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Data Report
for
Subsurface Investigation Former Drum Loading Area Building 292 Indian Head Division Naval Surface Warfare Center

Indian Head, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Northern Division Contract Number N62472-90-D-1298

Contract Task Order 0209

March 1996

Brown & Root Environmental

A Division of Halliburton NUS Corporation

129504/P

DATA REPORT
FOR
SUBSURFACE INVESTIGATION
FORMER DRUM LOADING AREA
BUILDING 292
INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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Environmental Branch Code 18
Naval Facilities Engineering Command
Washington Navy Yard, Building 212
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LIST OF ACRONYMS/ABBREVIATIONS

AFSP	Abbreviated Field Sampling Plan
AWQC	Ambient Water Quality Criteria
BGS	Below Ground Surface
CMP	Corrugated Metal Pipe
IHDIV-NSWC	Indian Head Division, Naval Surface Warfare Center
IW	Industrial Waste
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDE	Maryland Department of the Environment
ppb	Parts per billion
RBC	Risk-Based Criteria
RCRA	Resource Conservation and Recovery Act
RPM	Remedial Project Manager
SSL	Soil Screening Level
TCE	Trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TCT	Terra Cotta Pipe
μg/kg	Micrograms per kilogram
μg/L	Micrograms per liter
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

A field investigation was conducted at the Former Drum Loading Area, Site 57 at the IHDIV-NSWC, Indian Head, Maryland. The study area is located immediately south of Building No. 292, a facility that used trichloroethene (TCE) as a degreasing agent from the mid-1960s to 1989. The field investigation consisted of the collection of 25 soil-gas samples, and based on the field analysis of those samples, the collection of 2 soil samples (a "shallow" soil sample from 2 to 4 feet deep, and a "deep" soil sample from 10 to 12 feet deep) from each of four locations; 1 groundwater sample from each of two locations; and 1 storm water sample from each of two pipes discharging into a manhole (MH-1) in the study area. The resulting fixed-base laboratory analytical data demonstrate the presence of TCE in the soil, groundwater and storm water. Most of the other identified volatile organic compounds (VOCs) are among the degradation products of TCE.

The highest soil and groundwater contamination occurred at a point located approximately 35 feet southeast from the southern corner of Building No. 292. In that area, deep soil TCE concentrations ranged up to 150 μg/kg, and shallow soil TCE concentrations ranged up to 840,000 μg/kg. In the same area the TCE concentration in groundwater was 370,000 μg/L. A comparison of the detected contaminant concentrations with published regulatory concentration limits and other guidance indicates the potential need for remediation. The area of potential concern in the deeper soil appears to be relatively localized approximately 25 feet south of Building No. 292, and the area of potential concern in shallow soil may extend as far as 250 feet south of the building (pending verification). The groundwater samples verified the presence of high TCE concentrations, but the quantity of samples was not sufficient to delineate the extent of the contaminant plume. However, depending on the standard of comparison applied, the groundwater TCE contamination may extend more than 200 feet south of Building No.292. Although the presence of TCE was verified in the storm water, the scope of the field investigation did not include an investigation to identify potential sources of the TCE in the storm water.

Recommendations resulting from this effort include the following:

- Develop a conceptual model of the site-specific source/path/receptor relationships and define risk scenarios.

- Conduct a preliminary health and environmental risk assessment to verify the need for remediation and establish a basis for cleanup goal determinations.

- Develop a predictive model regarding the migration of contamination to the groundwater for the purpose of establishing site-specific cleanup goals for soil.

- Conduct additional field investigations to provide more definitive data regarding the extent of soil and groundwater contamination; to support a health and environmental risk assessment, the development of a predictive contaminant migration model, and the evaluation of potential remedial technologies; and to determine the source of contamination in the stormwater.

- Develop risk-based cleanup goals, and (if appropriate) evaluate remedial options.

- Investigate and identify the sources of flow into MH-1.

- Conduct a treatability study to evaluate the effectiveness of vapor extraction for the insitu treatment of contaminated soil and groundwater.

1.0 INTRODUCTION AND PROJECT BACKGROUND

The Northern Division of the Naval Facilities Engineering Command has issued Contract Task Order Number 0209 (CTO 209) to Brown & Root Environmental (B&R Environmental), a division of Halliburton NUS, under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-1298. CTO 209 is for preliminary environmental work to support a potential removal action at the Former Drum Loading Area near Building 292 at the Indian Head Division, Naval Surface Warfare Center, (IHDIV-NSWC), Indian Head, Maryland (Figure 1-1). This Data Report presents the results of a field investigation conducted at the Former Drum Loading Area, Installation Restoration (IR) Site 57 (Figure 1-2).

1.1 PROJECT BACKGROUND

The IHDIV-NSWC is located in the northwest section of Charles County, Maryland, 25 miles southwest of Washington, D.C. The principal mission of the facility is research, development, testing, evaluation, and production of propellant and explosive ingredients and of formulations used in ordnance devices.

In August 1995, B&R Environmental submitted to the Navy an Abbreviated Field Sampling Plan (AFSP) for Subsurface Investigation at the Former Drum Loading Area, Building 292, Indian Head Division, Naval Surface Warfare Center. The field investigation described in that plan was performed on September 26 and 27, 1995.

The area investigated emanates from the front of Building 292 at the main facility of the IHDIV-NSWC. Previous operations at the building involved vapor degreasing of metal parts using trichloroethene (TCE). It is believed that these operations may have resulted in the contamination of the soil and groundwater near the building.

1.1.1 Review of Existing Information

TCE was first detected in February 1994 at 53 micrograms per liter (μg/L, equivalent to parts per billion, ppb) at the industrial wastewater outfall designated IW-80 which is located approximately 1,000 feet south of Building 292 and serves the drainage basin that includes Building 292. This initial sampling was conducted because of an odor reported at IW-80. A sample collected from the same outfall in May 1994 detected 60.2 μg/L TCE. The Navy notified the Maryland Department of the Environment (MDE) of the TCE

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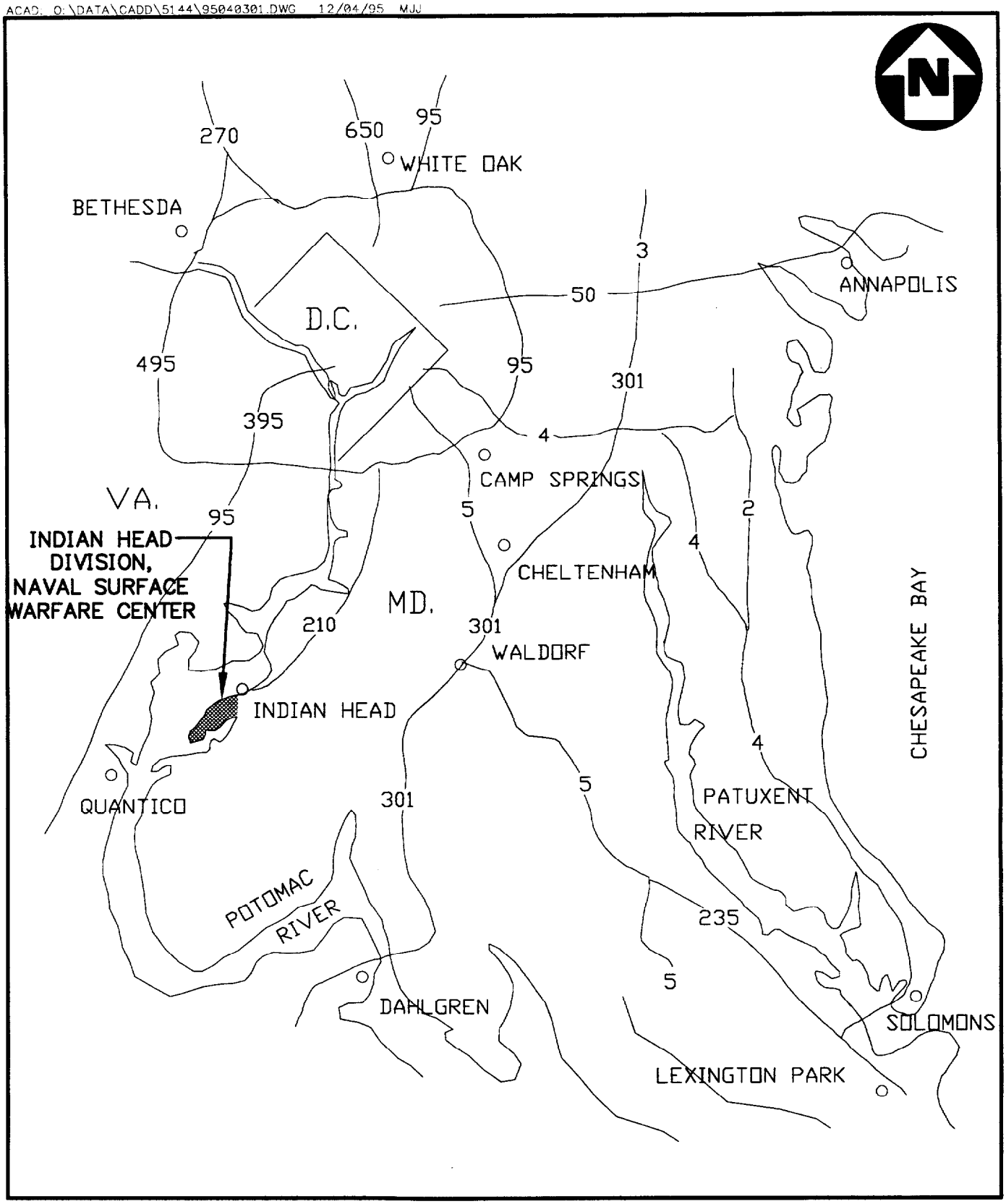

