, dry, very pale brown (10YR) (almost yellowish in color). Some evidence of oxidation.

Carbon tetrachloride in soil sample = µg/kg

Argonne National Laboratory **Boring ID: SB11**

Project: Morrill Phase I/II
Geologist: L. LaFreniere
Elevation: 1131 ft (Est.)
Total Depth: 13.19
Core Description: 0 to 13.19 ft
Log Date: 10/21/2003
Plot Date: 3/22/2004
Driller: Daryl Biere
Company: Argonne
Rig: Geoprobe



LITHOLOGY DESCRIPTION

NO SAMPLE

SILT: clayey, dry, friable, non-plastic, roots fragments, dark gray (10YR), non-calcareous.

NO SAMPLE

SILT: very clayey, evidence of oxidation, dry to slighly moist, non-plastic. Pale brown (10YR). Non-calcareous, traces of medium grained sand.

NO SAMPLE

CLAY: slighly silty, oxidized, plastic, moist. Very dark grayish brown (10YR), non-calcareous, root fragments present.

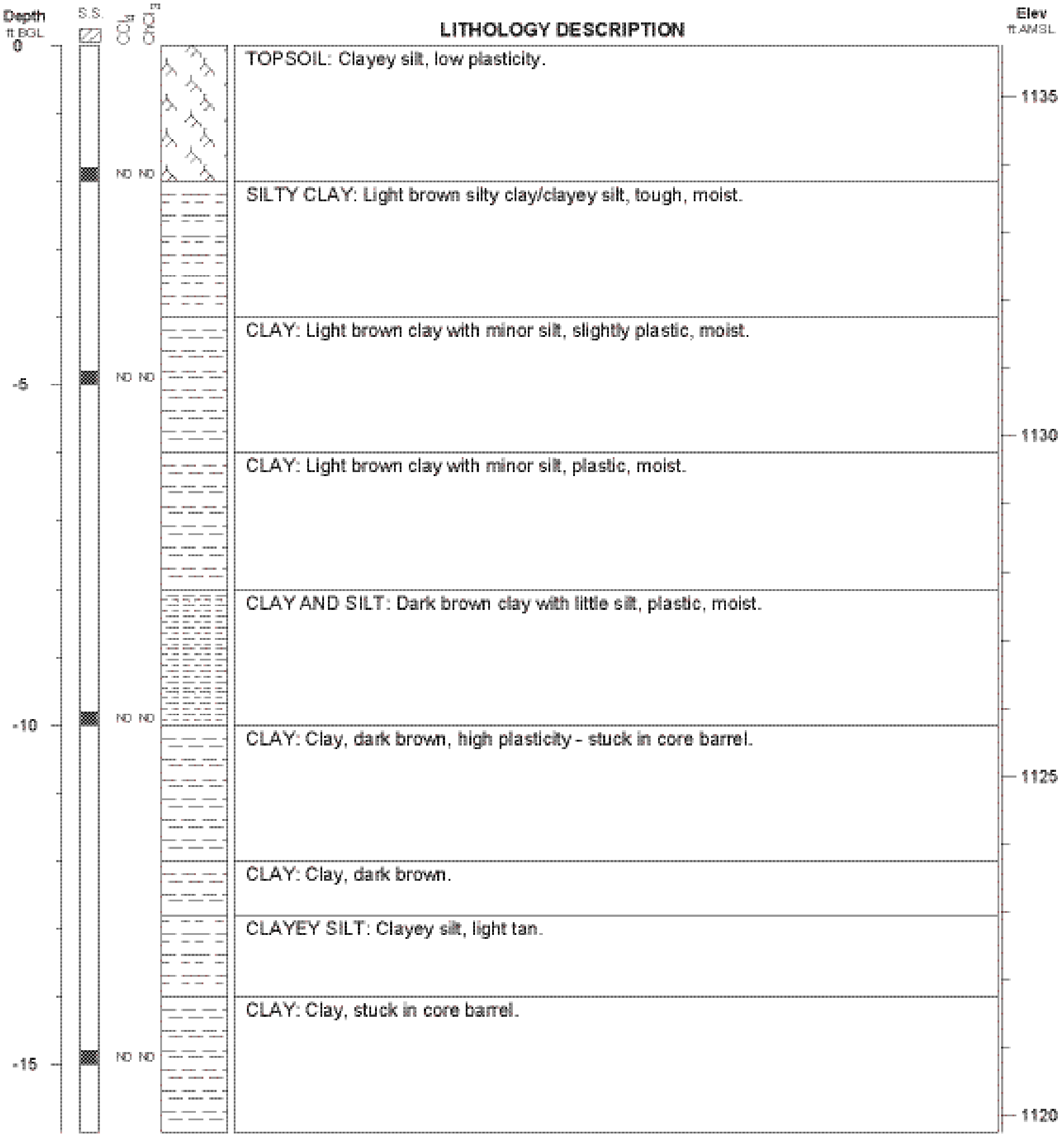
NO SAMPLE

CLAY: very silty, very slightly plastic, very slightly moist, root fragments abundant, hard, non-calcareous, very dark gray (10YR).

Carbon tetrachloride in soil sample = µg/kg

Argonne National Laboratory **Boring ID: SB12**

Project: Morrill Phase I/II
Geologist: T. Koelsch
Elevation: 1135.76 ft.
Total Depth: 16 ft.
Core Description: 0 to 16 ft.
Log Date: 10/20/2003
Plot Date: 12/9/2003
Driller: Daryl Biere
Company: Argonne
Rig: Geoprobe



LITHOLOGY DESCRIPTION

TOPSOIL: Clayey silt, low plasticity.

SILTY CLAY: Light brown silty clay/clayey silt, tough, moist.

CLAY: Light brown clay with minor silt, slightly plastic, moist.

CLAY: Light brown clay with minor silt, plastic, moist.

CLAY AND SILT: Dark brown clay with little silt, plastic, moist.

CLAY: Clay, dark brown, high plasticity - stuck in core barrel.

CLAY: Clay, dark brown.

CLAYEY SILT: Clayey silt, light tan.

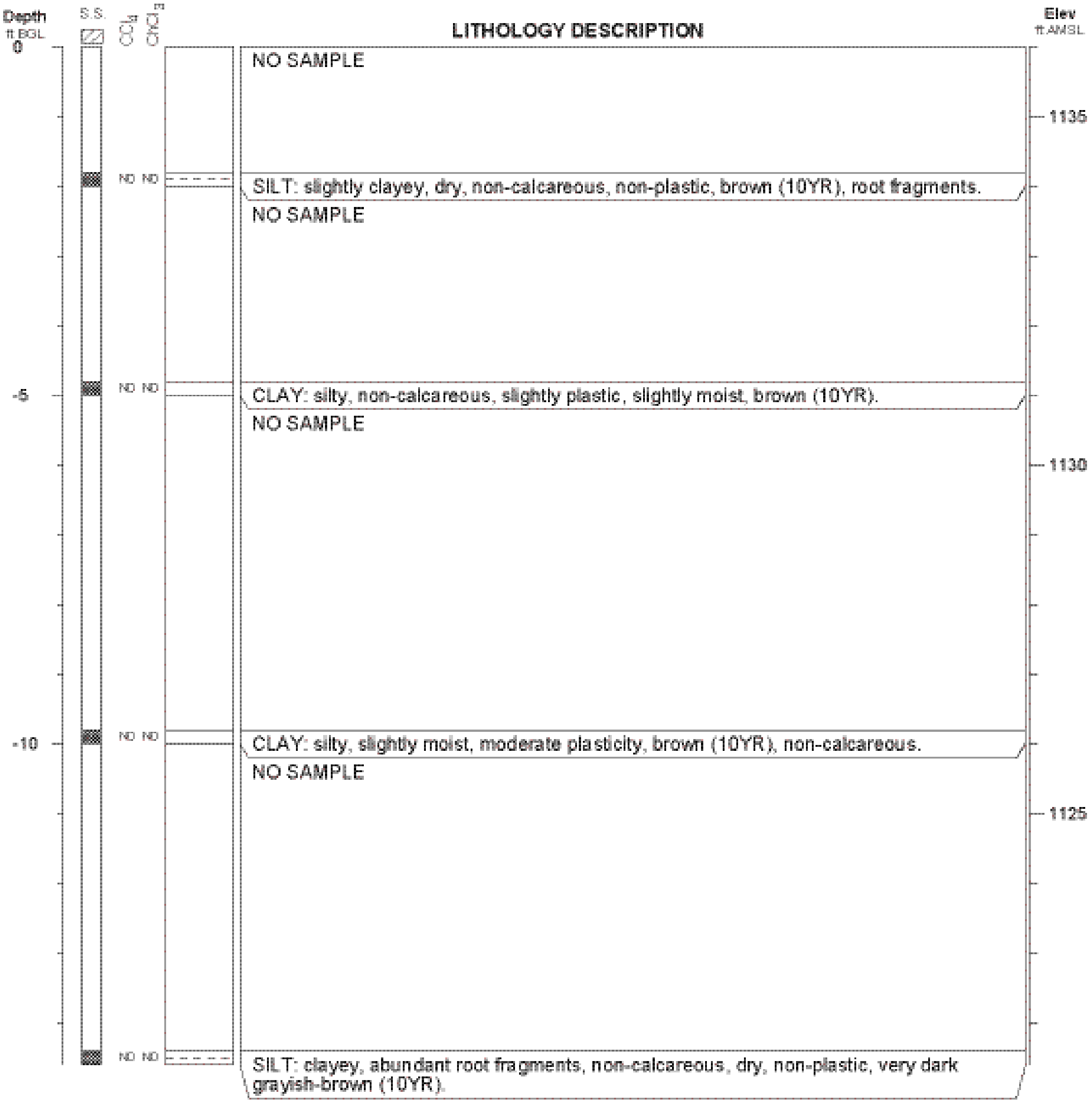
CLAY: Clay, stuck in core barrel.

Carbon tetrachloride in soil sample = µg/kg

Argonne National Laboratory

Boring ID: SB13

Project: Morrill Phase I/II
Geologist: L. LaFreniere
Elevation: 1136 ft (Est.)
Total Depth: 14.6 ft
Core Description: 0 to 14.6 ft
Log Date: 10/21/2003
Plot Date: 3/22/2004
Driller: Daryl Biere
Company: Argonne
Rig: Geoprobe



NO SAMPLE

SILT: slightly clayey, dry, non-calcareous, non-plastic, brown (10YR), root fragments.

NO SAMPLE

CLAY: silty, non-calcareous, slightly plastic, slightly moist, brown (10YR).

NO SAMPLE

CLAY: silty, slightly moist, moderate plasticity, brown (10YR), non-calcareous.

NO SAMPLE

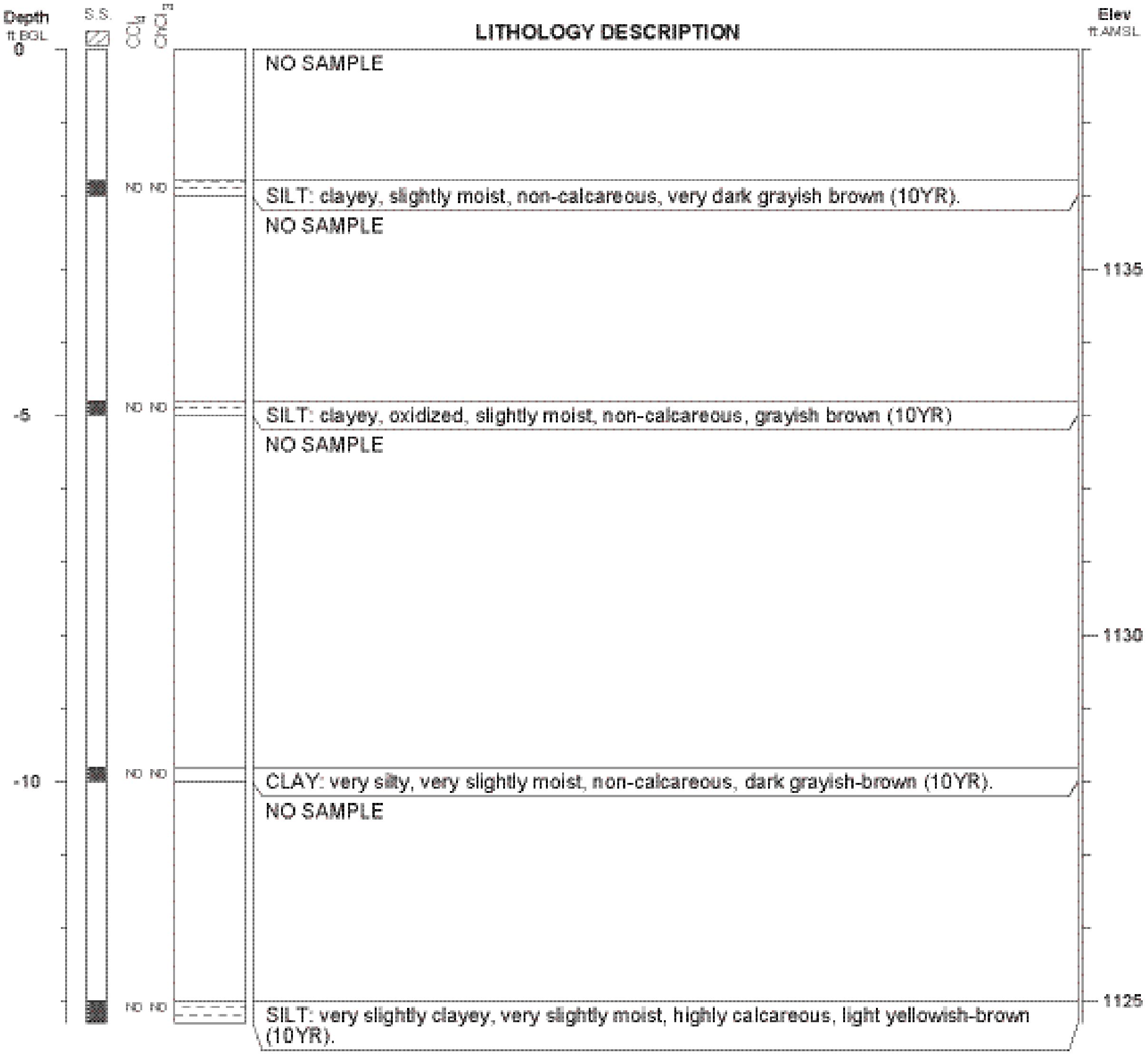
SILT: clayey, abundant root fragments, non-calcareous, dry, non-plastic, very dark grayish-brown (10YR).