VICINITY MAP
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
NOT TO SCALE

FIGURE 1-1

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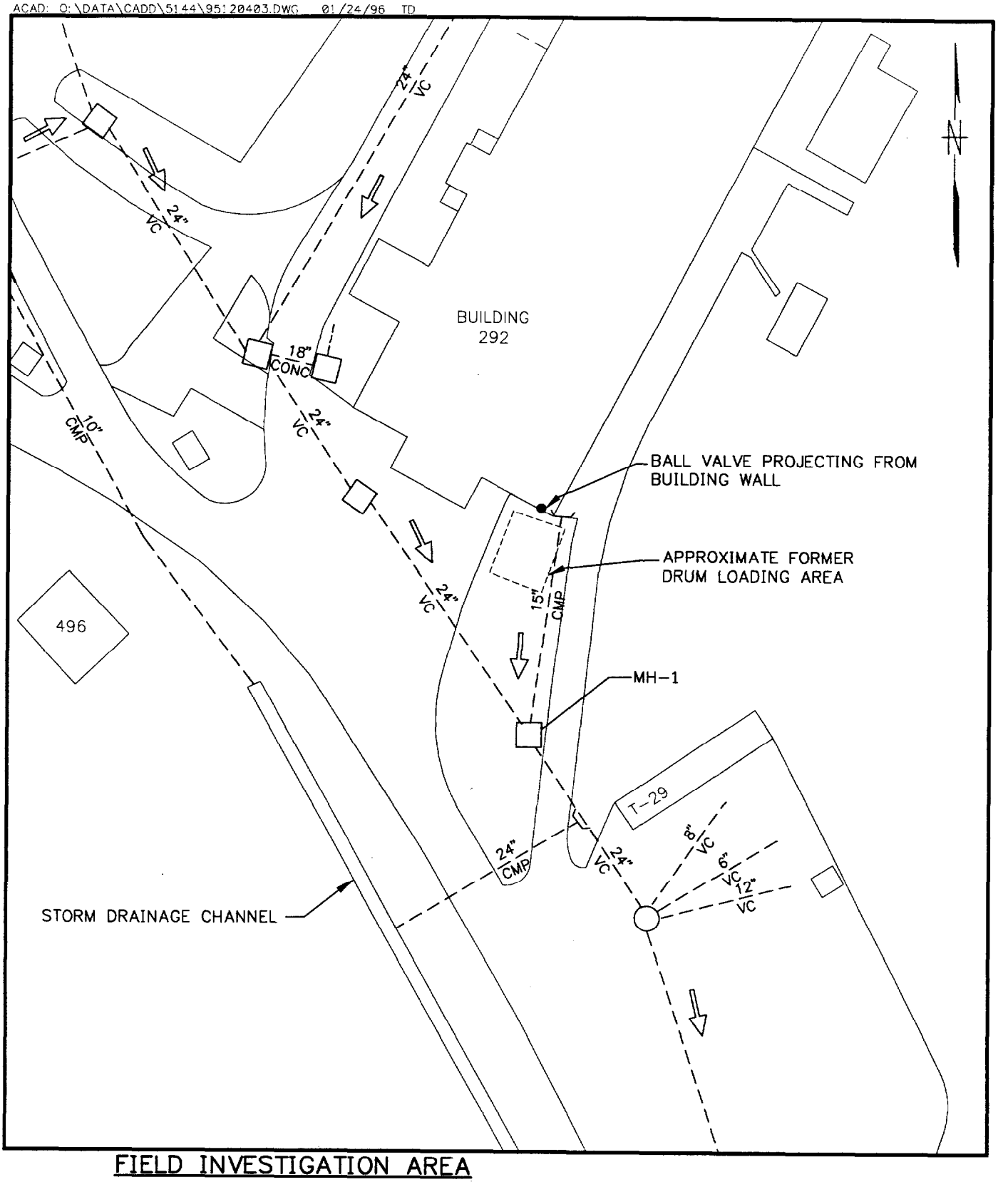

FIELD INVESTIGATION AREA
BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER,
INDIAN HEAD, MARYLAND

0 50 100
SCALE IN FEET

FIGURE 1-2

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CTO 209

discharge and submitted a revised National Pollutant Discharge Elimination System (NPDES) permit application on November 4, 1994, to MDE requesting approval of a 100 μg/L TCE discharge limit.

Since May 1994, the Navy has conducted several rounds of storm sewer sampling for TCE in an attempt to locate the source of TCE:

- July 12, 1994 - Sample results did not detect TCE or any other volatile organic priority pollutants of three sampling points upstream from Building 292 (Sampling Points 1, 2 and 3 on Figure 1-3).

- July 27, 1994 - Sample results did not detect TCE upstream of Building 292 (Sampling Point 3, Figure 1-3) but did detect TCE at MH-1 (62 μg/L) and approximately 1,000 feet downstream from Building 292 at IW-80 (47 μg/L) (Sampling Points 4 and 5, Figure 1-3). No other volatile organic priority pollutant was detected.

Building 292 operations reportedly included the following activities:

- 1,900-gallon TCE vapor degreaser used from the mid-1960s until 1989.

- Large solvent dip tanks used for general cleaning until the mid-1970s.

- Spent TCE piped to drums outside Building 292 via a ball valve through the wall of the building. Drums were reportedly stored on a grass-covered area near the ball valve and near MH-1.

The use of TCE at the facility was reportedly stopped in 1989. The Building 292 area is believed to be one potential source of TCE in the storm sewer. No other obvious sources of TCE are located in the vicinity.

1.1.2 Site Reconnaissance

On November 2, 1994, Halliburton NUS (now Brown & Root Environmental) conducted a reconnaissance of the Building 292 area. Participating personnel included R. Shawn Phillips, Remedial Project Manager (RPM), Engineering Field Activity Chesapeake; John Gee, senior project manager, B&R Environmental; Tony Klimek, senior project manager, B&R Environmental; and Thomas W. Symalla, environmental engineer, IHDIV-NSWC, Waste Management and Prevention Branch, Environmental Division.

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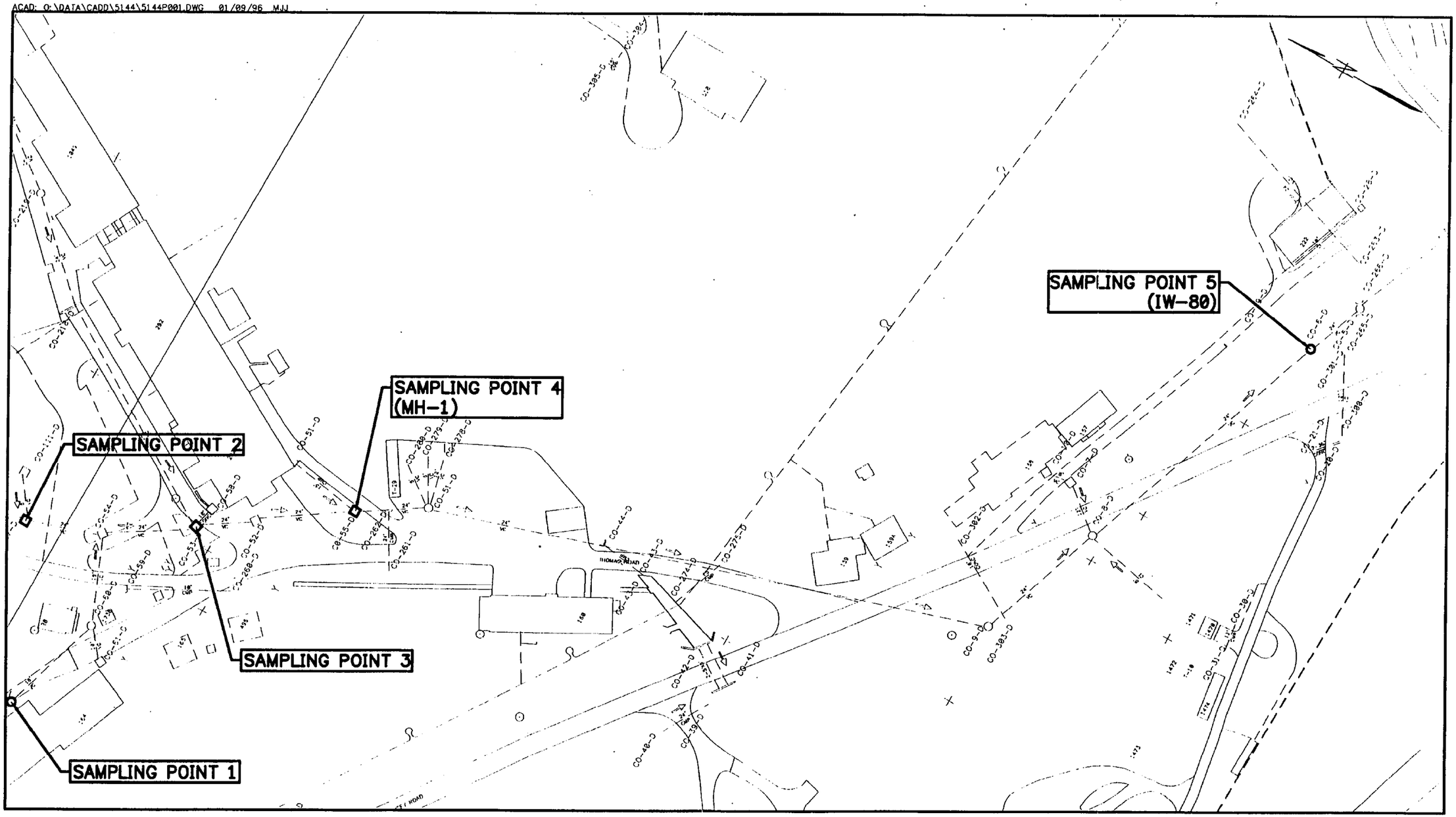

PAST INVESTIGATION SAMPLING POINTS
BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

0 100 200
SCALE IN FEET

FIGURE 1-3

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The site reconnaissance began near Building 292, where MH-1, located approximately 80 feet south of Building 292, was inspected first. MH-1, which is also known as Structure 430, (Master Shore Station Development Plan, 1991) is a rectangular manhole constructed of brick. The manhole extends approximately 2 feet above the ground surface. Several pipes that enter MH-1 were visible when looking down into the manhole. Three of these pipes enter the manhole from the northwest. One appeared to be a (18-inch) corrugated metal pipe (CMP) that was approximately 4 feet below ground surface (BGS) and was apparently connected to the gutters at ground surface on either side of Building 292. Below the CMP appeared a (18-inch) terra cotta pipe (TCP). Below the TCP was a third pipe of unidentified size and composition.