Carbon tetrachloride in soil sample = µg/kg

Argonne National Laboratory

Boring ID: SB14

Project: Morrill Phase I/II
Geologist: L. LaFreniere
Elevation: 1138 ft (Est.)
Total Depth: 13.3 ft
Core Description: 0 to 13.3 ft
Log Date: 10/22/2003
Plot Date: 3/22/2004
Driller: Daryl Biere
Company: Argonne
Rig: Geoprobe



LITHOLOGY DESCRIPTION

NO SAMPLE

SILT: clayey, slightly moist, non-calcareous, very dark grayish brown (10YR).

NO SAMPLE

SILT: clayey, oxidized, slightly moist, non-calcareous, grayish brown (10YR)

NO SAMPLE

CLAY: very silty, very slightly moist, non-calcareous, dark grayish-brown (10YR).

NO SAMPLE

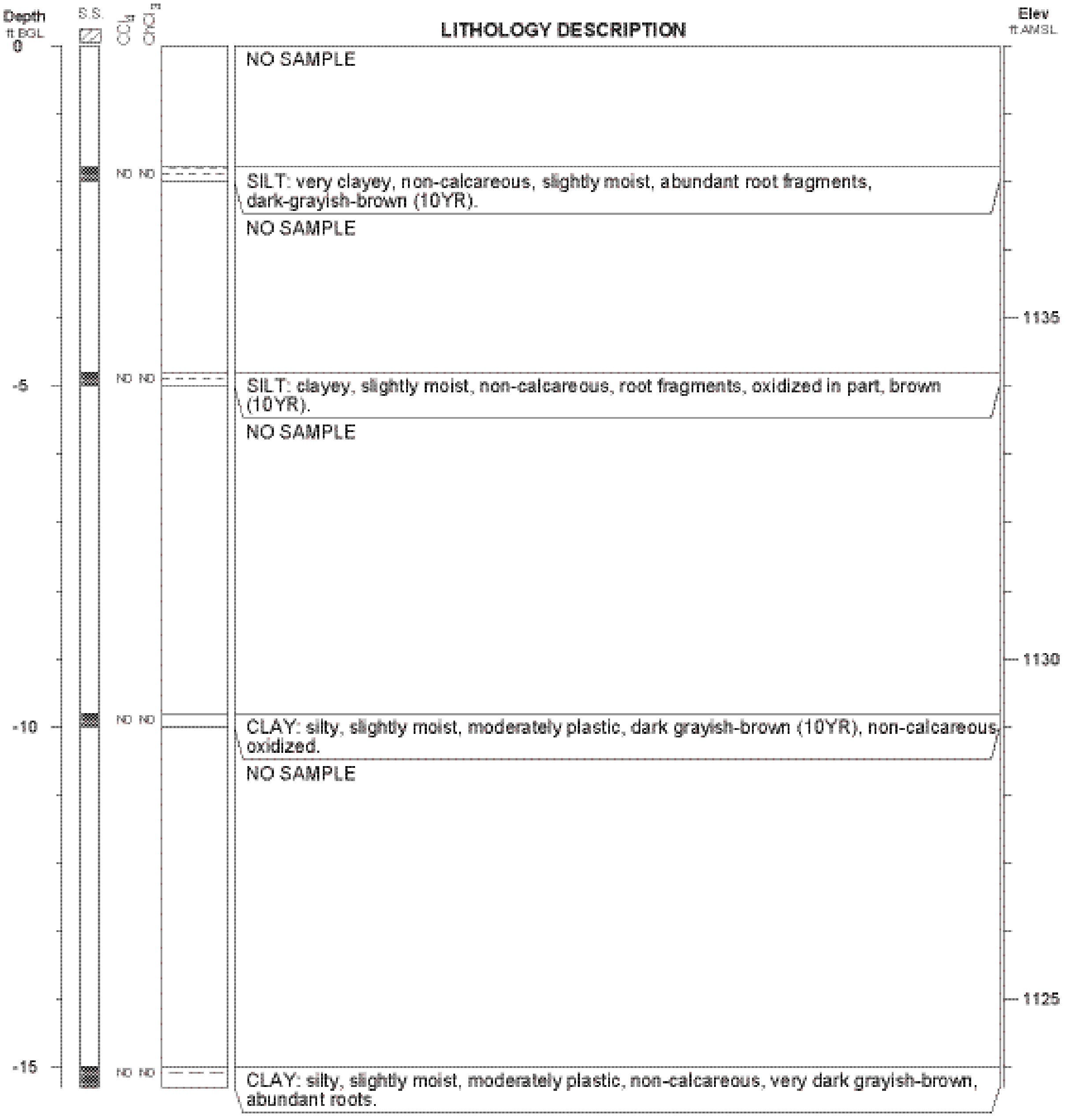
SILT: very slightly clayey, very slightly moist, highly calcareous, light yellowish-brown (10YR).

Carbon tetrachloride in soil sample = µg/kg

Argonne National Laboratory

Boring ID: SB15

Project: Morrill Phase I/II
Geologist: L. LaFreniere
Elevation: 1139 ft (Est.)
Total Depth: 15.3
Core Description: 0 to 15.3
Log Date: 10/22/2003
Plot Date: 3/22/2004
Driller: Daryl Biere
Company: Argonne
Rig: Geoprobe



NO SAMPLE

SILT: very clayey, non-calcareous, slightly moist, abundant root fragments, dark-grayish-brown (10YR).

NO SAMPLE

SILT: clayey, slightly moist, non-calcareous, root fragments, oxidized in part, brown (10YR).

NO SAMPLE

CLAY: silty, slightly moist, moderately plastic, dark grayish-brown (10YR), non-calcareous, oxidized.

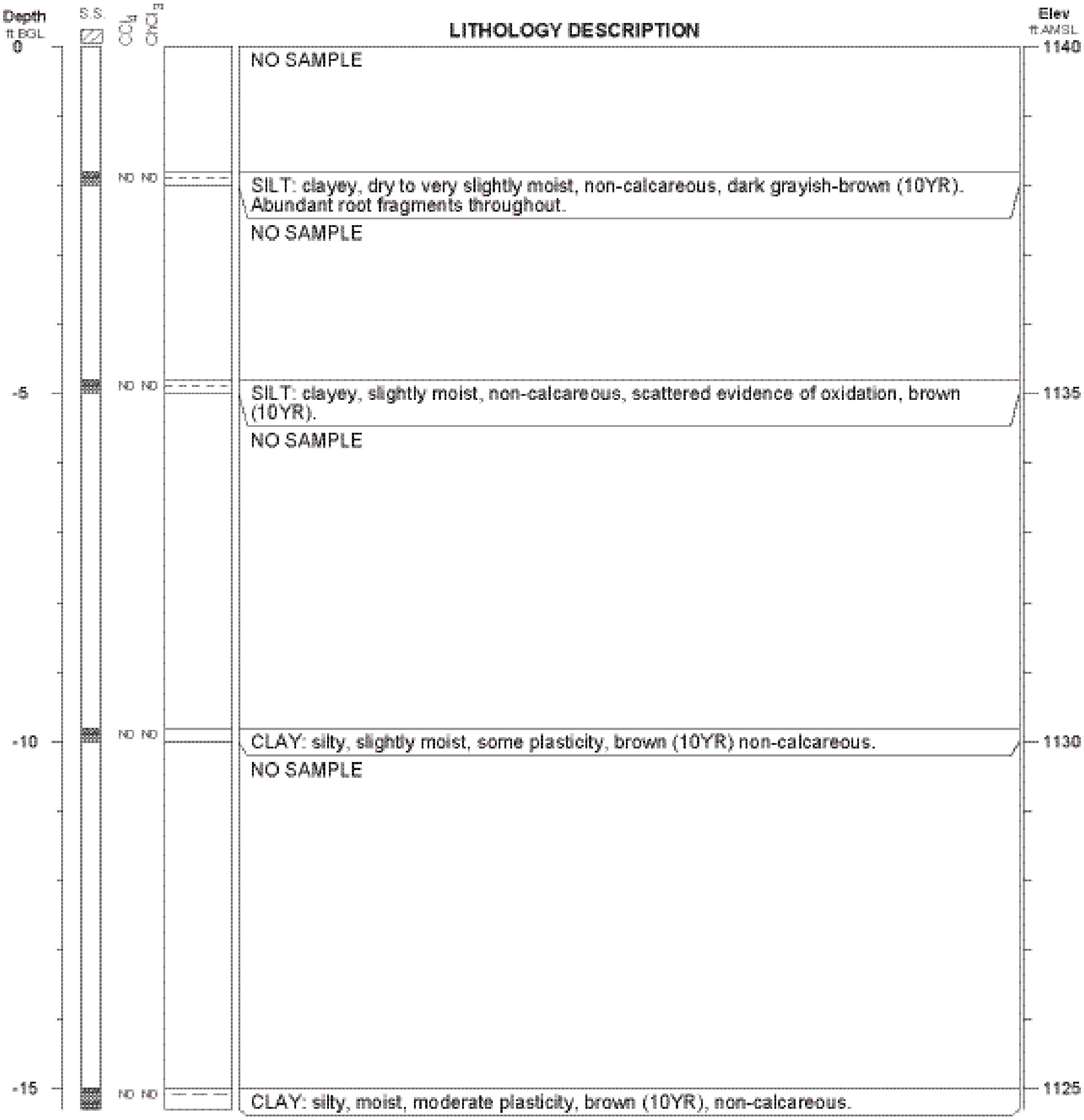
NO SAMPLE

CLAY: silty, slightly moist, moderately plastic, non-calcareous, very dark grayish-brown, abundant roots.

Carbon tetrachloride in soil sample = µg/kg

Argonne National Laboratory **Boring ID: SB16**

Project: Morrill Phase I/II
Geologist: L. LaFreniere
Elevation: 1140 ft (Est.)
Total Depth: 15.3 ft
Core Description: 0 to 15.3
Log Date: 10/22/2003
Plot Date: 3/22/2004
Driller: Daryl Biere
Company: Argonne
Rig: Geoprobe



NO SAMPLE

SILT: clayey, dry to very slightly moist, non-calcareous, dark grayish-brown (10YR). Abundant root fragments throughout.

NO SAMPLE

SILT: clayey, slightly moist, non-calcareous, scattered evidence of oxidation, brown (10YR).

NO SAMPLE

CLAY: silty, slightly moist, some plasticity, brown (10YR) non-calcareous.

NO SAMPLE

CLAY: silty, moist, moderate plasticity, brown (10YR), non-calcareous.

Carbon tetrachloride in soil sample = µg/kg

Appendix B:

Coordinates Survey Data

TABLE B.1 Survey data for Phase I sampling locations in Morrill, Kansas.

Location	Horizontal Location[a] (ft) Northing	Horizontal Location[a] (ft) Easting	Elevation[b] (ft AMSL)
MW1S	1957316.76	589130.2	1124.68[c]
MW1D	1957314.45	589129.06	1124.63[c]
MW2S	1958063.43	589789.61	1137.07[c]
MW3S	1957333.78	589929.06	1135.76[c]
MW4S	1956982.15	590083.24	1143.61[c]
MW5S	1958089.03	589182.24	1122.21[c]
SB09	1957520.92	589968.4	1131.15[d]

[a] Horizontal coordinates are target location centers. Northings and Eastings are Kansas State Plane Coordinates. Horizontal datum is North American Datum (NAD) 83.

[b] Vertical datum is National Geodetic Vertical Datum (NGVD) 88.

[c] Top of casing.

[d] Representative ground surface.

Source: Schwab-Eaton, Manhattan, Kansas.

Appendix C:

Soil Sample Data

TABLE C.1 Soil samples collected during the Phase I–Phase II investigation at Morrill, Kansas.