A 24-inch TCP entered the manhole from the southwest. Flow was observed entering MH-1 from the 18-inch CMP and from the lower pipe entering from the northwest. The flow from this lower pipe was significantly greater than that from the CMP and is reportedly noncontact cooling water from the base power plant.

A reconnaissance of the exterior of Building 292 revealed a number of pipes that extend through the walls of the building and discharge to the concrete storm sewer drain system for the building. In addition to these pipe discharges from inside the building, the ground-level storm sewer drains also receive roof drainage. B&R Environmental also observed possible spring discharge from a hill located southeast of the building that also discharges to this drain system. A sheen was present on the water from the spring. The building contains a number of hazardous waste storage sites. An inspection of the contents of the hazardous waste storage sites was not conducted.

A small degreaser unit was in place in Building 292 which uses 165 gallons of 1,1,1-Trichloroethane (1,1,1-TCA). According to a label on the unit, it was manufactured by Randall Manufacturing Company, of Hillside, New Jersey in March 1980. The degreaser unit is used to vaporize TCA for cleaning parts. According to plant personnel, the unit was installed in 1989 after the 1900 gallon degreaser unit was removed and the use of Trichloroethylene (TCE) was discontinued. The vapors collected in the hood of the machine run through a condenser and are then exhausted directly outside the building. Any vapors of 1,1,1-TCA that do make it past the condenser may, upon contact with ambient air, form condensate that drips onto the ground or into the gutter system at Building 292. According to the foreman of the facility, the degreaser unit was inactive from approximately January 1995 through June 1995. In addition, when the degreaser is not going to be used for several days, the 1,1,1-TCA is removed and is placed in 55-gallon drums for storage.

Several lines discharge from the degreaser to the gutter system at the building. These lines include cooling water for the condenser and a steam line, which heats the 1,1,1-TCA. Numerous drums of 1,1,1-TCA were

in the building. The used 1,1,1-TCA is recycled on site in a still, located adjacent to the degreaser unit. The workers in the facility transfer used 1,1,1-TCA into the still by pouring or pumping.

1.1.3 TCE/1,1,1-TCA Degradation and Impurities

TCE degrades in the environment to form cis-1,2-dichloroethene, trans-1,2-dichloroethene (1,2-DCE), 1,1-dichloroethene (1,1-DCE), and 1,2-dichloroethane (1,2-DCA). These compounds can subsequently degrade to form vinyl chloride and chloroethane. The presence of vinyl chloride is usually indicative of an older TCE discharge. Technical-grade TCE contains 0.035 percent 1,1,1-TCA, as well as chloroform, carbon tetrachloride, and other priority pollutants.

1,1,1-TCA degrades in the environment to form 1,1-DCE, 1,1-dichloroethane (1,1-DCA), vinyl chloride, and/or chloroethane. The presence of the last two compounds is usually indicative of an older 1,1,1-TCA discharge. Impurities in commercial-grade 1,1,1-TCA are normally below a concentration of 250 mg/L.

1.2 OBJECTIVE

The objective of the investigative work described in the AFSP (HNUS, 1995) was to investigate the area between MH-1 and the drum loading area near the ball valve in the wall of Building 292 to determine whether TCE or its degradation byproducts are present in the area. The objective of this Data Report is to present the analytical results of that investigative effort.

1.3 REPORT FORMAT

Section 1.0 of this Data Report contains the introduction and background information. Section 2.0 briefly describes the field investigation activities. Section 3.0 summarizes the analytical data resulting from the analysis of field samples. Section 4.0 provides a brief analysis of the resulting data and compares the data to limits published in pertinent regulations and guidance documents. Section 5.0 describes B&R Environmental's conclusions and recommendations for the Former Drum Loading Area (Site 57).

2.0 FIELD INVESTIGATION SUMMARY

This section briefly recounts the sampling approach outlined in the AFSP (HNUS, 1995) as well as the field investigation activities leading to the collection of the analytical data presented in Section 3.

The field sampling activities (with the exception of the collection of storm water samples) were executed by a B&R Environmental subcontractor, Tracer Research Corporation (Tracer), under the field supervision of a B&R Environmental Field Operations Leader (FOL). Tracer collected and field analyzed the soil gas samples and collected the soil and groundwater samples for shipment to a fixed-base laboratory. The storm water samples were collected by the B&R Environmental FOL for shipment to a fixed-base laboratory. Fixed-base laboratory analytical services were provided by General Physics Environmental Services, Inc. All soil, groundwater, and storm water samples were analyzed for Target Compound List (TCL) volatile organic compounds (VOCs).

Actual field sampling occurred on September 26 and September 27, 1995. Thirteen soil-gas samples were collected on September 26, and eleven were collected on September 27. Work on September 27 also included the collection of 8 soil samples, 2 groundwater samples, and 2 storm water samples which were analyzed in the fixed-base laboratory for TCL VOCs, and the analytical results validated.

2.1 OVERALL STRATEGY

The sampling scheme was designed to determine if TCE contamination was present in the former drum loading area and to provide rapid, approximate indication of the extent of TCE contamination.

2.2 SOIL-GAS SAMPLING

The approach called for the initial collection of 5 soil gas samples, then determining the placement of subsequent sampling locations based on the field analytical results from the preceding samples. The first of the 5 initial samples was to be placed near the southern corner of Building 292 with subsequent samples placed at 50-foot intervals toward the south on an axis passing through the drum loading area and over MH-1. The plan was to extend this line of samples until the analytical results indicated "non-detect."

The AFSP established parameters for adjusting the intervals between the soil-gas sampling points based on the field analytical results. If three adjacent samples along an axis exhibited the same order of magnitude

of contaminant concentration, the horizontal interval between sampling points could be increased to 100 feet. On the other hand, if three adjacent samples along an axis exhibited successive increases or decreases in concentration of an order of magnitude or more, the horizontal interval between sampling points could be decreased to 25 feet.

Once the limits of soil-gas contamination had been established along the north-south axis, a second axis perpendicular to the first (running generally east-west) was to be established emanating from the soil-gas point exhibiting the highest soil-gas contaminant concentration. Soil-gas sampling was to proceed from the identified point toward the east and toward the west in a manner similar to that described above for the north-south axis.

2.3 SOIL SAMPLING

The AFSP called for the identification of four soil sampling locations according to the following.

- One location as close as practical to each of the three soil gas sampling points exhibiting the highest contaminant concentrations.

- One location as close as practical to the first soil gas sampling location exhibiting a "non-detect" along the north-south axis.

At each of the identified locations, two samples were to be collected, one from the interval located 2 to 4 feet below ground surface, and one from near the soil/groundwater interface.

As the Section 3.0 discussion regarding soil-gas field analytical data shows, SG-06 is the southernmost sampling point along the north-south axis, and the soil-gas TCE concentration in that sample is reported as 0.01 ug/L rather than nondetected. When SG-06 sample was analyzed in the field, the TCE results were reported as nondetected; however, a subsequent quality assurance check of the soil-gas field data by Tracer indicated that a small "peak" did exist for TCE. Consequently, the field-reported concentration was modified at the time the Tracer field report was prepared such that SG-06 was reported in the document as 0.01 ug/L. Because the field report was prepared after completion of the field activities, the selection of soil and groundwater sampling points was based on the originally reported nondetect for SG-06.

2.4 GROUNDWATER SAMPLING

Similar to the approach for identifying the soil sampling locations, two groundwater sampling locations were identified, one located as close as possible to the soil-gas sampling point exhibiting the highest contaminant concentration, and a second located near the first soil-gas sampling point exhibiting a "non-detect" along the north-south axis.

As indicated in the Section 3.0 discussion regarding groundwater sampling, sample GW-14-13 was collected at location SG-05, and SG-05 is located immediately upgradient (i.e., the next-to-last sample along the north-south axis) from SG-06, which was reported in the field to be the first nondetect along the north-south axis. The initial effort to collect GW-14-13 was actually made at SG-06 in conformance with the sampling scheme described in the AFSP; however, on four attempts, the sampling probe hit refusal at approximately 13 to 14 feet deep without encountering groundwater. To secure a groundwater sample, the rig was moved upgradient to SG-05, where three attempts finally resulted in a groundwater sample. Both groundwater samples (GW-11-11 and GW-14-13) were described by field personnel as containing sediments.