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
SB01	MRSB01-S-16409	1.8–2.0	10/22/03	Dry to slightly moist, very dark grayish brown, clayey silt with trace of subrounded sand; noncalcareous. Root fragments throughout.
SB01	MRSB01-S-16410	4.8–5.0	10/22/03	Moist, brown, very silty clay; noncalcareous, moderately plastic.
SB01	MRSB01-S-16411	9.8–10.0	10/22/03	Slightly oxidized silty clay; moderately plastic.
SB01	MRSB01-S-16412	15.0–15.3	10/22/03	Clayey silt with abundant angular gravel; highly calcareous.
SB02	MRSB02-S-16401	1.8–2.0	10/22/03	Dry to very slightly moist, dark grayish brown, slightly clayey silt; noncalcareous. Abundant root fragments.
SB02	MRSB02-S-16402	4.8–5.0	10/22/03	Slightly moist, grayish brown, clayey silt; noncalcareous, slightly oxidized.
SB02	MRSB02-S-16403	9.8–10.0	10/22/03	Slightly moist, dark grayish brown, silty clay; noncalcareous, medium plasticity.
SB02	MRSB02-S-16404	15.0–15.3	10/22/03	Slightly moist, brown, very silty clay; mottled with very dark grayish brown, less silty clay; noncalcareous, moderately plastic.
SB03	MRSB03-S-16414	1.8–2.0	10/22/03	Slightly moist, dark grayish brown, very clayey silt; noncalcareous. Abundant root fragments.
SB03	MRSB03-S-16415	4.8–5.0	10/22/03	Very slightly moist, clayey silt; noncalcareous, oxidized.
SB03	MRSB03-S-16417	9.8–10.0	10/22/03	Slightly moist, brown, very silty clay; noncalcareous, oxidized. Minor root fragments.
SB03	MRSB03-S-16428	14.9–15.0	10/22/03	Yellowish brown clayey, fine to medium grained sand; highly calcareous, friable, loose, oxidized.
SB03	MRSB03-S-16428A	15.0–15.1	10/22/03	Slightly moist, very pale brown, very silty clay; calcareous, moderately plastic. Sample collected at base of interval.
SB04	MRSB04-S-16392	1.8–2.0	10/21/03	Slightly moist, very dark grayish brown, clayey silt; noncalcareous. Root fragments throughout.
SB04	MRSB04-S-16393	4.8–5.0	10/21/03	Dark yellowish brown, clayey silt; noncalcareous, very slightly plastic, oxidized.
SB04	MRSB04-S-16394	9.8–10.0	10/21/03	Dark yellowish brown, silty clay; noncalcareous, slightly plastic, oxidized.
SB04	MRSB04-S-16395	13.8–14.1	10/21/03	Dry, light yellowish brown, slightly silty clay; noncalcareous, nonplastic, friable.
SB05	MRSB05-S-16383	1.8–2.0	10/21/03	Slightly moist, very dark grayish brown, silty clay; noncalcareous, moderately plastic.
SB05	MRSB05-S-16385	4.8–5.0	10/21/03	Slightly moist, brown, clayey silt; noncalcareous, oxidized.
SB05	MRSB05-S-16386	9.8–10.0	10/21/03	Brown silty clay; noncalcareous, moderately plastic, oxidized.
SB05	MRSB05-S-16387	14.5–14.6	10/21/03	Brown silty clay; noncalcareous, moderately plastic, oxidized.
SB06	MRSB06-S-16353	1.8–2.0	10/20/03	Very dark gray clay.
SB06	MRSB06-S-16354	4.8–5.0	10/20/03	Pale brown silty clay.
SB06	MRSB06-S-16355	9.8–10.0	10/20/03	Dark yellowish brown, clayey silt.
SB06	MRSB06-S-16356	14.8–15.0	10/20/03	Dark yellowish brown clay.

TABLE C.1 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
SB07	MRSB07-S-16379	1.8–2.0	10/21/03	Dry, very dark grayish brown, silty clay; noncalcareous, nonplastic. Root fragments.
SB07	MRSB07-S-16380	4.8–5.0	10/21/03	Slightly moist, dark yellowish brown, clayey silt; slightly plastic, oxidized.
SB07	MRSB07-S-16381	9.8–10.0	10/21/03	Slightly moist, very dark grayish brown, silty clay; noncalcareous, moderately plastic.
SB07	MRSB07-S-16382	14.1–14.3	10/21/03	Dry to very slightly moist, light yellowish brown, clayey silt; noncalcareous, oxidized.
SB08	MRSB08-S-16357	1.8–2.0	10/20/03	Very dark grayish brown, silty sand.
SB08	MRSB08-S-16358	4.8–5.0	10/20/03	Grayish brown, silty sandy clay.
SB08	MRSB08-S-16359	9.8–10.0	10/20/03	Dark brown, silty clay with sand. Iron staining.
SB08	MRSB08-S-16360	14.8–15.0	10/20/03	Dark yellowish brown clay mixed with brownish yellow silt.
SB09	MRSB09-S-16362	1.8–2.0	10/21/03	Dry to very slightly moist, dark grayish brown, clayey silt; calcareous.
SB09	MRSB09-S-16363	4.8–5.0	10/21/03	Very slightly moist, dark gray to dark grayish brown, silty clay; oxidized, moderately plastic, slightly calcareous.
SB09	MRSB09-S-16364	9.8–10.0	10/21/03	Very slightly moist, very dark grayish brown, silty clay; moderately plastic, noncalcareous, less silty than above.
SB09	MRSB09-S-16365	14.8–15.0	10/21/03	Moist, yellowish brown, slightly silty clay; plastic, noncalcareous, with evidence of oxidation.
SB10	MRSB10-S-16366	1.8–2.0	10/21/03	Dry to slightly moist, dark grayish brown, clayey silt; slightly calcareous.
SB10	MRSB10-S-16367	4.8–5.0	10/21/03	Dry grayish brown, very clayey silt; noncalcareous.
SB10	MRSB10-S-16368	9.8–10.0	10/21/03	Moist, dark reddish brown, slightly silty clay; slightly plastic, noncalcareous, with oxidation.
SB10	MRSB10-S-16369	13.0–13.2	10/21/03	Dry, very pale brown (almost yellowish in color), silty limestone; hard, highly calcareous, with some evidence of oxidation.
SB11	MRSB11-S-16370	1.8–2.0	10/21/03	Dry, dark gray, clayey silt; friable, nonplastic, noncalcareous. Root fragments.
SB11	MRSB11-S-16371	4.8–5.0	10/21/03	Dry to slightly moist, pale brown, very clayey silt, with trace of medium grained sand; nonplastic, noncalcareous, with evidence of oxidation.
SB11	MRSB11-S-16372	9.8–10.0	10/21/03	Moist, very dark grayish brown, slightly silty clay; plastic, noncalcareous, oxidized. Root fragments.
SB11	MRSB11-S-16378	13.7–13.9	10/21/03	Very slightly moist, very dark gray, very silty clay; slightly plastic, noncalcareous, hard. Abundant root fragments.
SB12	MRSB12-S-16349	1.8–2.0	10/20/03	Dark grayish brown, silty clay.
SB12	MRSB12-S-16350	4.8–5.0	10/20/03	Grayish brown, silty clay with iron and manganese oxide staining.
SB12	MRSB12-S-16351	9.8–10.0	10/20/03	Brown clay.
SB12	MRSB12-S-16352	14.8–15.0	10/20/03	Brown silty clay.

TABLE C.1 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
SB13	MRSB13-S-16388	1.8–2.0	10/21/03	Dry, brown silt with some clay; noncalcareous, nonplastic. Root fragments.
SB13	MRSB13-S-16389	4.8–5.0	10/21/03	Slightly moist, brown, silty clay; noncalcareous, slightly plastic.
SB13	MRSB13-S-16390	9.8–10.0	10/21/03	Slightly moist, brown, silty clay; noncalcareous, moderately plastic.
SB13	MRSB13-S-16391	14.4–14.6	10/21/03	Dry, very dark grayish brown, clayey silt; noncalcareous, nonplastic. Abundant root fragments.
SB14	MRSB14-S-16397	1.8–2.0	10/22/03	Slightly moist, very dark grayish brown, clayey silt; noncalcareous.
SB14	MRSB14-S-16398	4.8–5.0	10/22/03	Slightly moist, grayish brown, clayey silt; noncalcareous, oxidized.
SB14	MRSB14-S-16399	9.8–10.0	10/22/03	Very slightly moist, dark grayish brown, very silty clay; noncalcareous.
SB14	MRSB14-S-16400	13.0–13.3	10/22/03	Very slightly moist, light yellowish brown, very slightly clayey silt; highly calcareous.
SB15	MRSB15-S-16429	1.8–2.0	10/22/03	Slightly moist, dark grayish brown, very clayey silt; noncalcareous. Abundant root fragments.
SB15	MRSB15-S-16430	4.8–5.0	10/22/03	Slightly moist, brown, clayey silt; noncalcareous, oxidized. Some root fragments.
SB15	MRSB15-S-16431	9.8–10.0	10/22/03	Slightly moist, dark grayish brown, silty clay; noncalcareous, oxidized, moderately plastic.
SB15	MRSB15-S-16433	15.0–15.3	10/22/03	Slightly moist, very dark grayish brown, silty clay; noncalcareous, moderately plastic. Abundant roots.
SB16	MRSB16-S-16405	1.8–2.0	10/22/03	Dry to very slightly moist, dark grayish brown, clayey silt; noncalcareous. Abundant root fragments throughout.
SB16	MRSB16-S-16406	4.8–5.0	10/22/03	Slightly moist, brown, clayey silt; noncalcareous, with scattered evidence of oxidation.
SB16	MRSB16-S-16407	9.8–10.0	10/22/03	Slightly moist, brown, silty clay; noncalcareous, some plasticity.
SB16	MRSB16-S-16408	15.0–15.3	10/22/03	Moist, brown, silty clay; noncalcareous, moderate plasticity.
Q C	MRQCBG-S-16435	0.9–1.0	10/23/03	Background near-surface soil sample from edge of cornfield approximately 60 yards north of former CCC/USDA grain storage facility

TABLE C.2 Results of VOC analyses on soil samples collected during the Phase I–Phase II investigation at Morrill, Kansas.

				Concentration (µg/kg)	
Location	Sample	Depth (ft BGL)	Sample Date	Carbon Tetrachloride	Chloroform
SB01	MRSB01-S-16409	1.8–2.0	10/22/03	ND[a]	ND
SB01	MRSB01-S-16410	4.8–5.0	10/22/03	ND	ND
SB01	MRSB01-S-16411	9.8–10.0	10/22/03	ND	ND
SB01	MRSB01-S-16412	15.0–15.3	10/22/03	ND	ND
SB02	MRSB02-S-16401	1.8–2.0	10/22/03	ND	ND
SB02	MRSB02-S-16402	4.8–5.0	10/22/03	ND	ND
SB02	MRSB02-S-16403	9.8–10.0	10/22/03	ND	ND
SB02	MRSB02-S-16404	15.0–15.3	10/22/03	ND	ND
SB03	MRSB03-S-16414	1.8–2.0	10/22/03	ND	ND
SB03	MRSB03-S-16415	4.8–5.0	10/22/03	ND	ND
SB03	MRSB03-S-16417	9.8–10.0	10/22/03	ND	ND
SB03	MRSB03-S-16428	14.9–15.0	10/22/03	ND	ND
SB03	MRSB03-S-16428A	15.0–15.1	10/22/03	b	b
SB04	MRSB04-S-16392	1.8–2.0	10/21/03	ND	ND
SB04	MRSB04-S-16393	4.8–5.0	10/21/03	ND	ND
SB04	MRSB04-S-16394	9.8–10.0	10/21/03	ND	ND
SB04	MRSB04-S-16395	13.8–14.1	10/21/03	ND	ND
SB05	MRSB05-S-16383	1.8–2.0	10/21/03	ND	ND
SB05	MRSB05-S-16385	4.8–5.0	10/21/03	ND	ND
SB05	MRSB05-S-16386	9.8–10.0	10/21/03	ND	ND
SB05	MRSB05-S-16387	14.5–14.6	10/21/03	ND	ND
SB06	MRSB06-S-16353	1.8–2.0	10/20/03	ND	ND
SB06	MRSB06-S-16354	4.8–5.0	10/20/03	ND	ND
SB06	MRSB06-S-16355	9.8–10.0	10/20/03	ND	ND
SB06	MRSB06-S-16356	14.8–15.0	10/20/03	ND	ND
SB07	MRSB07-S-16379	1.8–2.0	10/21/03	ND	ND
SB07	MRSB07-S-16380	4.8–5.0	10/21/03	ND	ND
SB07	MRSB07-S-16381	9.8–10.0	10/21/03	ND	ND
SB07	MRSB07-S-16382	14.1–14.3	10/21/03	ND	ND
SB08	MRSB08-S-16357	1.8–2.0	10/20/03	ND	ND
SB08	MRSB08-S-16358	4.8–5.0	10/20/03	ND	ND
SB08	MRSB08-S-16359	9.8–10.0	10/20/03	ND	ND
SB08	MRSB08-S-16360	14.8–15.0	10/20/03	ND	ND
SB09	MRSB09-S-16362	1.8–2.0	10/21/03	ND	ND
SB09	MRSB09-S-16363	4.8–5.0	10/21/03	ND	ND
SB09	MRSB09-S-16364	9.8–10.0	10/21/03	ND	ND
SB09	MRSB09-S-16365	14.8–15.0	10/21/03	ND	ND
SB10	MRSB10-S-16366	1.8–2.0	10/21/03	ND	ND
SB10	MRSB10-S-16367	4.8–5.0	10/21/03	ND	ND
SB10	MRSB10-S-16368	9.8–10.0	10/21/03	ND	ND
SB10	MRSB10-S-16369	13.0–13.2	10/21/03	ND	ND

TABLE C.2 (Cont.).