2.5 STORM-WATER SAMPLING

The AFSP required the collection of two storm-water samples. Both were to be collected from MH-1, located approximately 80 feet south from the south corner of Building 292. One discrete sample was to be collected from the upper pipe of the pipes discharging into the manhole, and a second discrete sample from the pipe immediately below the first, assuming there was flow present in the pipes during the field investigation.

Flow was present in the pipes during the field investigation. SW-01-14 was collected from the upper pipe, and SW-02-09 was collected from the lower pipe. Both samples were described by field personnel as visibly clear and without odor.

3.0 SUMMARY OF FIELD INVESTIGATION RESULTS

This section discusses the analytical results from the samples collected during the field investigation and offers an assessment of that data.

3.1 SOIL-GAS ANALYTICAL RESULTS

The soil-gas field analytical results appear in Table 3-1. Soil-gas sampling locations and the field TCE analytical results with respect to TCE are shown on Figures 3-1 and 3-2.

The soil gas data confirm the presence of TCE in the subsurface with the point of apparent highest concentration located approximately 30 feet southwest of the southern corner of Building 292 (SG-07 on Figure 3-1). Figure 3-2 is a computer-generated representation of the soil-gas field data and illustrates a plume of TCE in soil gas extending generally toward the south-southeast.

Based on the sampling scheme described in Section 2.0, the critical soil-gas sampling points were the three exhibiting the highest TCE concentrations (SG-02 at 3,200 μg/L, SG-07 at 9,600 μg/L, and SG-10 at 2,500 μg/L) and the first nondetect result along the north-south axis extending southward from Building 292.

As described in Section 2.0, the first nondetect soil-gas sample along the north-south axis, as reported in the field, was SG-06. Following completion of the field activities, a quality assurance check by Tracer of field soil-gas results determined that the TCE soil-gas concentration should be reported as 0.01 μg/L in the Tracer field report. Consequently, although Table 3-1 shows a TCE concentration of 0.01 μg/L for SG-06, the field selection of subsequent sampling locations was based on a field-reported, nondetect TCE soil-gas concentration at SG-06.

3.2 SOIL SAMPLE ANALYTICAL RESULTS

The validated analytical results for the soil samples are shown in Table 3-2. As described in Section 2.2.2, the locations for soil samples were determined based on the field-reported results of the soil-gas analyses. To clarify which soil gas sample served as the basis for collecting each soil sample, the designation (i.e., location) of the "responsible" soil-gas sample has been included in the column headings of Table 3-2 immediately below the sample number for each soil sample.

TABLE 3-1

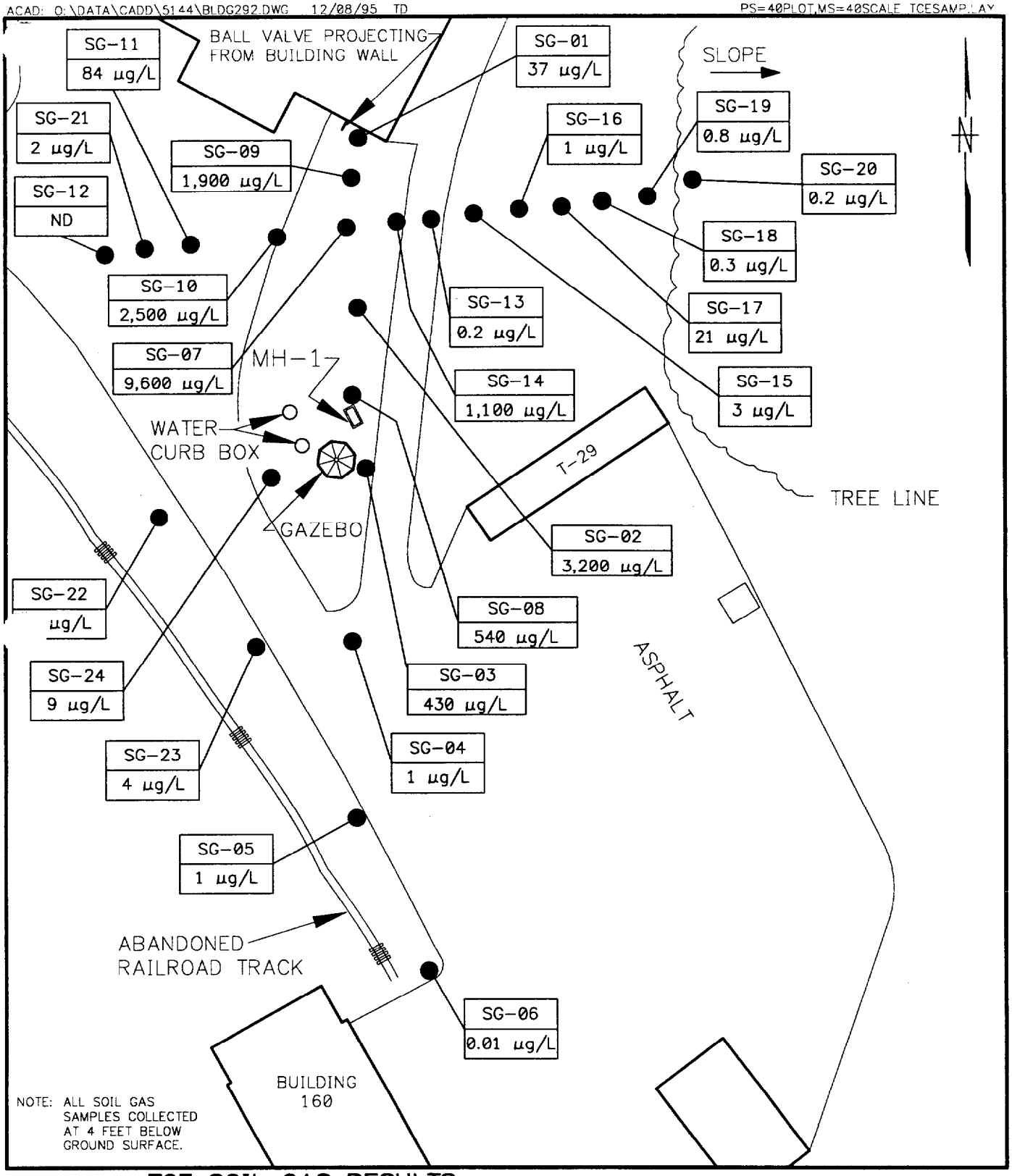
SOIL-GAS FIELD ANALYTICAL RESULTS
SEPTEMBER 26 AND 27, 1995
BUILDING 292, FORMER DRUM STORAGE AREA
INDIAN HEAD, MARYLAND

Sample Number (2)	Analytical Results (1)		
	1,1-DCE ug/L	Total 1,2-DCE ug/L	TCE ug/L
SG- 01	0.05	6	37
SG- 02	2	120	3200
SG- 03	0.02	0.4	430
SG- 04	<0.02	<0.2	1
SG- 05	<0.02	<0.2	1
SG- 06	<0.02	<0.2	0.01
SG- 06 DUP (3)	<0.01	<0.09	0.02
SG- 07	1	130	9600
SG- 08	0.02	10	540
SG- 09	1	110	1900
SG- 10	2	220	2500
SG- 11	0.02	9	84
SG- 12	<0.02	<0.2	<0.002
SG- 13	0.4	12	0.2
SG- 14	1	120	1100
SG- 15	<0.02	<0.2	3
SG- 16	<0.01	<0.09	1
SG- 17	<0.01	<0.09	21
SG- 18	<0.02	<0.2	0.3
SG- 19	<0.02	<0.2	0.8
SG- 20	<0.02	<0.2	<0.004
SG- 21	<0.02	<0.2	2
SG- 22	<0.01	<0.09	1
SG- 23	<0.01	0.5	4
SG- 24	<0.02	0.6	31

(1) Analytical results preceeded by "<" indicate "Not Detected" at the detection limit shown.

(2) All soil gas samples collected at 4 feet below ground surface.