Location	Sample	Depth (ft BGL)	Sample Date	Concentration (µg/kg) Carbon Tetrachloride	Chloroform
SB11	MRSB11-S-16370	1.8–2.0	10/21/03	ND	ND
SB11	MRSB11-S-16371	4.8–5.0	10/21/03	ND	ND
SB11	MRSB11-S-16372	9.8–10.0	10/21/03	ND	ND
SB11	MRSB11-S-16378	13.7–13.9	10/21/03	ND	ND
SB12	MRSB12-S-16349	1.8–2.0	10/20/03	ND	ND
SB12	MRSB12-S-16350	4.8–5.0	10/20/03	ND	ND
SB12	MRSB12-S-16351	9.8–10.0	10/20/03	ND	ND
SB12	MRSB12-S-16352	14.8–15.0	10/20/03	ND	ND
SB13	MRSB13-S-16388	1.8–2.0	10/21/03	ND	ND
SB13	MRSB13-S-16389	4.8–5.0	10/21/03	ND	ND
SB13	MRSB13-S-16390	9.8–10.0	10/21/03	ND	ND
SB13	MRSB13-S-16391	14.4–14.6	10/21/03	ND	ND
SB14	MRSB14-S-16397	1.8–2.0	10/22/03	ND	ND
SB14	MRSB14-S-16398	4.8–5.0	10/22/03	ND	ND
SB14	MRSB14-S-16399	9.8–10.0	10/22/03	ND	ND
SB14	MRSB14-S-16400	13.0–13.3	10/22/03	ND	ND
SB15	MRSB15-S-16429	1.8–2.0	10/22/03	ND	ND
SB15	MRSB15-S-16430	4.8–5.0	10/22/03	ND	ND
SB15	MRSB15-S-16431	9.8–10.0	10/22/03	ND	ND
SB15	MRSB15-S-16433	15.0–15.3	10/22/03	ND	ND
SB16	MRSB16-S-16405	1.8–2.0	10/22/03	ND	ND
SB16	MRSB16-S-16406	4.8–5.0	10/22/03	ND	ND
SB16	MRSB16-S-16407	9.8–10.0	10/22/03	ND	ND
SB16	MRSB16-S-16408	15.0–15.3	10/22/03	ND	ND

[a] ND, not detected at the quantitation limit of 10 µg/kg for analysis by the purge-and-trap method.

[b] Analysis for total organic carbon only.

TABLE C.3 Results of total organic carbon analyses on soil samples collected during the Phase I–Phase II investigation at Morrill, Kansas.

Location	Sample	Depth (ft BGL)	Sample Date	Total Organic Carbon (mg/kg)
SB01	MRSB01-S-16409	1.8–2.0	10/22/03	17,500
SB01	MRSB01-S-16410	4.8–5.0	10/22/03	2,920
SB01	MRSB01-S-16411	9.8–10.0	10/22/03	5,750
SB01	MRSB01-S-16412	15.0–15.3	10/22/03	17,700
SB02	MRSB02-S-16401	1.8–2.0	10/22/03	13,400
SB02	MRSB02-S-16402	4.8–5.0	10/22/03	3,070
SB02	MRSB02-S-16403	9.8–10.0	10/22/03	4,540
SB02	MRSB02-S-16404	15.0–15.3	10/22/03	28,800
SB03	MRSB03-S-16414	1.8–2.0	10/22/03	6,550
SB03	MRSB03-S-16415	4.8–5.0	10/22/03	4,100
SB03	MRSB03-S-16417	9.8–10.0	10/22/03	5,440
SB03	MRSB03-S-16428	14.9–15.0	10/22/03	40,400
SB03	MRSB03-S-16428A	15.0–15.1	10/22/03	5,360
SB04	MRSB04-S-16392	1.8–2.0	10/21/03	17,400
SB04	MRSB04-S-16393	4.8–5.0	10/21/03	3,360
SB04	MRSB04-S-16394	9.8–10.0	10/21/03	5,130
SB04	MRSB04-S-16395	13.8–14.1	10/21/03	9,920
SB05	MRSB05-S-16383	1.8–2.0	10/21/03	10,900
SB05	MRSB05-S-16385	4.8–5.0	10/21/03	3,720
SB05	MRSB05-S-16386	9.8–10.0	10/21/03	4,870
SB05	MRSB05-S-16387	14.5–14.6	10/21/03	9,380
SB06	MRSB06-S-16353	1.8–2.0	10/20/03	10,300
SB06	MRSB06-S-16354	4.8–5.0	10/20/03	1,840
SB06	MRSB06-S-16355	9.8–10.0	10/20/03	4,880
SB06	MRSB06-S-16356	14.8–15.0	10/20/03	586
SB07	MRSB07-S-16379	1.8–2.0	10/21/03	8,750
SB07	MRSB07-S-16380	4.8–5.0	10/21/03	2,280
SB07	MRSB07-S-16381	9.8–10.0	10/21/03	6,560
SB07	MRSB07-S-16382	14.1–14.3	10/21/03	< 125 U[a]
SB08	MRSB08-S-16357	1.8–2.0	10/20/03	12,900
SB08	MRSB08-S-16358	4.8–5.0	10/20/03	1,510
SB08	MRSB08-S-16359	9.8–10.0	10/20/03	5,660
SB08	MRSB08-S-16360	14.8–15.0	10/20/03	2,390
SB09	MRSB09-S-16362	1.8–2.0	10/21/03	18,900
SB09	MRSB09-S-16363	4.8–5.0	10/21/03	4,610
SB09	MRSB09-S-16364	9.8–10.0	10/21/03	6,390
SB09	MRSB09-S-16365	14.8–15.0	10/21/03	< 133 U[a]
SB10	MRSB10-S-16366	1.8–2.0	10/21/03	20,900
SB10	MRSB10-S-16367	4.8–5.0	10/21/03	4,490
SB10	MRSB10-S-16368	9.8–10.0	10/21/03	4,410
SB10	MRSB10-S-16369	13.0–13.2	10/21/03	26,100

TABLE C.3 (Cont.).

Location	Sample	Depth (ft BGL)	Sample Date	Total Organic Carbon (mg/kg)
SB11	MRSB11-S-16370	1.8–2.0	10/21/03	15,800
SB11	MRSB11-S-16371	4.8–5.0	10/21/03	2,300
SB11	MRSB11-S-16372	9.8–10.0	10/21/03	7,090
SB11	MRSB11-S-16378	13.7–13.9	10/21/03	17,600
SB12	MRSB12-S-16349	1.8–2.0	10/20/03	10,400
SB12	MRSB12-S-16350	4.8–5.0	10/20/03	2,380
SB12	MRSB12-S-16351	9.8–10.0	10/20/03	5,890
SB12	MRSB12-S-16352	14.8–15.0	10/20/03	3,550
SB13	MRSB13-S-16388	1.8–2.0	10/21/03	12,900
SB13	MRSB13-S-16389	4.8–5.0	10/21/03	2,660
SB13	MRSB13-S-16390	9.8–10.0	10/21/03	5,280
SB13	MRSB13-S-16391	14.4–14.6	10/21/03	25,900
SB14	MRSB14-S-16397	1.8–2.0	10/22/03	25,400
SB14	MRSB14-S-16398	4.8–5.0	10/22/03	3,260
SB14	MRSB14-S-16399	9.8–10.0	10/22/03	5,800
SB14	MRSB14-S-16400	13.0–13.3	10/22/03	12,500
SB15	MRSB15-S-16429	1.8–2.0	10/22/03	13,400
SB15	MRSB15-S-16430	4.8–5.0	10/22/03	2,490
SB15	MRSB15-S-16431	9.8–10.0	10/22/03	4,690
SB15	MRSB15-S-16433	15.0–15.3	10/22/03	16,200
SB16	MRSB16-S-16405	1.8–2.0	10/22/03	10,900
SB16	MRSB16-S-16406	4.8–5.0	10/22/03	3,210
SB16	MRSB16-S-16407	9.8–10.0	10/22/03	4,730
SB16	MRSB16-S-16408	15.0–15.3	10/22/03	638

[a] U, not detected at indicated reporting limit.

Appendix D:

Water Sample Data

TABLE D.1 Groundwater and surface water samples collected during the Phase I–Phase II investigation at Morrill, Kansas.

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
Groundwater samples				
MW1S	MRMW1S-W-16422	11–51	10/23/03	Depth to water[a] = 30.36 ft. Measured depth of 4-in. well = 54.04 ft. Sample collected after purging 70 gal. Sample slightly cloudy.
MW1D	MRMW1D-W-16421	63–88	10/22/03	Depth to water[a] = 28.39 ft. Measured depth of 4-in. well = 88.50 ft. Sample collected after purging 92 gal. Sample clear.
MW2S	MRMW02-W-16419	13–53	10/22/03	Depth to water[a] = 42.21 ft. Measured depth of 4-in. well = 53.35 ft. Sample collected after purging dry and allowing to recover. Sample slightly cloudy with silt.
MW3S	MRMW03-W-16423	18–48	10/23/03	Depth to water[a] = 36.47 ft. Measured depth of 4-in. well = 47.79 ft. Sample collected after purging 73 gal. Sample clear.
MW4S	MRMW04-W-16418	17–47	10/21/03	Depth to water[a] = 46.4 ft. Measured depth of 4-in. well = 47.8 ft. Sample collected after purging to near dryness and allowing to recover. Sample cloudy with silt.
MW5S	MRMW05-W-16420	15–55	10/22/03	Depth to water[a] = 31.40 ft. Measured depth of 4-in. well = 55.72 ft. Sample collected after purging 48 gal. Sample clear.
Surface water samples				
SW01	MRSW01-W-16425	–[b]	10/23/03	Sample from beneath bridge (west side) in running water.
SW02	MRSW02-W-16426	–	10/23/03	Pooled water covered with duckweed at input point of dry, wooded waterway. Pooled water approximately 10 ft by 15 ft at 1 ft depth.
SW03	MRSW03-W-16427	–	10/23/03	Pooled area at juncture of stream running from reservoir area 200 yards to the south and west with the dry, weedy waterway 200 yards to the northwest.

[a] Depths to water were measured from the top of the casing.

[b] Depth is not applicable.

TABLE D.2 Field measurements made prior to collection of groundwater samples during the Phase I–Phase II investigation at Morrill, Kansas.

Location	Sample	Depth (ft BGL)	Sample Date	Temperature (°C)	pH	Conductivity (µS/cm)	Redox Potential (mV)
MW1S	MRMW1S-W-16422	11–51	10/23/03	14.6	7.14	933	13
MW1D	MRMW1D-W-16421	63–88	10/22/03	14.9	6.87	2,620	25
MW2S	MRMW02-W-16419	13–53	10/22/03	16.2	6.86	875	20
MW3S	MRMW03-W-16423	18–48	10/23/03	16.8	7.23	655	6
MW4S	MRMW04-W-16418	17–47	10/21/03	NR[a]	7.17	758	NR
MW5S	MRMW05-W-16420	15–55	10/22/03	15.3	7.10	816	6

[a] NR, measurement not recorded.

TABLE D.3 Results of analyses for VOCs on groundwater and surface water samples collected during the Phase I–Phase II investigation at Morrill, Kansas.

				Concentration (µg/L)	
Location	Sample	Depth (ft BGL)	Sample Date	Carbon Tetrachloride	Chloroform
Groundwater samples					
MW1S	MRMW1S-W-16422	11–51	10/23/03	33	1.6
MW1D	MRMW1D-W-16421	63–88	10/22/03	ND[a]	ND
MW2S	MRMW02-W-16419	13–53	10/22/03	ND	ND
MW3S	MRMW03-W-16423	18–48	10/23/03	89	2.7
MW4S	MRMW04-W-16418	17–47	10/21/03	ND	ND
MW5S	MRMW05-W-16420	15–55	10/22/03	5.8	ND
Surface water samples					
SW01	MRSW01-W-16425	–[b]	10/23/03	ND	ND
SW02	MRSW02-W-16426	–	10/23/03	ND	ND
SW03	MRSW03-W-16427	–	10/23/03	ND	ND

[a] ND, contaminant not detected at the quantitation limit of 1 µg/L for the purge-and-trap analysis.

[b] Depth is not applicable.

TABLE D.4 Results of inorganic analyses on groundwater samples collected during the Phase I–Phase II investigation at Morrill, Kansas.