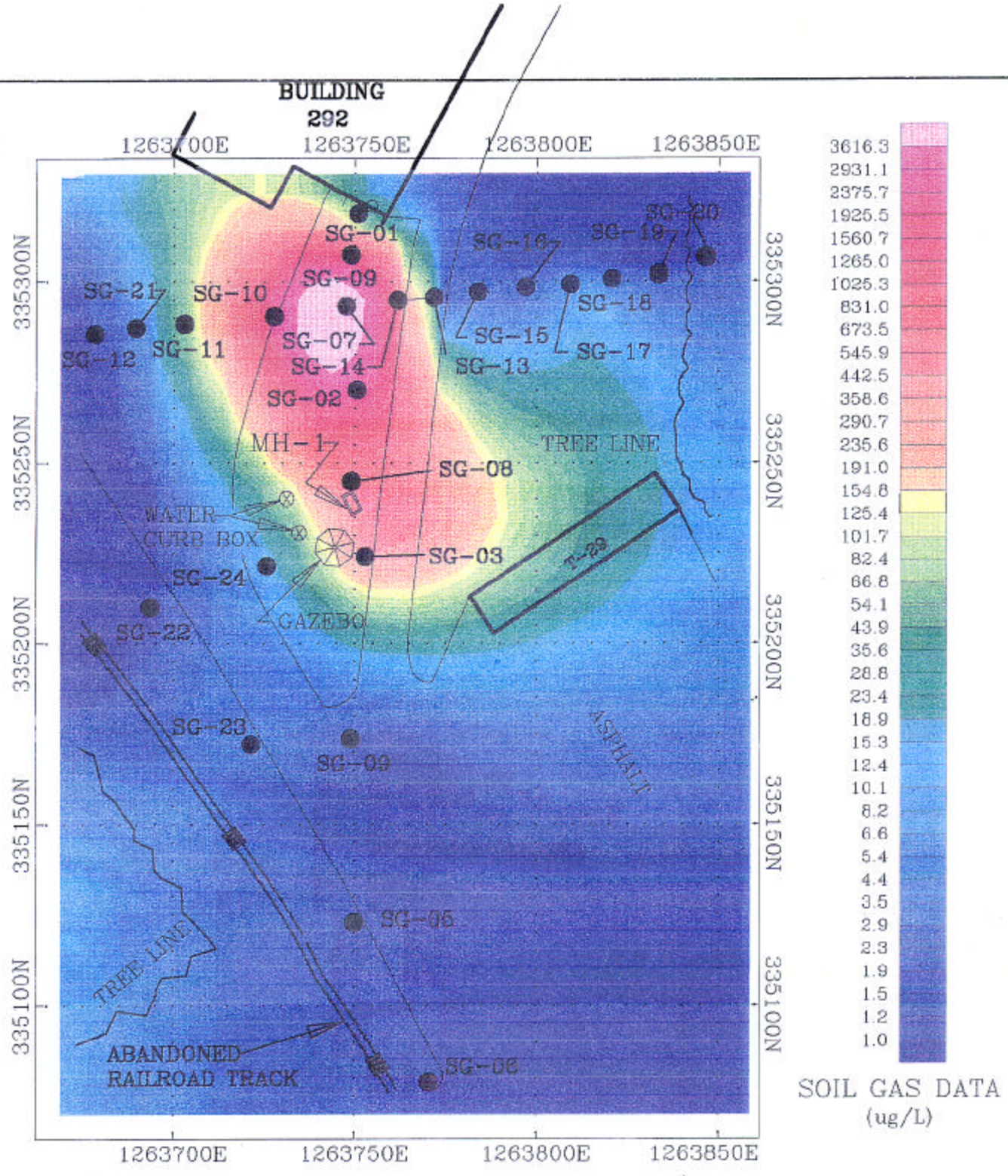
(3) Duplicate Sample



TCE SOIL GAS RESULTS
LDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER,
INDIAN HEAD, MARYLAND

FIGURE 3-1

Brown & Root Environmental



TCE SOIL GAS CONTOURS

BUILDING 292, FORMER DRUM LOADING AREA

NAVAL SURFACE WARFARE CENTER, INDIAN HEAD, MD

25 0 25 50
(feet)

N

FIGURE 3-2

Brown & Root Environmental

TABLE 3-2

SOIL ANALYTICAL DATA
SEPTEMBER 26 AND 27, 1995
BUILDING 292, FORMER DRUM STORAGE AREA
INDIAN HEAD, MARYLAND

Sample Number	SO-01-2/4	SO-05-10/12	SO-06-2/4	SO-07-2/4	SO-08-10/12	SO-09-2/4	SO-10-10/12	SO-12-2/4	SO-13-10/12
Corresponding Soil-Gas Sample	(SG-06)	(SG-06)	(SG-06)	(SG-02)	(SG-02)	(SG-07)	(SG-07)	(SG-10)	(SG-10)
Depth Below Grade (Feet)	(2 to 4)	(10 to 12)	(2 to 4)	(2 to 4)	(10 to 12)	(2 to 4)	(10 to 12)	(2 to 4)	(10 to 12)
Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
CHLOROMETHANE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
BROMOMETHANE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
VINYL CHLORIDE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
CHLOROETHANE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
METHYLENE CHLORIDE	9 B	4 B	4 B	8 B	3 B	7 B	4 B	4 B	8 B
ACETONE	160 J	99 J	150 J	85 J	82 J	34 B	12 U	12 B	16 B
CARBON DISULFIDE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
1,1-DICHLOROETHENE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
1,1-DICHLOROETHANE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
1,2-DICHLOROETHENE (TOTAL)	18	12 U	14	37,000	11 U	36	15	10 J	12 U
CHLOROFORM	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
1,2-DICHLOROETHANE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
2-BUTANONE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
1,1,1-TRICHLOROETHANE	12 U	12 U	12 U	12 UJ	11 U	10	4 J	5 J	12 U
CARBON TETRACHLORIDE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
BROMODICHLOROMETHANE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
1,2-DICHLOROPROPANE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
CIS-1,3-DICHLOROPROPENE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
TRICHLOROETHENE	140	3 J	220	840,000	4 J	9,300 J	150	120	12 U
DIBROMOCHLOROMETHANE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
1,1,2-TRICHLOROETHANE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
BENZENE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
TRANS-1,3-DICHLOROPROPENE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
BROMOFORM	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
4-METHYL-2-PENTANONE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
2-HEXANONE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
TETRACHLOROETHENE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
1,1,2,2-TETRACHLOROETHANE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
TOLUENE	5 B	4 B	3 B	4 B	3 B	13 B	6 B	6 B	24 B
CHLOROBENZENE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
ETHYLBENZENE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
STYRENE	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U
XYLENE (TOTAL)	12 U	12 U	12 U	12 UJ	11 U	12 U	12 U	11 U	12 U

Data Validation Qualifers: U = Value is a nondetect as reported by the laboratory.
B = Positive result is considered to be an artifact of blank contamination, and should not be considered present.
J = Positive result is considered to be estimated based on various technical reasons (i.e., holding time exceedence, continuing calibration High MS/MSD %R and RPD, noncompliant internal standard areas, or values d>50%, less than the CRQL).
UL = Nondetected result is considered to be biased low as a result of low surrogate %R.
UJ = Nondetected result is considered to be estimated as a result of noncompliant internal standard areas. No bias can be determined.

Two soil samples were collected at each of the three soil-gas sample locations (SG-02, -07 and -10) exhibiting the highest TCE concentrations. The fourth soil sample was collected at SG-06, the soil sample exhibiting the lowest soil-gas TCE concentration along the north-south axis as explained in Section 2.0.

As Table 3-2 shows, data validators determined that detections of methylene chloride and toluene were artifacts of blank contamination and should not be viewed as indicating the presence of those compounds. The same is true for acetone in samples SO-09-2/4, SO-12-2/4, and SO-13-10/12.

TCE was the compound most consistently detected in soil. Only SO-13-10/12 indicated a nondetect for TCE. The highest TCE concentrations were found in SO-07-2/4 (collected at SG-02) at 840,000 μg/kg and SO-09-2/4 (collected at SG-07) at 9,300 μg/kg. SO-07-2/4 additionally exhibited a 1,2-dichloroethene (Total) concentration of 3,700 μg/kg. As shown on the table, other contaminants were also detected, but at lower concentrations.

3.3 GROUNDWATER AND STORM-WATER SAMPLE ANALYTICAL RESULTS

The validated analytical results for the groundwater and storm-water samples are shown in Table 3-3. As described in Section 3.3 for soil samples, groundwater sample locations are designated based on the "corresponding" soil-gas sample locations, which appear in Table 3-3. Section 2.2.3 described the determination of groundwater sample collection locations based on soil-gas results. Storm-water samples were collected from MH-1 as required by the AFSP and described in Section 2.2.4.

Table 3-3 identified instances of blank contamination in the groundwater and surface water samples. None of the compounds methylene chloride, acetone, carbon disulfide, benzene, or toluene should be viewed as contained in any of the samples, since all concentrations were either nondetect or the result of blank contamination. In sample SW-01-04 1,1,1-trichloroethane was also determined to be an artifact of blank contamination.

As with the soil samples, the most consistently detected compound in the groundwater and surface-water samples was TCE. It was detected in all water samples, but at a much higher concentration in GW-11-11 (370,000 μg/L), which was collected at SG-07, the location exhibiting the highest TCE soil gas concentration. GW-11-11 was generally the most contaminated of the two groundwater samples. In addition to TCE, it also contained vinyl chloride at 2,000 μg/L and 1,2-dichloroethane at 52,000 μg/L. Of the two storm water samples, the sample collected from the uppermost pipe in MH-1 (SW-01-04) exhibited the