				Concentration (mg/L or ppm)							
Location	Sample	Depth (ft BGL)	Sample Date	Alkalinity	Aluminum	Calcium	Chloride	Iron	Magnesium	Manganese	Nitrate as N
MW1S	MRMW1S-W-16422	11–51	10/23/03	323	0.2 U[a]	123	67.8	0.1 U	31.4	0.015 U	14.3
MW1D	MRMW1D-W-16421	63–88	10/22/03	278	0.2 U	572	19	0.102	49.5	0.0284	0.2 U
MW2S	MRMW02-W-16419	13–53	10/22/03	295	0.2 U	129	23.2	0.1 U	31.0	0.015 U	25.1
MW3S	MRMW03-W-16423	18–48	10/23/03	298	0.2 U	93.4	3.38	0.1 U	17.5	0.015 U	12.1
MW4S	MRMW04-W-16418	17–47	10/21/03	327	0.2 U	89.5	11.1	0.1 U	36.0	0.015 U	19.9
MW5S	MRMW05-W-16420	15–55	10/22/03	308	0.2 U	117	12.2	0.1 U	31.6	0.015 U	20.4

				Concentration (mg/L or ppm)							
				Nitrate/Nitrite Nitrogen	Phosphate	Phosphorus	Potassium	Silicon	Sodium	Sulfate	Zinc
MW1S	MRMW1S-W-16422	11–51	10/23/03	13.5	0.2 U	0.25 U	5 U	7.69	35.0	32.5	0.02 U
MW1D	MRMW1D-W-16421	63–88	10/22/03	0.01 U	0.4 U	0.25 U	5 U	7.79	26.4	1430	0.02 U
MW2S	MRMW02-W-16419	13–53	10/22/03	24.2	0.2 U	0.25 U	5 U	8.62	18.7	44	0.02 U
MW3S	MRMW03-W-16423	18–48	10/23/03	11.5	0.2 U	0.25 U	5 U	7.34	20.2	19.7	0.02 U
MW4S	MRMW04-W-16418	17–47	10/21/03	18.3	0.2 U	0.25 U	5 U	7.90	19.8	21.3	0.02 U
MW5S	MRMW05-W-16420	15–55	10/22/03	19.1	0.2 U	0.25 U	5 U	8.32	19.0	53.3	0.02 U

[a] U, not detected above indicated reporting limit.

Appendix E:

Water Level Data

TABLE E.1 Hand-measured water levels at Morrill in October 2003.

Well Number	Date Measured	Depth to Groundwater[a] (ft)	Elevation (ft AMSL)	
			Reference	Groundwater
MW1S	10/23/2003	30.36	1124.68	1094.32
MW2S	10/22/2003	42.21	1137.07	1094.86
MW3S	10/23/2003	36.47	1135.76	1099.29
MW4S	10/21/2003	46.40	1143.61	1097.21
MW5S	10/22/2003	31.40	1122.21	1090.81

[a] Measured from top of casing.

Appendix F:

Quality Control for Sample Collection, Handling, and Analysis

Appendix F:

Quality Control for Sample Collection, Handling, and Analysis

Soil and groundwater sampling was conducted during the Phase I–Phase II investigation at Morrill, Kansas, to (1) verify an association of carbon tetrachloride with the former CCC/USDA facility and (2) verify the contaminant migration pathway from the former facility. Throughout the investigation, QA/QC samples were collected to monitor sample collection, handling, and analysis. The QA/QC procedures for sample collection, handling, and analysis are described in detail in the *Master Work Plan* (Argonne 2002) and the site-specific *Work Plan* (Argonne 2003). Evaluation of the organic analytical data was consistent with regulatory guidelines (EPA 1994).

F.1 Sampling to Monitor Sampling Collection, Handling, and Analysis Procedures

Sample collection and handling activities were monitored by the documentation of samples as they were collected and the use of chain-of-custody (COC) forms and custody seals to ensure sample integrity during handling and shipment. Some minor discrepancies in sample identities as listed on the COC records, sample containers, or analytical data reports were resolved by comparison of the various documentation records.

1. Trip blank MRQCTB-W-16436 was shipped to AGEM Laboratory on October 23, 2003, without being listed on the associated COC 2137. The discrepancy was noted upon receipt, and the trip blank was analyzed on October 27, 2003.

2. Groundwater sample MRMW02-W-16419 was collected on October 22, 2003, and shipped to AGEM Laboratory on October 23, 2003, under COC 2137. It was incorrectly logged in by the laboratory as MRMW02-W-16417 prior to its analysis on October 27, 2003.

The QA/QC samples collected included a background near-surface soil sample, equipment rinsates, and trip blanks. Blind field replicate samples were collected, and samples were selected for duplicate analyses as a measure of analytical precision. The QA/QC samples are listed in

Table F.1. Analytical results for carbon tetrachloride and chloroform in QA/QC samples collected to monitor sample collection and handling activities are in Table F.2.

F.1.1 Background Soil Sample

A background near-surface soil sample (MRQCBG-S-16435) was collected to provide a baseline for the soil survey conducted in October 2003. Contamination was not detected.

F.1.2 Equipment Rinsates

Rinsate samples were collected to ensure that decontamination procedures were adequate to prevent cross-contamination during sample collection. Neither carbon tetrachloride nor chloroform was detected in the rinsate samples.

F.1.3 Trip Blanks

Trip blanks were prepared and included with soil or water samples sent to the laboratory for organic analysis, as an indicator of cross-contamination during shipment. Neither carbon tetrachloride nor chloroform was detected in the trip blanks shipped with water or soil samples to the AGEM Laboratory or with water samples to Clayton Laboratory, Novi, Michigan. Chloroform was detected in a blank of the methanol used for soil extraction, shipped with soil samples to Severn-Trent Laboratory, Colchester, Vermont, for verification organic analysis as described in Section F.2.3.

F.1.4 Replicate Samples and Duplicate Analyses

As an indicator of the consistency of the sampling methodology and to provide a measure of analytical precision, blind replicate soil and groundwater samples were collected. In addition, the AGEM Laboratory selected some samples for duplicate organic analyses and selected another group of samples for verification analysis at a second laboratory. Blind replicate samples, samples selected for duplicate analyses, and samples selected for verification organic analysis are listed in Table F.1.

F.2 Quality Control for Organic Analysis of Soil Samples

In subsurface soil sampling at 16 soil boring locations (SB01–SB16), 72 soil samples (including 8 blind field replicate samples) were collected for organic analysis. The analyses were conducted at the AGEM Laboratory with a modification of EPA Method 8260B (the purge-and-trap method), as referenced in the EPA's SW-846 (EPA 1998) to achieve a detection limit of 10 μg/kg. To verify the accuracy of these quantitative analytical results, random soil samples were split and prepared for verification analysis at Severn-Trent Laboratory with the same analytical method.

The following sections describe QC measures followed during the analysis of the soil samples and discuss the quality of the organic analytical data from each laboratory. Analytical data from the AGEM Laboratory are discussed in Section F.2.1, and analytical data from Severn-Trent Laboratory are discussed in Section F.2.2. The analytical results from the two laboratories are compared in Section F.2.3.

F.2.1 Organic Analysis of Soil Samples at the AGEM Laboratory

Soil samples were quick-frozen on dry ice as they were collected. At the AGEM Laboratory, the VOCs in each soil sample were extracted from the sample matrix with methanol.

For the purge-and-trap soil analyses, an aliquot of the methanol extract was purged, and the volatile species were transferred to a sorbent tube. After purging, the sorbent tube was heated and backflushed with an inert gas to desorb the components into the gas chromatograph-mass spectrometer system. The compounds eluting from the gas chromatograph column were identified by retention time and by comparison with reference library spectra. The concentration of each component was calculated by comparison of the mass spectrometer response for the quantitation ion to the responses for internal standards.

At the AGEM Laboratory, soil samples were analyzed with the purge-and-trap method in 8 sample delivery groups (SDGs), as shown in Table F.3. The QA/QC procedures followed included initial and continuing calibration of instruments, analysis of laboratory blanks, monitoring of surrogate spike recovery, analysis of replicate samples, and duplicate analyses of selected samples. Significant results include the following:

- Soil samples were received with custody seals intact and at the appropriate temperature. All samples were analyzed within required holding times. Because of instrument error, the analysis of sample MRSB11-S-16371 was not successful. A split of this sample was submitted to the secondary laboratory for verification analysis. The result from the secondary laboratory is reported (Table C.2 in Appendix C).

- Contaminants of concern were not detected in the laboratory method blanks. However, in the initial preparation of some soil samples, chloroform, methylene chloride, and 1,1,1-trichloroethane were detected in the methanol extractant and in the resulting analytical results for the soil samples. Additional aliquots of the samples were extracted again with a higher grade of methanol. In the analysis of the second extract, those contaminants were not present.

- For each SDG, analytical instrument calibration was monitored by the analysis of calibration check standards. Table F.3 shows the relative percent difference (RPD) between the actual and measured concentrations of the standards. The concentrations of calibration check standards measured in all SDGs were within the acceptable range of ±20%.

- Surrogate standard determinations were performed on the samples and blanks by using the surrogate spike compounds fluorobenzene, 4-bromofluorobenzene, and 1,4-dichlorobenzene-d_4. Table F.3 shows the percent recoveries of these system-monitoring compounds for each analysis. With the five exceptions described below, samples in which the surrogate recovery was below the acceptable limit of 80% in the initial analysis were successfully reanalyzed. High recovery in the analysis of calibration check standards in SDG 03-10-23 and SDG 03-11-3 and in the duplicate analysis of sample MRSB16-S-16408 in SDG 03-11-3 did not inhibit contaminant detection. The exceptions are as follows:

- Three surrogate compounds were recovered at < 80% in the analysis of trip blank MRQCTB-S-16348 in SDG 03-10-21. The result is accepted without qualification, because no contamination was detected in the associated samples.

- Recovery was low for one of three spike compounds in the analysis of the calibration check standard in SDG 03-10-22. Results for the samples analyzed in this SDG are accepted on the basis of secondary analyses in other SDGs.

- Two of three surrogate compounds were recovered at < 80% in the analysis of sample MRSB04-S-16393 in SDG 03-10-24. Neither carbon tetrachloride nor chloroform was evident in the chromatogram for the analysis. This lack of response and the absence of contamination in two other soil samples from the same sampling location (SB04), which were analyzed with recovery within the QC limits, indicate that qualification of the data is not warranted.

- Three surrogate compounds were recovered at < 80% in the analysis of sample MRSB04-S-16392 and its duplicate analysis as MRSB04-S-16392DUP in SDG 03-10-24. Neither carbon tetrachloride nor chloroform was evident in the chromatograms for the analyses. This lack of response and the absence of contamination in two other soil samples from the same sampling location (SB04), which were analyzed with recovery within the QC limits, indicate that qualification of the data is not warranted.

- Slightly low recovery (79%) for one of three surrogate compounds in the analysis of sample MRSB13-S-16389 in SDG 03-11-7 does not warrant qualification.

- Dual analyses of soil samples were conducted as a measure of consistency in the sampling and analytical methodologies. The dual analyses involved both the analysis of blind replicate samples submitted to the laboratory and duplicate analyses of samples selected by the laboratory, as identified in Table F.1. The results for these secondary analyses support the initial analyses.

The analytical data from the AGEM Laboratory are acceptable for quantitative determination of contaminant distribution in the near-surface and subsurface soils.

F.2.2 Organic Analysis of Soil Samples at Severn-Trent Laboratory

In accordance with the QA/QC procedures defined in the *Master Work Plan* (Argonne 2002), selected soil samples analyzed for VOCs at the AGEM Laboratory with EPA Method 8260B were subjected to verification analysis at a second laboratory with the same analytical procedure. The results from the two laboratories are compared in Section F.2.3. Below is a discussion of the quality of the organic analytical data from Severn-Trent Laboratory.

Nine replicate soil samples were shipped to Severn-Trent Laboratory for organic analysis with EPA Method 8260B. The samples were sent in one shipment with a trip blank. A complete CLP-level data package was provided. The QA/QC procedures followed included initial and continuing calibration of instruments, analysis of laboratory blanks, monitoring of surrogate spike recovery, and spike analysis of QC samples. Significant results include the following:

- Soil samples shipped to the Severn-Trent Laboratory were received with custody seals intact and at the appropriate temperature. All samples were analyzed within required holding times.

- Analytical instruments were properly tuned; initial and continuing calibration checks remained within the allowable limits.

- Carbon tetrachloride was not detected in the methanol used for soil extraction or in the instrument blanks. However, chloroform was present in the methanol at a concentration of 14 μg/kg. Chloroform concentrations in the resulting analyses are therefore qualified. Methylene chloride and 1,1,1-trichloroethane were also detected in the methanol at 590 μg/kg and 96 μg/kg, respectively. Trace concentrations of hexachlorbutadiene, naphthalene, and 1,2,3-trichlorobenzene were identified in the instrument blank analyzed in association with the samples.

- Surrogate standard determinations were performed on samples and blanks by using the surrogate spike compounds toluene-d_8, 1,2-dichloroethane-d_4, 4-bromofluorobenzene, and 1,2-dichlorobenzene-d_4. Table F.4 shows the recoveries of the system-monitoring compounds for each analysis. The recovery of 1,2-dichloroethane-d_4 at 130% in the associated QC sample was above the QC limit of 120% for this compound.

- To evaluate the matrix effect of samples on the analytical methodology, a matrix spike/matrix spike duplicate analysis of a QC sample was performed with a suite of spike compounds that included carbon tetrachloride and chloroform. Table F.5 shows the recovery and RPD values for carbon tetrachloride and chloroform in the spike/spike duplicate analyses. The QC limits were met for these contaminants of concern, but other compounds exhibited recoveries outside their respective limits and high RPD values.