TABLE 3-3

GROUNDWATER AND STORM-WATER ANALYTICAL DATA
BUILDING 292, FORMER DRUM STORAGE AREA
INDIAN HEAD, MARYLAND

Sample Number	GW-11-11	GW-14-13	SW-01-04	SW-02-09
Corresponding Soil-Gas Sample	(SG-07)	(SG-05)	(MH #1)	(MH #1)
Depth Below Grade (Feet)	(11)	(13)	N/A	N/A
Units	ug/L	ug/L	ug/L	ug/L
CHLOROMETHANE	10 U	10 UL	10 U	10 U
BROMOMETHANE	10 U	10 UL	10 U	10 U
VINYL CHLORIDE	2,000	10 UL	10 U	10 U
CHLOROETHANE	6 J	10 UL	10 U	10 U
METHYLENE CHLORIDE	2 B	2 B	2 B	2 B
ACETONE	28 B	10 UJ	6 B	5 B
CARBON DISULFIDE	9 B	5 B	10 U	10 U
1,1-DICHLOROETHENE	140	10 UL	10 U	10 U
1,1-DICHLOROETHANE	65	10 UL	10 U	10 U
1,2-DICHLOROETHENE (TOTAL)	52,000	10 UL	7 J	10 U
CHLOROFORM	10 U	10 UL	10 U	10 U
1,2-DICHLOROETHANE	5 J	10 UL	10 U	10 U
2-BUTANONE	10 U	10 UL	10 U	10 U
1,1,1-TRICHLOROETHANE	260 J	10 UL	2 B	10 U
CARBON TETRACHLORIDE	10 UJ	10 UL	10 U	10 U
BROMODICHLOROMETHANE	10 UJ	10 UL	10 U	10 U
1,2-DICHLOROPROPANE	10 UJ	10 UL	10 U	10 U
CIS-1,3-DICHLOROPROPENE	10 UJ	10 UL	10 U	10 U
TRICHLOROETHENE	370,000	3 J	39	2 J
DIBROMOCHLOROMETHANE	10 UJ	10 UL	10 U	10 U
1,1,2-TRICHLOROETHANE	108 J	10 UL	10 U	10 U
BENZENE	2 B	10 UL	10 U	10 U
TRANS-1,3-DICHLOROPROPENE	10 UJ	10 UL	10 U	10 U
BROMOFORM	10 UJ	10 UL	10 U	10 U
4-METHYL-2-PENTANONE	10 U	10 UL	10 U	10 U
2-HEXANONE	10 U	10 UL	10 U	10 U
TETRACHLOROETHENE	61	10 UL	10 U	10 U
1,1,2,2-TETRACHLOROETHANE	10 U	10 UL	10 U	10 U
TOLUENE	9 B	10 UL	10 U	10 U
CHLOROBENZENE	10 U	10 UL	10 U	10 U
ETHYLBENZENE	10 U	10 UL	10 U	10 U
STYRENE	10 U	10 UL	10 U	10 U
XYLENE (TOTAL)	10 U	10 UL	10 U	10 U

Data Validation Qualifers: U = Value is a nondetect as reported by the laboratory.
B = Positive result is considered to be an artifact of blank contamination, and should not be considered present.
J = Positive result is considered to be estimated based on various technical reasons (i.e., holding time exceedence, continuing calibration D>50%, High MS/MSD %R and RPD, noncompliant internal standard areas, or values less than the CRQL).
UL = Nondetected result is considered to be biased low as a result of low surrogate %R.

UJ = Nondetected result is considered to be estimated as a result of noncompliant internal standard areas. No bias can be determined.

highest concentration of TCE (39 μg/L). Other contaminants were found in the groundwater and storm-water samples, but at lower concentrations.

4.0 DATA ASSESSMENT

Although a human health and environmental risk assessment is beyond the scope of this document, it is possible to assess the analytical data by comparing the results to several pertinent contaminant concentration limits presented in environmental regulations and guidelines. Those used for comparative purposes in this document are presented and discussed in the Appendix. Although the Appendix addresses the range of analytes included among the TCL volatile compounds, the discussions and tables within this section focus specifically on compounds detected during the analysis of samples collected during this effort.

The data assessment discussions which follow address soil, groundwater, and storm water. Soil gas is not assessed in this section beyond the discussions present previously in Sections 2.2.1 and 3.2 because soil gas results are chiefly of value as an indicator of the presence of, and the extent of, subsurface contamination. Soil-gas results are not applicable to risk assessments and are not comparable to regulatory requirements/guidelines.

4.1 SOIL DATA

Table 4-1 displays the soil data, but limits the presentation to detected soil contaminants. Figure 4-1 illustrates the locations that were the sources of the detected concentrations. Because the soil sample collection points were so close to the soil-gas sampling points as to be essentially the same locations, Figure 4-1 shows the soil analytical results in the same locations as used on Figure 3-2 for the "corresponding" soil-gas samples. The Regulatory Criteria and Guidance values shown in Table 4-1 are taken from the Appendix and consist of Risk Based Concentrations (RBCs) and Soil Screening Levels (SSLs) published by U.S. EPA Region III (EPA, 1995) for the contaminants detected in the soil samples. A comparison of the two tables shows that, of the detected contaminants included among the RBCs and SSLs, only TCE exceeds the published concentrations; that is, none of the detected concentrations for acetone, 1,2-dichloroethene (total), or 1,1,1-trichloroethane exceed the regulatory values listed in Table 4-1.

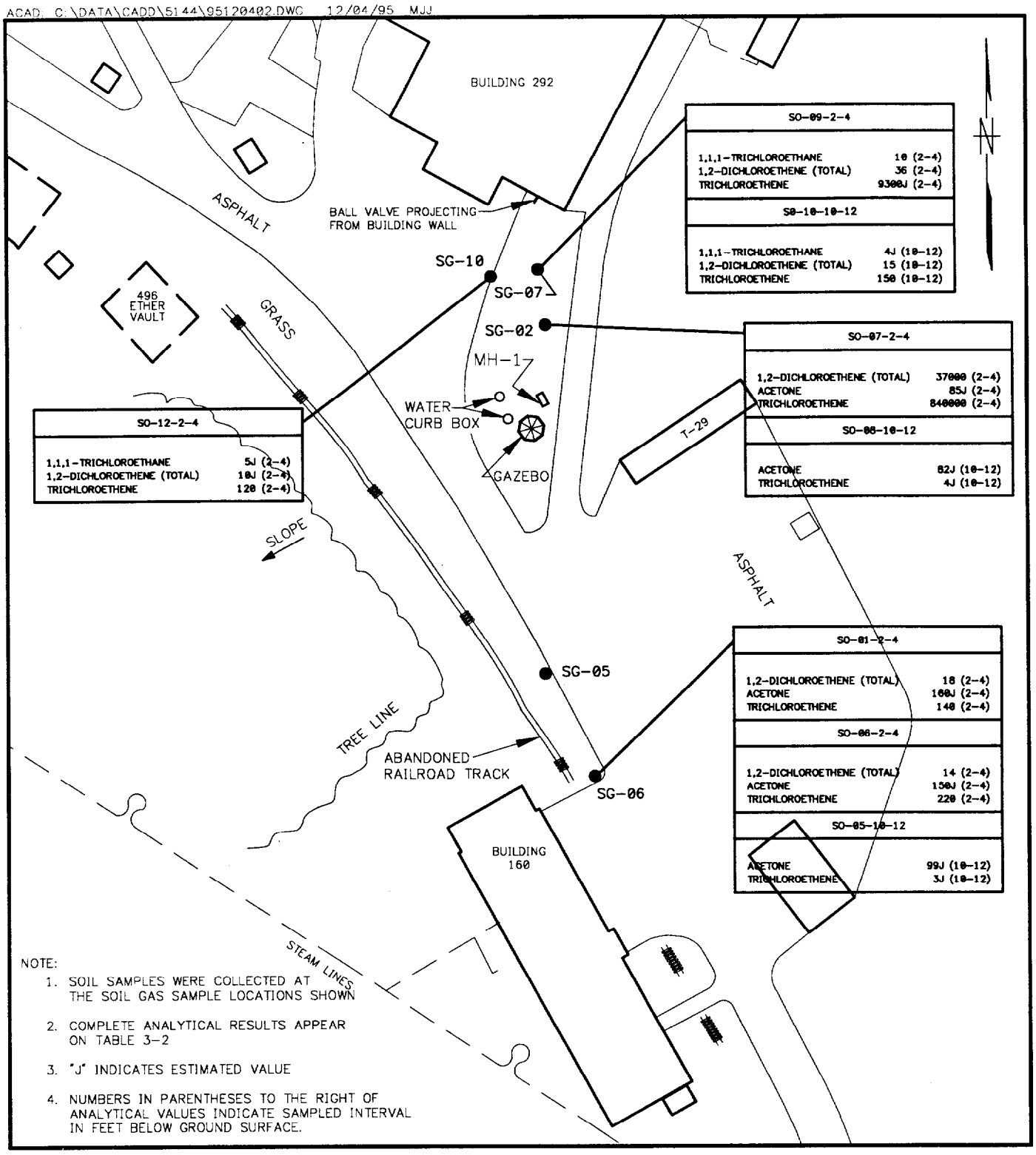
The most stringent TCE regulatory concentration in Table 4-1 is 20 μg/kg. That value is an EPA Region III Soil Screening Level (SSL) for concentrations in soil that may result in sufficient contaminant migration to groundwater as to be of concern regarding the consequent concentration in groundwater. The 20 μg/kg concentration is exceeded by a single deep soil sample, sample SO-10-10/12 (150 μg/kg), which was collected at SG-07, the location exhibiting the greatest TCE concentration in soil gas (9,600 μg/L) and the

TABLE 4-1

SOIL ANALYTICAL RESULTS AND REGULATORY CRITERIA AND GUIDANCE
BUILDING 292, FORMER DRUM STORAGE AREA
INDIAN HEAD, MARYLAND

SOIL ANALYTICAL RESULTS										REGULATORY CRITERIA AND GUIDANCE			
Sample Number	SO-01-2/4	SO-05-10/12	SO-06-2/4	SO-07-2/4	SO-08-10/12	SO-09-2/4	SO-10-10/12	SO-12-2/4	SO-13-10/12	U.S. EPA Region III (2)			
Corresponding Soil-Gas Sample	(SG-06)	(SG-06)	(SG-06)	(SG-02)	(SG-02)	(SG-07)	(SG-07)	(SG-10)	(SG-10)	Risk Based Concentrations (RBCs)		Soil Screening Levels - Transfers from Soil to:	
										Soil Ingestion			
Depth Below Grade (Feet)	(2 to 4)	(10 to 12)	(2 to 4)	(2 to 4)	(10 to 12)	(2 to 4)	(10 to 12)	(2 to 4)	(10 to 12)	Residential	Industrial	Air	Groundwater
Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
ACETONE	160 J	99 J	150 J	85 J	82 J	B	ND	B	B	7,800,000	200,000,000	62,000,000	8,000
1,2-DICHLOROETHENE (TOTAL)	18	ND	14	37,000	ND	36	15	10 J	ND	700,000	18,000,000		
1,1,1-TRICHLOROETHANE	ND (1)	ND	ND	ND	ND	10	4 J	5 J	ND	7,000,000	180,000,000	980,000	900
TRICHLOROETHENE	140	3 J	220	840,000	4 J	9,300 J	150	120	ND	58,000	520,000	3,000	20

(1) ND = Not Detected
(2) US EPA Region III, 1995, Communication from Roy L. Smith, Senior Toxicologist, to RBC Table Mailing List.
(3) B = Positive result is considered to be an artifact of blank contamination, and should not be considered present.
NOTE: Shaded Soil Analytical Results exceed one or more Regulatory Criteria and Guidance values.