- The organic analytical data from Severn-Trent Laboratory for the replicate soil samples are acceptable for comparison with AGEM Laboratory data. Qualification of the Severn-Trent data is warranted because of the identified recovery errors in the QC sample and spike/spike duplicate analysis.

F.2.3 Verification Organic Analysis of Soil Samples

In accordance with the QA/QC procedures defined in the *Master Work Plan* (Argonne 2002), selected soil samples analyzed at the AGEM Laboratory with EPA Method 8260B were subjected to verification analysis at a second laboratory. Splits of 9 of the 64 soil samples analyzed at the AGEM Laboratory (14% of the soil samples) were prepared for verification analysis at Severn-Trent Laboratory. However, only 8 of the 9 samples were used for verification analysis of the AGEM Laboratory results. Because of an instrument error, analysis of sample MRSB11-S-16371 at the AGEM Laboratory was not successful. The result for that sample from Severn-Trent Laboratory is reported as the primary analytical result, as opposed to a QC analysis.

Analysis of the soil samples at the AGEM Laboratory with EPA Method 8260B detected no carbon tetrachloride or chloroform at a quantitation limit of 10 μg/kg. No carbon tetrachloride was detected in five of the eight soil samples subjected to verification analysis at Severn-Trent Laboratory. For three samples, Severn-Trent reported estimated concentrations of carbon tetrachloride below the quantitation limit of 10 μg/kg. Chloroform was detected at < 19 μg/kg in all of the samples analyzed at Severn-Trent Laboratory, at levels similar to the concentration detected (14 μg/kg) in the methanol used for preparation of the verification samples. Table F.6 compares the analytical results for carbon tetrachloride and chloroform in the soil samples analyzed at both laboratories. Results from the AGEM Laboratory showing no carbon tetrachloride contamination in the soil above the quantitation limit of 10 μg/kg are supported by verification analysis at Severn-Trent Laboratory with the same analytical method.

F.3 Quality Control for Total Organic Carbon Analyses of Soil Samples

Sixty-five soil samples in four SDGs were analyzed at Severn-Trent Laboratory for total organic carbon by the Lloyd Kahn method. This method uses high-temperature combustion and an infrared detector to measure carbon dioxide. Inorganic carbon is removed from the samples by treating them with a phosphoric acid solution before analysis. Samples were analyzed in triplicate. The three individual determinations were averaged to derive the reported result for each sample.

Quality control for the TOC analyses included analysis of a laboratory control sample and analysis of a spiked sample with each SDG. Recoveries of the known analyte concentrations for these samples are summarized in Table F.7. In addition, one sample from each SDG was selected for replicate analysis. The RPD values for the reported concentrations for these samples are summarized in Table F.8.

In SDG 96802, the recovery in the QC sample, at 118%, was above the upper QC limit of 115%, and the results of the replicate analysis yielded a high RPD value (25%). However, the spike was recovered well in the matrix spike analysis at 99%, and qualification of the data is not warranted.

The TOC results for soil samples from Severn-Trent Laboratory are acceptable on the basis of the recovery of known concentrations of TOC in QC and matrix spike samples and the RPD values in replicate analyses.

F.4 Quality Control for Organic Analysis of Water Samples

Seven groundwater samples and four surface water samples (including one blind replicate groundwater sample and one blind replicate surface water sample) were collected for organic analysis. These samples and the associated QC samples were shipped immediately to the AGEM Laboratory for analysis with EPA Method 524.2 (EPA 1998). To verify the accuracy of the results, duplicate (split) samples were collected for verification analysis at Clayton Laboratory with CLP methodology (EPA 1989). On the basis of its results, the AGEM Laboratory selected duplicate samples for the actual verification analysis.

The following sections describe QC measures followed during analysis of the water samples and the quality of the organic analytical data from each laboratory. Analytical data from the AGEM Laboratory are discussed in Section F.4.1, and analytical data from Clayton Laboratory are discussed in Section F.4.2. The data from the two laboratories are compared in Section F.4.3.

F.4.1 Organic Analysis of Water Samples at the AGEM Laboratory

Water samples shipped to the AGEM Laboratory were analyzed by the purge-and-trap method with a gas chromatograph-mass spectrometer system. For the purge-and-trap analyses, VOCs present in the groundwater samples were extracted (purged) from the sample matrix by bubbling an inert gas through each sample. The purged components were trapped in a specified sorbent tube. After the purging, the sorbent tube was heated and backflushed with an inert gas to desorb the components into the gas chromatograph-mass spectrometer system. The compounds eluting from the gas chromatograph column were identified by retention time and by comparison with reference library spectra. The concentration of each component was calculated by comparison of the mass spectrometer response for the quantitation ion to the response for corresponding calibration curves, internal standards, or both. Calibration checks with each SDG were required to be within ±20% of the standard.

Water samples submitted to the AGEM Laboratory for organic analysis were analyzed in one SDG. Table F.9 identifies the groundwater and associated QC samples analyzed in this SDG. The QA/QC procedures followed included analysis of instrument calibration check standards, analysis of laboratory blanks, monitoring of surrogate spike recovery, and duplicate analyses. Significant results include the following:

- Samples shipped to the AGEM Laboratory were received with custody seals intact and at the appropriate temperature. All samples were analyzed within required holding times.

- Contaminants of concern were not detected in laboratory method blanks analyzed with the samples.

- Analytical instrument calibration was monitored by the analysis of calibration check standards. Table F.9 shows the RPD between the known and calculated concentrations of the standards. The measured concentrations of calibration check standards were in the acceptable range of ±20%.

- Surrogate standard determinations were performed on samples and blanks by using surrogate spike compounds fluorobenzene, 1,2-dichlorobenzene-d_4, and 4-bromofluorobenzene. Table F.9 shows the percent recoveries of these system-monitoring compounds for each analysis. The surrogate recoveries were in the QC range of 80-120% for all analyses.

- As a measure of the consistency in the sampling and analytical methodologies, one blind replicate groundwater sample and one blind replicate surface water sample were collected and analyzed. Table F.10 summarizes the analytical results for the initial samples and their associated replicates. Agreement is excellent, indicating consistency in both the sampling and analytical methodologies.

The analytical data from the AGEM Laboratory are acceptable for quantitative determination of contaminant distribution in groundwater.

F.4.2 Organic Analysis of Water Samples at Clayton Laboratory

In accordance with the QA/QC procedures defined in the *Master Work Plan* (Argonne 2002), the analyses of water samples at the AGEM Laboratory with EPA Method 524.2 were verified by using EPA-defined CLP methodology. On the basis of its results, the AGEM Laboratory selected replicate samples (identified in Table F.1) for the verification analysis. The AGEM Laboratory and CLP analytical results for the replicate samples are compared in Section F.4.3. Below is a discussion of the quality of the organic analytical data obtained by using CLP methodology.

Three replicate groundwater samples were shipped to Clayton Laboratory for organic analysis with CLP methodology. The samples were sent in one shipment with a trip blank. A complete CLP data package was provided. The QA/QC procedures followed in the CLP analysis included initial and continuing calibration of instruments, analysis of laboratory blanks, monitoring of surrogate spike recovery, and matrix spike/matrix spike duplicate analyses. Significant results include the following:

- Samples shipped to the CLP laboratory were received with custody seals intact. The temperature of the samples upon receipt was recorded as 14°C. All samples were analyzed within required holding times.

- Analytical instruments were properly tuned; initial and continuing calibration checks remained within the allowable limits.

- Contaminants of concern were not detected in the trip blank or laboratory method blanks. Acetone and 2-butanone were present at low concentrations (2 μg/L and 3 μg/L, respectively) in the trip blank. Acetone was present at low concentration (3 μg/L) in the laboratory blank.

- Surrogate standard determinations were performed on samples and blanks by using the surrogate spike compounds toluene-d_8, 4-bromofluorobenzene, and 1,2-dichloroethane-d_4. Table F.11 shows the percent recovery of the system-monitoring compounds for each of the CLP analyses. For all analyses, recoveries of the surrogate spikes were within the acceptable range (identified in Table F.11) specific to each surrogate.

- To evaluate the matrix effect of samples on the analytical methodology, a matrix spike/matrix spike duplicate analysis was performed in accordance with CLP protocol by using compounds 1,1-dichloroethene, trichloroethene, chlorobenzene, toluene, and benzene. Table F.12 shows the percent recovery of each spike compound in this analysis, as well as the calculated RPD between the analytical results for the spike and the spike duplicate. The QC limits were met for the analyses.

Organic analytical data from Clayton Laboratory for the replicate groundwater samples are acceptable for comparison with the AGEM Laboratory data.

F.4.3 Verification Organic Analysis of Water Samples

In accordance with the QA/QC procedures defined in the *Master Work Plan* (Argonne 2002), three selected replicates of the water samples analyzed at the AGEM Laboratory with EPA Method 524.2 were subjected to verification analysis with EPA-defined CLP methodology. Table F.13 compares the analytical results for carbon tetrachloride and chloroform obtained with the two methods.

Analytical results for water samples analyzed at the AGEM Laboratory with EPA Method 524.2 are supported by the analytical results for replicate samples analyzed at Clayton Laboratory with EPA CLP methodology. Two groundwater samples analyzed at the AGEM Laboratory in which no contamination was detected were analyzed at Clayton Laboratory with similar results. For sample MRMW05-W-16420, in which carbon tetrachloride was present, the RPD between the concentrations reported by the two laboratories was 9%. Chloroform was not detected in this sample by either laboratory.

F.5 Quality Control for Inorganic Analyses of Groundwater Samples

During the Phase I–Phase II investigation, groundwater samples were collected for inorganic analysis to aid in geochemical characterization of the water-bearing zone. These samples were shipped immediately to Severn-Trent Laboratory for preservation, filtration, and analysis. The analyses included alkalinity by EPA Method 310, dissolved anion concentrations (chloride, sulfate, nitrate, and phosphate) by EPA Method 300, nitrate/nitrite nitrogen by EPA

Method 353, and dissolved metals (aluminum, calcium, iron, magnesium, manganese, phosphorus, potassium, silicon, sodium, and zinc) by EPA Method 6010.

Inorganic analysis of the groundwater samples was conducted in one SDG. The QA/QC procedures followed included instrument calibration through analysis of spiked calibration check standards, verification of interelement and background correction factors through the analysis of interference check samples for the inductively coupled plasma procedure, analysis of QC samples, and the duplicate analysis of selected samples. Significant points are as follows:

- Initial and continuing calibration of analytical equipment was verified according to method protocol by the analysis of instrument check standards to determine instrument drift. Accuracy was measured as the percent recovery of known concentrations of the metals and anions of concern added to the calibration check standards.

- Interelement and background correction factors for the inductively coupled plasma procedure were determined through the analysis of interference check samples. The results fell within the control range of ±20% of the established mean value for the SDG.

- Accuracy in the analytical methodology was measured by the analysis of QC samples. The recoveries of known concentrations of the metals and anions of concern in spiked laboratory samples, shown in Table F.14, were within the desired range of 80–120%. Good precision is indicated by the low RPD values between the initial and secondary analyses.

The inorganic results for groundwater samples from Severn-Trent Laboratory are judged acceptable on the basis of the recovery of known concentrations of the analytes of concern in a QC sample analyzed with the groundwater samples and RPD values in duplicate analyses.

TABLE F.1 Quality control samples collected during the Phase I–Phase II investigation at Morrill, Kansas.

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
Background soil sample				
QC	MRQCBG-S-16435	0.9–1.0	10/23/03	Background near-surface soil sample from edge of cornfield approximately 60 yards north of former CCC/USDA grain storage facility.
Trip blanks sent with soil samples for organic analysis				
QC	MRQCTB-S-16348	–	10/20/03	Trip blank sent to the AGEM Laboratory with soil samples listed on COC 2181.
QC	MRQCTB-S-16361	–	10/21/03	Trip blank sent to the AGEM Laboratory with soil samples listed on COCs 2182 and 2183.
QC	MRTB02-S-16396	–	10/22/03	Trip blank sent to the AGEM Laboratory with soil samples listed on COCs 2135 and 2136.
QC	MRQCTB03-S-16434	–	10/22/03	Trip blank sent to the AGEM Laboratory with soil samples listed on COCs 2141 and 2142.
QC	MR-S-TRIPBLANK	–	10/28/03	Trip blank sent to Severn-Trent Laboratory with soil samples selected for verification organic analysis and listed on COC 1034.
Blind replicate soil samples				
SB01	MRQCDU-S-16413	9.8–10.0	10/22/03	Replicate of sample MRSB01-S-16411.
SB03	MRQCDU-S-16416	4.8–5.0	10/22/03	Replicate of sample MRSB03-S-16415.
SB05	MRSB05-S-16384	1.8–2.0	10/21/03	Replicate of sample MRSB05-S-16383.
SB09	MRQCDU-S-16373	1.8–2.0	10/21/03	Replicate of sample MRSB09-S-16362.
SB09	MRQCDU-S-16375	4.8–5.0	10/21/03	Replicate of sample MRSB09-S-16363.
SB09	MRQCDU-S-16376	9.8–10.0	10/21/03	Replicate of sample MRSB09-S-16364.
SB09	MRQCDU-S-16377	14.8–15.0	10/21/03	Replicate of sample MRSB09-S-16365.
SB15	MRQCDU-S-16432	9.8–10.0	10/22/03	Replicate of sample MRSB15-S-16431.
Soil samples selected by the AGEM Laboratory for duplicate organic analyses				
QC	MRQCBG-S-16435	0.9–1.0	10/23/03	Background near-surface soil sample from edge of cornfield approximately 60 yards north of former CCC/USDA grain storage facility.
SB02	MRSB02-S-16404	15.0–15.3	10/22/03	Slightly moist, brown, very silty clay; mottled with very dark grayish brown, less silty clay; noncalcareous, moderately plastic.
SB04	MRSB04-S-16392	1.8–2.0	10/21/03	Slightly moist, very dark grayish brown, clayey silt; noncalcareous. Root fragments throughout.
SB09	MRSB09-S-16363	4.8–5.0	10/20/03	Very slightly moist, dark gray to dark grayish brown, silty clay; oxidized, moderately plastic, slightly calcareous.
SB11	MRSB11-S-16378	13.7–13.9	10/20/03	Very slightly moist, very dark gray, very silty clay; slightly plastic, noncalcareous, hard. Root fragments abundant.
SB12	MRSB12-S-16350	4.8–5.0	10/20/03	Grayish brown, silty clay with iron and manganese oxide staining.
SB12	MRSB12-S-16351	9.8–10.0	10/21/03	Brown clay.
SB12	MRSB12-S-16352	14.8–15.0	10/20/03	Brown silty clay.