DETECTED SOIL CONTAMINANTS (ug/kg)
BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER,
INDIAN HEAD, MARYLAND

0 50 100
SCALE IN FEET

FIGURE 4-1

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second highest in soil (9,300 μg/kg). The 20 μg/kg TCE concentration is exceeded by all shallow soil samples. This includes SO-01-2/4 (140 μg/kg) and SO-06-2/4 (220 μg/kg), duplicate samples collected from location SG-06, which was the soil-gas sample exhibiting the lowest concentration (0.01 μg/L) along the north-south axis.

The SSL for TCE, which may be of concern in connection with the inhalation of volatiles, is 3,000 μg/kg. That concentration is exceeded by the shallow soil samples collected at SG-02 (840,000 μg/kg) and SG-07 (9300 μg/kg), sampling locations separated by approximately 25 feet.

One sample, SO-07-2/4, exhibited a TCE concentration in excess of the EPA Risk-Based Concentrations (RBCs) in Table 4-1. None of the other soil samples exceed the RBCs, including SO-09-2/4, which is located approximately 25 feet downgradient from SO-07-2/4.

Data from the deeper soil samples (10 to 12 feet below ground surface) indicate that TCE contamination in deeper soil may be very localized. The TCE concentration in the deep soil sample collected at SG-07 (SO-10-10/12) exceeded the SSL, but the SSL concentration was not exceeded by the deep samples from SG-02 (SG-08-10/12) and SG-10 (SO-13-10/12), which are located approximately 25 and 20 feet, respectively, from SG-07. This indicates that deep soil with TCE concentrations exceeding the SSLs may be limited to a radius of less than 25 feet from SG-07.

TCE concentrations for shallow soil present a less clear picture. Evaluating shallow soil TCE contamination solely on the basis of the most stringent SSL, which is based on a groundwater protection scenario, may be inappropriate. Although the data set is small, all the soil samples indicate a pattern of less TCE contamination in the deeper soil. Furthermore, with the exception of location SG-07, the deep soil TCE concentrations are consistently below the SSL for groundwater protection.

Because the shallow soil TCE concentrations are consistently higher than the groundwater protection SSL, the potential migration of TCE to the deeper soil may simply be occurring at a very slow rate. TCE use at Building 292 commenced in the mid-1960s and ended in 1989. The current analytical evidence indicates that TCE contamination has not migrated to the deeper soil (again, with the exception of SG-07) at a rapid rate.

The "air protection" SSL of 3,000 μg/kg, although exceeded by two soil samples (SO-07-2/4 at 840 mg/kg and SO-09-2/4 at 9.3 mg/kg), may also be an inappropriate measure of the degree of concern assignable to the contamination detected in the soil within the study area. The most shallow of the soil samples were

collected from a 2- to 4-foot-deep soil interval. At that depth, the sampled soil is not likely to readily emit significant quantities volatiles to the air. Two considerations make it difficult to dismiss the air consideration entirely. First, no actual surface soil samples were collected, and it should be considered that the "near" surface soil samples may be representative of surface soil contaminant concentrations. Second, should soil excavation be necessary within the study area at a future date, the contaminated soil may be exposed and volatiles released. Similar considerations apply regarding comparison of soil contamination to the RBCs shown in Table 4-1.

4.2 GROUNDWATER CONTAMINATION

Table 4-2 displays the groundwater and storm-water data for Site 57, but limits the presentation to detected contaminants. Figure 4-2 illustrates the locations which served as the sources of the detected groundwater and storm-water contaminant concentrations. As with Figure 4-1, Figure 4-2 shows the water analytical results in the same location as used in Figure 3-2 for the "corresponding" soil gas sample. Table 4-2 also displays regulatory criteria and guidance values taken from the Appendix, including RBCs and SSLs published by EPA Region III, as well as US EPA Ambient Water Quality Criteria (AWQC), National Primary Drinking Water Standards Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs), and State of Maryland MCLs for contaminants detected in the groundwater and storm water samples. An examination of Table 4-2 shows that, of the two groundwater samples collected, sample GW-11-11, which was collected at SG-07, is notably more contaminated than GW-14-13, which was collected at SG-05, a location of very low soil-gas concentration (see Section 2.2.3).

Of the contaminants detected in GW-11-11 for which values are shown in Table 4-2, only chloroethane and 1,1-dichloroethane are below the regulatory values. At 260 μg/L in GW-11-11, 1,1,1-trichloroethane does not exceed either the RBC or the AWQC, but it does exceed the Federal MCL and MCLG as well as the State of Maryland MCL, all of which are set at 200 μg/L. Other detected contaminants all exceed the regulatory values, especially TCE, with a concentration of 370,000 μg/L.

The only detection in GW-14-13 consists of 3 μg/L of TCE. None of the other contaminants detected in GW-11-11 were found in GW-14-13. The 3 μg/L TCE concentration exceeds values for the RBC, the AWQC and the National Primary Drinking Water Standards MCLG, but not the Federal or State MCLs.

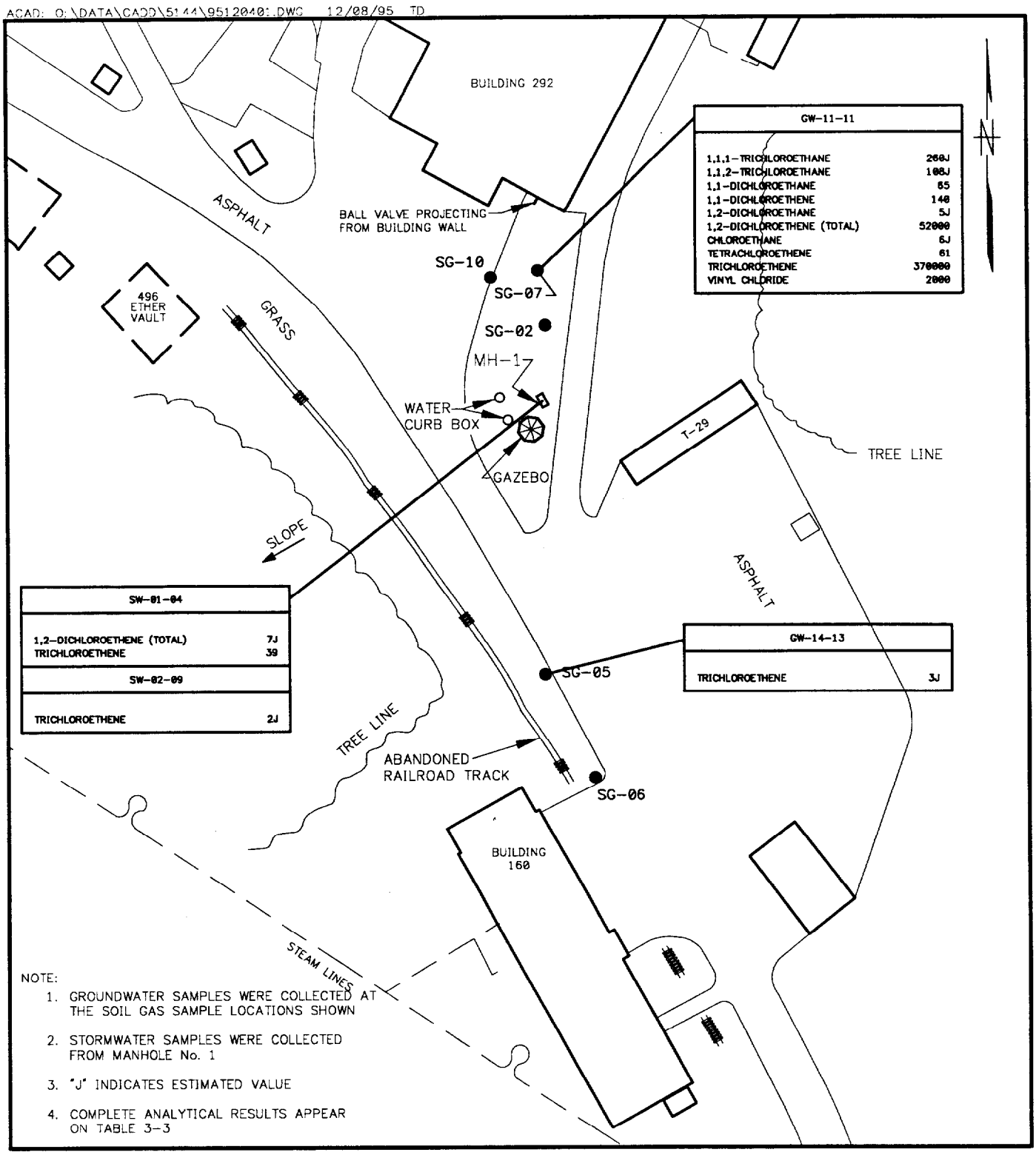
Based solely on the two groundwater samples collected, the extent of groundwater contaminant migration may to be limited to within or near the study area.