TABLE F.1 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
Soil samples selected by the AGEM Laboratory for duplicate organic analyses (Cont.)				
SB13	MRSB13-S-16388	1.8–2.0	10/21/03	Dry, brown silt with some clay; noncalcareous, nonplastic. Root fragments.
SB14	MRSB14-S-16400	13.0–13.3	10/22/03	Very slightly moist, light yellowish brown, very slightly clayey silt; highly calcareous.
Soil samples sent to Severn-Trent Laboratory for verification organic analysis				
SB05	MRSB05-S-16387	14.5–14.6	10/21/03	Brown silty clay; noncalcareous, moderately plastic, oxidized.
SB06	MRSB06-S-16355	9.8–10.0	10/20/03	Dark yellowish brown, clayey silt.
SB07	MRSB07-S-16381	9.8–10.0	10/21/03	Slightly moist, very dark grayish brown, silty clay; noncalcareous, moderately plastic.
SB09	MRSB09-S-16365	14.8–15.0	10/21/03	Moist, yellowish brown, slightly silty clay; plastic, noncalcareous, with evidence of oxidation.
SB10	MRSB10-S-16367	4.8–5.0	10/21/03	Dry grayish brown, very clayey silt; noncalcareous.
SB11	MRSB11-S-16371	4.8–5.0	10/21/03	Dry to slightly moist, pale brown, very clayey silt, with trace of medium grained sand; nonplastic, noncalcareous, with evidence of oxidation. This sample was not successfully analyzed at the primary laboratory because of instrument failure. The result from the verification laboratory is reported as the primary result (Table C.2, Appendix C).
SB12	MRSB12-S-16350	4.8–5.0	10/20/03	Grayish brown, silty clay with iron and manganese oxide staining.
SB12	MRSB12-S-16351	9.8–10.0	10/20/03	Brown clay.
SB12	MRSB12-S-16352	14.8–15.0	10/20/03	Brown silty clay.
Equipment rinsates				
QC	MRQCRI-W-16499	–	10/24/03	Rinsate of decontaminated coring tip used for collection of soil samples.
QC	MRQCRI-W-16500	–	10/24/03	Rinsate of decontaminated coring tip used for collection of soil samples.
Trip blanks sent with water samples for organic analyses				
QC	MRQCTB-W-16436	–	10/23/03	Trip blank sent to the AGEM Laboratory with samples listed on COC 2137.
QC	MRQCTB-W-16498	–	10/23/03	Trip blank sent to the AGEM Laboratory with samples listed on COC 2144. Also representative field blank of water used for equipment decontamination.
QC	MR-TRIPBLANK	–	10/27/03	Trip blank sent to Clayton Laboratory with water samples selected for verification organic analysis and listed on COC 1033.
Blind replicate water samples				
MW3S	MRQCDU-W-16424	18–48	10/23/03	Replicate of groundwater sample MRMW03-W-16423.
SW01	MRQCDU-W-16437	–	10/23/03	Replicate of surface water sample MRSW01-W-16425.

TABLE F.1 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
Water samples sent to Clayton Laboratory for verification organic analysis				
MW2S	MRMW02-W-16419	13–53	10/22/03	Monitoring well sample collected after purging to dryness and allowing to recover. Sample slightly cloudy with silt.
MW4S	MRMW04-W-16418	17–47	10/21/03	Monitoring well sample collected after purging nearly to dryness and allowing to recover. Sample cloudy with silt.
MW5S	MRMW05-W-16420	15–55	10/22/03	Monitoring well sample collected after purging 48 gal. Sample clear.

TABLE F.2 Results of organic analyses on quality control samples collected to monitor sample collection and handling activities.

Sample	Sample Date	Concentration (µg/L in water; µg/kg in soil)		
		Carbon Tetrachloride	Chloroform	Quantitation Limit
Background soil sample				
MRQCBG-S-16435	10/23/03	ND[a]	ND	10
Trip blanks sent with soil samples for organic analysis				
MRQCTB-S-16348	10/20/03	ND	ND	10
MRQCTB-S-16361	10/21/03	ND	ND	10
MRQCTB03-S-16434	10/22/03	ND	ND	10
MRTB02-S-16396	10/22/03	ND	ND	10
MR-S-TRIPBLANK	10/28/03	ND	14	10
Equipment rinsates				
MRQCRI-W-16499	10/24/03	ND	ND	1
MRQCRI-W-16500	10/24/03	ND	ND	1
Trip blanks sent with water samples for organic analysis				
MRQCTB-W-16436	10/23/03	ND	ND	1
MRQCTB-W-16498	10/23/03	ND	ND	1
MR-TRIPBLANK	10/27/03	ND	ND	5

[a] ND, contaminant not detected at the quantitation limit indicated.

TABLE F.3 Results of organic analyses on quality control samples collected to monitor soil analyses at the AGEM Laboratory by the purge-and-trap method.

				Measured Values for Calibration Check Standards			
	Recovery of Surrogate Compounds[a] (%)			Carbon Tetrachloride		Chloroform	
Sample	Fluorobenzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	Concentration (µg/kg)	RPD[b]	Concentration (µg/kg)	RPD[b]
SDG 03-10-21, analysis date October 21, 2003							
20 µg/kg standard	118	112	111	19.08	4.7	20.71	3.5
Methanol blank	100	100	100				
MRSB12-S-16351	120	125[c]	122[c]	Reanalyzed in SDG 03-10-22 without error.			
MRSB12-S-16351DUP	108	108	104				
MRSB12-S-16352	106	106	105				
MRQCTB-S-16348	67[c]	75[c]	73[c]	Accepted. No contamination detected in associated soil samples.			
Methanol blank	100	100	100				
MRSB12-S-16350	94	95	94				
SDG 03-10-22, analysis date October 22, 2003							
20 µg/kg standard	75[c]	100	94	21.63	7.8	22.53	11.9
Methanol blank	100	100	100				
MRSB12-S-16349	105	107	109	Only sample in this SDG without a secondary analysis.			
MRSB12-S-16350DUP	88	95	92				
MRSB12-S-16351	87	95	92				
MRSB12-S-16352	96	102	94				
MRSB12-S-16352DUP	93	100	96				
SDG 03-10-23, analysis date October 23, 2003							
20 µg/kg standard	123[c]	125[c]	125[c]	22.03	9.7	21.98	9.4
Methanol blank	119	113	113				
MRSB10-S-16367	104	101	101				
MRSB09-S-16364	112	114	116				
MRSB06-S-16356	105	108	108				
MRSB06-S-16354	103	106	106				
MRSB10-S-16366	102	107	108				
MRSB08-S-16359	98	104	102				

TABLE F.3 (Cont.)

				Measured Values for Calibration Check Standards			
	Recovery of Surrogate Compounds[a] (%)			Carbon Tetrachloride		Chloroform	
Sample	Fluorobenzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	Concentration (µg/kg)	RPD[b]	Concentration (µg/kg)	RPD[b]
SDG 03-10-23, analysis date October 23, 2003 (Cont.)							
MRSB06-S-16353	100	104	104				
MRSB11-S-16370	99	98	95				
Methanol blank	100	100	100				
MRSB11-S-16372	88	70[c]	74[c]	Duplicate analysis below without error.			
MRSB11-S-16372	95	100	100	Second analysis reported.			
MRSB06-S-16355	102	102	103				
MRSB09-S-16362	102	111	108				
MRSB10-S-16369	102	106	103				
MRQCDU-S-16376	97	98	98				
MRSB10-S-16368	95	99	95				
MRQCDU-S-16375	95	97	96				
MRQCDU-S-16377	97	97	96				
MRSB08-S-16357	106	107	107				
MRSB08-S-16358	103	103	102				
MRSB11-S-16378	100	103	101				
MRSB09-S-16365	72[c]	83	77[c]	Reanalyzed in SDG 03-11-7 without error.			
MRSB09-S-16363	97	100	100				
MRSB08-S-16360	93	96	92				
MRSB11-S-16378RE	98	98	96				
MRQCTB-S-16361	86	97	99				
Methanol blank	100	112	113				
SDG 03-10-24, analysis date October 24, 2003							
20 µg/kg standard	107	109	102	20.35	1.7	21.6	7.7
Methanol blank	100	100	100				
MRQCDU-S-16373	103	106	106				
MRSB07-S-16380	102	109	113				
MRSB14-S-16397	95	103	100				
MRSB04-S-16394	94	101	99				
MRSB07-S-16381	93	100	98				
MRSB04-S-16393	71[c]	81	78[c]	Not reanalyzed.			
MRSB13-S-16389	57[c]	62[c]	59[c]	Reanalyzed in SDG 03-11-7 with error.			
MRSB04-S-16392	73[c]	76[c]	75[c]	First analysis with low recovery.			

TABLE F.3 (Cont.)

	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
				Carbon Tetrachloride		Chloroform	
Sample	Fluorobenzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	Concentration (µg/kg)	RPD[b]	Concentration (µg/kg)	RPD[b]
SDG 03-10-24, analysis date October 24, 2003 (Cont.)							
MRSB04-S-16392DUP	62[c]	50[c]	51[c]	Second analysis with low recovery.			
MRSB07-S-16379	87	96	94				
MRSB05-S-16385	90	97	92				
MRSB05-S-16383	80	87	86				
MRSB04-S-16395	91	93	92				
MRSB14-S-16399	75[c]	80	77[c]	Reanalyzed in SDG 03-11-7 without error.			
MRSB02-S-16401	86	90	87				
SDG 03-11-3, analysis date November 3, 2003							
20 µg/kg standard	134[c]	141[c]	141[c]	18.52	7.7	18.94	5.4
Methanol blank	100	100	100				
MRSB05-S-16386	104	116	108				
MRSB05-S-16384	112	124[c]	116	Reanalyzed in SDG 03-11-7 without error.			
MRSB13-S-16388	111	120	113				
MRSB16-S-16405	106	118	110				
MRSB05-S-16387	99	110	103				
MRSB13-S-16391	97	108	101				
MRSB14-S-16398	98	105	99				
MRSB14-S-16400	92	103	96				
MRSB14-S-16400DUP	97	103	98				
MRSB02-S-16402	95	106	102				
MRSB13-S-16390	95	105	99				
MRSB16-S-16406	105	110	104				
MRSB02-S-16403	101	114	103				
MRSB02-S-16404	97	128[c]	105	Reanalyzed in SDG 03-11-7 without error.			
MRSB16-S-16408	91	89	78[c]	Reanalyzed in SDG 03-11-7 without error.			
MRSB16-S-16408DUP	104	124[c]	111	Accepted.			

TABLE F.3 (Cont.)

	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
				Carbon Tetrachloride		Chloroform	
Sample	Fluorobenzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	Concentration (µg/kg)	RPD[b]	Concentration (µg/kg)	RPD[b]
SDG 03-11-5, analysis date November 5, 2003							
20 µg/kg standard	98	109	104	18.51	7.7	19.48	2.6
Methanol blank	100	100	100				
MRSB07-S-16382	93	99	100				
MRSB16-S-16407	91	99	102				
MRTB02-S-16396	89	101	106				
MRSB03-S-16417	93	106	107				
MRSB01-S-16411	90	96	99				
MRSB15-S-16431	83	90	92				
MRQCBG-S-16435	81	96	91				
MRQCBG-S-16435DUP	85	103	96				
MRSB15-S-16433	78[c]	67[c]	70[c]	Duplicate analysis below without error.			
MRSB15-S-16433	92	99	103	Second analysis reported.			
MRSB01-S-16409	89	95	98				
MRQCDU-S-16416	86	92	94				
MRSB03-S-16428	83	86	87				
MRSB03-S-16415	81	83	87				
MRSB15-S-16429	83	89	90				
SDG 03-11-6, analysis date November 6, 2003							
20 µg/kg standard	103	109	108	17.44	13.7	18.18	9.5
Methanol blank	100	100	100				
MRSB01-S-16412	96	97	98				
MRSB01-S-16410	99	104	104				
MRQCDU-S-16432	94	100	100				
MRSB03-S-16414	96	102	101				
MRSB15-S-16430	92	98	98				
MRQCDU-S-16413	90	98	96				
MRSB09-S-16363DUP	91	105	100				
MRQCTB03-S-16434	78[c]	65[c]	68[c]	Duplicate analysis below without error.			
MRQCTB03-S-16434DUP	86	97	100	Second analysis reported.			

TABLE F.3 (Cont.)

	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
				Carbon Tetrachloride		Chloroform	
Sample	Fluorobenzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	Concentration (µg/kg)	RPD[b]	Concentration (µg/kg)	RPD[b]
SDG 03-11-7, analysis date November 7, 2003							
20 µg/kg standard	111	108	104	18.78	6.3	20.07	0.3
Methanol blank	100	100	100				
MRSB09-S-16365	110	94	96				
MRSB14-S-16399	90	90	87				
MRSB13-S-16389	79[c]	96	81	Accepted.			
MRSB05-S-16384	82	93	85				
MRSB16-S-16408	85	100	89				
MRSB13-S-16388DUP	84	96	88				
MRSB02-S-16404	81	90	82				
MRSB02-S-16404DUP	81	90	84				

[a] Quality control limits for recovery of surrogate compounds: 80–120%.

[b] Quality control limits for RPD for calibration check standards: ±20%.

[c] Surrogate recovery outside the quality control limit.

TABLE F.4 Recovery of system-monitoring compounds in verification organic analysis of soil samples at Severn-Trent Laboratory with EPA Method 8260B.[a]

		Recovery[b] (%)			
Sample	Analysis Date	Toluene-d_8	1,2-Dichloro-ethane-d_4	Bromofluoro-benzene	1,2-Dichloro-benzene-d_4
MEOH BLANK	11/2/03	98	114	108	103
NWZI MEOHLCS	11/2/03	101	130[c]	111	110
MRSB12-S-16350	11/2/03	91	99	97	93
MRSB12-S-16351	11/2/03	113	114	111	106
MRSB12-S-16352	11/2/03	104	108	104	101
MRSB06-S-16355	11/2/03	106	113	106	105
MRSB11-S-16371	11/2/03	94	97	97	95
MRSB05-S-16387	11/2/03	99	112	110	103
MRSB09-S-16365	11/2/03	108	114	109	101
MRSB07-S-16381	11/2/03	108	116	120	109
MRSB10-S-16367	11/2/03	107	114	112	108
MR-S-TRIPBLANK	11/2/03	104	110	108	100
MRSB07-S-16381MS	11/2/03	106	118	106	100
MRSB07-S-16381MSD	11/2/03	96	116	100	94
NWZI LCS	11/2/03	105	114	105	105
NWZI LCSD	11/2/03	106	113	111	110
VBLKJ5	11/2/03	102	108	113	106

[a] All samples were in SDG 96888.

[b] Quality control limits for recovery are as follows:

Analyte	QC Limits (%)
Toluene-d_8	81–117
1,2-Dichloroethane-d_4	80–120
Bromofluorobenzene	74–121
1,2-Dichlorobenzene-d_4	80–120

[c] Recovery outside the quality control limit for this analyte.

TABLE F.5 Recovery and relative percent difference values for spike/spike duplicate organic analyses of soil samples at Severn-Trent Laboratory.

	Concentration (µg/kg)				Recovery (%)			Difference (%)	
Compound	Sample	Spike Added	Spike Analysis	Duplicate Analysis	Spike Analysis	Duplicate Analysis	Q C Limit	R PD	Q C Limit
Spike/spike duplicate analysis of MRSB07-S-16381 in SDG 96888									
Chloroform	3.1 J[a]	85	86	79	98	89	74-106	10	40
Carbon tetrachloride	0	85	83	77	98	90	62-106	5	40
Spike/spike duplicate analysis of NWZI LCS in SDG 96888									
Chloroform	0	10	10	10	100	100	74-106	0	40
Carbon tetrachloride	0	10	10	10	100	100	62-106	0	40

[a] Qualifier J indicates an estimated concentration below the method quantitation limit of 10 µg/kg.

TABLE F.6 Results of organic analyses on soil samples analyzed both at the AGEM Laboratory and at Severn-Trent Laboratory.

			Concentration (μg/kg)			
			Carbon Tetrachloride		Chloroform	
Location	Sample	Depth (ft BGL)	AGEM	STL[a]	AGEM	STL[a]
SB05	MRSB05-S-16387	14.5–14.6	ND[b]	ND	ND	3.2 B[c]
SB06	MRSB06-S-16355	9.8–10.0	ND	ND	ND	3.3 B
SB07	MRSB07-S-16381	9.8–10.0	ND	ND	ND	3.1 B
SB09	MRSB09-S-16365	14.8–15.0	ND	ND	ND	9.5 B
SB10	MRSB10-S-16367	4.8–5.0	ND	ND	ND	1.9 B
SB12	MRSB12-S-16350	4.8–5.0	ND	3.3 J[d]	ND	16 B
SB12	MRSB12-S-16351	9.8–10.0	ND	5.4 J	ND	18 B
SB12	MRSB12-S-16352	14.8–15.0	ND	4.6 J	ND	19 B

[a] High surrogate recovery in the control sample and high spike recovery and relative percent difference in the spike/spike duplicate sample during verification analysis at STL.

[b] ND, contaminant not detected.

[c] B, contaminant detected in blank of methanol used for soil extraction.

[d] Qualifier J indicates an estimated concentration below the method quantitation limit of 10 μg/kg.

TABLE F.7 Percent recovery of known analyte concentrations obtained during total organic carbon analyses of quality control samples at Severn-Trent Laboratory

		Concentration (mg/kg)			
SDG	Sample	Sample	Spike	Detected	Recovery[a] (%)
96799	LCS	0	8,500	9,390	110.4
96799	MRSB05-S-16383MS	10,900	74,742	74,200	86.6
96802	LCS	0	8,500	10,100	118.8
96802	MRSB02-S-16404MS	28,800	59,678	88,000	99.4
96803	LCS	0	8,500	9,760	114.8
96803	MRSB02-S-16401MS	13,400	101,648	113,100	98.3
96804	LCS	0	8,500	8,790	103.4
96804	MRSB08-S-16360MS	2,390	86,717	89,500	100.4

[a] Quality control ranges for recovery are as follows:

Sample	QC Limits (%)
Quality control	85–115
Spike	75–125

TABLE F.8 Relative percent difference values for recovery of known analyte concentrations in total organic carbon analyses at Severn-Trent Laboratory

SDG	Sample	Concentration (mg/kg) Sample	Concentration (mg/kg) Replicate	Relative Percent Difference[a]
96799	MRSB05-S-16383	10,900	12,100	10.0
96802	MRSB02-S-16404	28,800	22,400	25.0
96803	MRSB02-S-16401	13,400	12,900	4.0
96804	MRSB08-S-16360	2,390	2,010	17.0

[a] Quality control range is 20%.

TABLE F.9 Results of organic analyses on quality control samples collected to monitor water analyses at the AGEM Laboratory by the purge-and-trap method.

				Measured Values for Calibration Check Standards			
	Recovery of Surrogate Compounds[a] (%)			Carbon Tetrachloride		Chloroform	
Sample	Fluorobenzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	Concentration (µg/L)	RPD[b]	Concentration (µg/L)	RPD[b]
SDG 03-10-27, analysis date October 27, 2003							
20-µg/L standard	96	96	99	20.99	4.8	22.04	9.7
Laboratory blank	100	100	100				
MRMW04-W-16418	85	88	85				
MRMW02-W-16419	102	100	97				
MRMW05-W-16420	95	96	92				
MRMW1D-W-16421	93	97	94				
MRMW1S-W-16422	94	96	93				
MRMW03-W-16423	95	98	92				
MRQCDU-W-16424	95	93	89				
MRSW01-W-16425	96	96	92				
MRQCTB-W-16436	96	92	89				
MRSW02-W-16426	92	86	83				
MRSW03-W-16427	106	103	103				
MRQCTB-W-16498	93	88	83				
MRQCDU-W-16437	99	94	90				
MRQCRI-W-16500	97	100	92				
MRQCRI-W-16499	97	91	87				
Laboratory blank	89	90	84				

[a] Quality control limits for recovery of surrogate compounds: 80–120%.

[b] Quality control limits for RPD for calibration check standards: ±20%.

TABLE F.10 Replicate water sample results from the AGEM Laboratory for Morrill, Kansas.

				Concentration (µg/L)	
Location	Sample	Depth (ft BGL)	Sample Date	Carbon Tetrachloride	Chloroform
MW3S	MRMW03-W-16423	18–48	10/23/03	89	2.7
MW3S	MRQCDU-W-16424	18–48	10/23/03	88	2.7
SW01	MRSW01-W-16425	–	10/23/03	ND[a]	ND
SW01	MRQCDU-W-16437	–	10/23/03	ND	ND

[a] ND, contaminant not detected.

TABLE F.11 Recovery of system monitoring compounds in organic analyses of water samples at Clayton Laboratory

Sample	Analysis Date	Sample Delivery Group	Recovery[a] (%)		
			Toluene-d_8	Bromofluoro-benzene	1,2-Dichloro-ethane-d_4
VBLKJB	10/31/03	3101030-ARG172	100	102	100
MR-TRIPBLANK	10/31/03	3101030-ARG172	98	100	104
MRMW04-W-16418	10/31/03	3101030-ARG172	100	100	106
MRMW04-W-16418MS	10/31/03	3101030-ARG172	100	98	106
MRMW04-W-16418MSD	10/31/03	3101030-ARG172	100	96	110
MRMW05-W-16420	10/31/03	3101030-ARG172	102	98	112
MRMW02-W-16419	10/31/03	3101030-ARG172	100	96	108
VHBLKJA	10/31/03	3101030-ARG172	102	98	108

[a] Quality control limits for recovery are as follows:

Analyte	QC Limits (%)
Toluene-d_8	88–110
Bromofluorobenzene	86–115
1,2-Dichloroethane-d_4	76–114

TABLE F.12 Recovery and relative percent difference values for spike/spike duplicate organic analyses at Clayton Laboratory with CLP methodology.

	Concentration (µg/L)				Recovery (%)			Difference (%)	
Compound	Sample	Spike Added	Spike Analysis	Duplicate Analysis	Spike Analysis	Duplicate Analysis	Q C Limit	R PD	Q C Limit
MS/MSD analysis of MRMW04-W-16418 with SDG 3101030-ARG172									
1,1-Dichloroethene	0	50	52	57	104	114	61–145	9	14
Trichloroethene	0	50	47	51	94	102	71–120	8	14
Benzene	0	50	52	56	104	112	76–127	7	11
Toluene	0	50	52	56	104	112	76–125	7	13
Chlorobenzene	0	50	51	55	102	110	75–130	8	13

TABLE F.13 Results of carbon tetrachloride and chloroform analyses of groundwater samples at the AGEM Laboratory and at Clayton Laboratory.

				Concentration (µg/L)			
				Carbon Tetrachloride		Chloroform	
Location	Sample	Depth (ft BGL)	Sample Date	AGEM	Clayton[a]	AGEM	Clayton[a]
MW02	MRMW02-W-16419	13–53	10/22/03	ND[b]	ND	ND	ND
MW04	MRMW04-W-16418	17–47	10/21/03	ND	ND	ND	ND
MW05	MRMW05-W-16420	15–55	10/22/03	5.8	5.3	ND	ND

[a] Sample temperature upon arrival at Clayton Laboratory was 14°C.

[b] ND, contaminant not detected at quantitation limit of 1 µg/L for purge-and-trap analysis at AGEM Laboratory or 5 µg/L for CLP analysis at Clayton Laboratory.

TABLE F.14 Percent recoveries of known analyte concentrations obtained during inorganic analyses of quality control samples at Severn-Trent Laboratory.

	Initial Analysis			Secondary Analysis		
	Concentration (µg/L)					
Compound	Spike	Detected	Recovery (%)	Concentration Detected (µg/L)	Recovery (%)	Relative Percent Difference
Total Alkalinity	100,000	105,000	105.1	NA[a]	NA	NA
Chloride	5,000	4,870	97.4	NA	NA	NA
Sulfate	10,000	9,360	93.6	NA	NA	NA
Nitrate as Nitrogen	3,000	2,940	98	2,900	96.7	1.3
Nitrate/Nitrite Nitrogen	7,340	7,890	107.5	NA	NA	NA
Phosphate	2,000	2,010	100.5	2,050	102.5	2.0
Aluminum	51,000	52,270	102.5	50,890	99.8	2.7
Calcium	50,000	50,930	101.9	49,710	99.4	2.5
Iron	50,500	52,000	103	50,670	100.3	2.7
Magnesium	50,000	50,810	101.6	49,510	99	2.6
Manganese	500	485.8	97.2	472.9	94.6	2.7
Potassium	50,000	49,040	98.1	47,780	95.6	2.6
Phosphorus	1,000	1,049	104.9	936.9	93.7	11.3
Sodium	50,000	50,670	101.3	49,250	98.5	2.8
Silicon	1,000	1,142	114.2	1,168	116.8	2.3
Zinc	500	492.2	98.4	482.2	96.4	2.1

[a] NA, not analyzed.