TABLE 4-2

GROUNDWATER AND STORM WATER ANALYTICAL RESULTS AND REGULATORY CRITERIA AND GUIDANCE
BUILDING 292, FORMER DRUM STORAGE AREA
INDIAN HEAD, MARYLAND

GROUNDWATER AND STORM WATER ANALYTICAL RESULTS					REGULATORY CRITERIA AND GUIDANCE						
Sample Number	GW-11-11	GW-14-13	SW-01-04	SW-02-09	U.S. EPA Region III (2)	EPA - Ambient	National Primary Drinking Water Standard				State of Maryland
Corresponding Soil Gas Sample	SG-07	SG-05	MH #1	MH #1	Risk-Based Concentrations (RBCs)	Water Quanity Criteria (3)	Maximum Contaminant		Maximum Contaminant Level		Maximum Contaminant
Depth Below Grade (Feet)	11	13	N/A (1)	N/A	Tap Water	(AWQCs)	Level (MCL) (4)		Goal (MCLG) (5)		Level (MCL) (6)
Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	Status	ug/L	Status	ug/L
VINYL CHLORIDE	2,000	ND (7)	ND	ND	0.019						2
CHLOROETHANE	6	ND	ND	ND	8,600						
1,1-DICHLOROETHENE	140	ND	ND	ND	0.044	0.057	7	F (8)	7	F	7
1,1-DICHLOROETHANE	65	ND	ND	ND	810						
1,2-DICHLOROETHENE (TOTAL)	52,000	ND	7	ND	55		70	F	70	F	
1,2-DICHLOROETHANE	5	ND	ND	ND	0.12						5
1,1,1-TRICHLOROETHANE	260	ND	B	ND	1300	3100	200	F	200	F	200
TRICHLOROETHENE	370,000	3	39	2	1.6	2.7	5	F	0	F	5
1,1,2-TRICHLOROETHANE	108	ND	ND	ND	0.19	0.6					5
TETRACHLOROETHENE	61	ND	ND	ND	1.1	0.8	5	F	0	F	5

(1) N/A = Not Applicable. Sample collected in a manhole.
(2) US EPA Region III, 1995, Communication from Roy L. Smith, Senior Toxicologist, to RBC Table Mailing List.
(3) 40 CFR 131.36
(4) 40 CFR 141.61
(5) 40 CFR 141.50
(6) COMAR 26.04.01.07
(7) ND = Not Detected
(8) F = Final
(9) B = Positive result is considered to be an artifact of blank contamination, and should not be considered present.
NOTE: Shaded Groundwater and Storm Water Analytical Results exceed one or more Regulatory Criteria and Guidance values.



DETECTED GROUNDWATER AND STORMWATER CONTAMINANTS (µg/L)
BUILDING 292, FORMER DRUM LOADING AREA
NAVAL SURFACE WARFARE CENTER, INDIAN HEAD, MARYLAND

0 50 100
SCALE IN FEET

FIGURE 4-2

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4.3 STORM-WATER CONTAMINATION

Table 4-2 also applies to the storm-water samples collected from MH-1. The difference between the two storm-water samples is the detection of 1,2-dichloroethene (total) at 7 μg/L in SW-01-04, the upper of the two pipes sampled. That sample also contained 39 μg/L of TCE, a concentration that exceeded all of the regulatory values in Table 4-2. The TCE detected in SW-02-09 (from the lower pipe) was 2 μg/L, which exceeds the RBC and the Federal MCLG. At this writing, no information was available regarding the upstream routing of the sampled pipes. The detected contaminants may be the result of infiltration occurring within the study area, or they may have originated at a source upstream of the study area.

4.4 DATA ASSESSMENT SUMMARY

TCE contamination is present in the study area soil. At the 10- to 12-foot depth, TCE contamination appears very localized near the area of SG-07. Current data indicate that the deeper contamination may be limited to within a 25-foot radius of SG-07. Shallow, 2- to 4-foot deep soils show evidence of contamination over a wider area, possibly extending to SG-06 (approximately 240 feet south of Building 292 along the north-south axis). However, the east-west dimension of the contaminated soil area is less certain based on the available data; that is, only soil-gas data are available for that purpose.

The extent of TCE contamination in soil (and groundwater) may not be accurately represented by the soil-gas results shown on Figure 3-2 for two reasons. First, there is not a strong correlation between the soil-gas data and the analytical data from the soil samples. Second, the shapes of the contours are dictated, to a large degree, by the pattern of the soil-gas sampling, and that pattern was selected somewhat subjectively. At issue is the direction of the north-south axis. In particular, the direction of the axis was set based on visual observation of the local surface topography and on the assumption that the groundwater downgradient direction coincided with the topographic down-slope direction. However, the true local groundwater flow direction may vary from the topographic down-slope direction, and the axis of the groundwater contaminant plume will more closely follow the groundwater flow direction. Thus, an axis selected on the basis of topography may not coincide with the contaminant plume's axis.

The 20 μg/kg SSL for protection of groundwater is key to determining the size of the area requiring soil remediation. As an example, the next most stringent regulatory TCE value in Table 4-1 is 3,000 μg/kg for soil concentrations protective of air. Based on the existing data and applying the SSL of 3,000 μg/kg, the shallow soils at only SG-02 and SG-07 would be in need of remediation.

As discussed in Section 4.2, the available data tend to support a view that the TCE migration from shallow soil to groundwater occurs at a relatively slow rate. Thus a higher TCE concentration in soil may be permitted while retaining groundwater protectiveness. Site-specific data regarding TCE leachability, soil permeability, and total organic carbon in the soil would allow a site-specific determination of the concentration of TCE in soil that will maintain protection of groundwater. Higher values would indicate that a smaller area of shallow soil requires remediation to meet the groundwater protection objective.

Analysis of the two groundwater samples collected verify the presence of TCE in the groundwater. However, sample analyses further indicate the possibility that groundwater contamination requiring remediation (as determined by comparison with the MCLs for the National Primary Drinking Water Standards and the State of Maryland) is not widespread. For instance, comparing GW-14-13 with the MCLs, the groundwater TCE plume may not extend beyond SG-05.

Storm-water samples show the presence of TCE, but the potential source of the TCE in the storm water is in question. Previous storm-water system sampling conducted in an effort to identify the source of TCE in IW-80 (located approximately 1,000 feet downgradient from Building 292) found no TCE present in the upstream storm-water collection system. The source of TCE found in MH-1 may be groundwater infiltration either directly into the manhole or via open joints in the pipes discharging into the manhole.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The results of the field investigation conducted in the study area confirm the presence of TCE in soil and groundwater. A comparison of the analytical data with published guidelines and regulatory contaminant limits indicates the potential need for remediating TCE in the soil and groundwater subject to verification via a site-specific risk assessment. Although the limited data base meets the needs of the immediate objective, the possible need for initiating a remedial action within the study area causes several questions to arise. The questions (i.e., data gaps) center on site-specific verification of the need for remediation, the cleanup criteria to be applied, the extent of the contamination in environmental media, and the determination of the engineering properties affecting the selection of a remedial approach. This section discusses those items and recommends steps to provide the answers.

5.1 THE NEED FOR REMEDIATION

Although the data comparisons described in earlier sections indicate the possible need for remedial activity, that need has not been demonstrated on a site-specific basis. In particular, a human health and environmental risk assessment would verify the need for remediation and would define the risk scenarios which then provide a framework for determining "acceptable" contaminant concentrations in environmental media (i.e., cleanup goals). The following questions relate to a site-specific determination that remediation is necessary.

a. What are the human health and environmental risks presented by contaminated soil and groundwater?

   The development of a conceptual model which defines site-specific source/path/receptor relationships will establish a framework for risk assessment scenarios. A health and environmental risk assessment will further define the risk scenarios appropriate for this specific site and verify the need for remediating environmental media.

b. What is the level of contamination in surface soil?

   Surface soil samples collected from the area of apparent maximum contamination (SO-07) would provide data for an assessment of risks connected with direct contact exposure routes.

c. What is the site-specific potential for TCE to migrate to the groundwater?

The model used to develop the Region III RBCs should be rerun using more site-specific parameters to improve the model's applicability to the study area. The viability of the model's results will increase to the extent that the input parameters are more site-specific. The parameters may include estimated rainfall, overburden permeability, vertical contaminant concentration profile in the overburden, ability of the contaminants to leach from the overburden soil, and depth to groundwater, as well as aquifer thickness, conductivity, and flow.

5.2 CLEANUP CRITERIA

The guidelines (i.e., RBCs and SSLs) that served as the basis for evaluating the site-related data are designed to be conservative approximations and are each based on of a set of assumed site conditions and exposure scenarios. Although they serve the purpose of an initial "first cut", site-specific conditions should be accounted for in the development of a more definitive evaluation. The following questions relate to a more definitive evaluation of site conditions.

a. What site-specific cleanup criteria might be applied to soil and groundwater?

Scenarios developed as part of the risk assessment effort will serve the development of site-specific cleanup criteria.

b. How high can the TCE concentration in soil be while still being protective of the groundwater?

The contaminant migration model mentioned in Section 5.1 will serve the development of potential cleanup criteria based on the protection of groundwater.

5.3 EXTENT OF CONTAMINATION

A determination of how much of the environmental media requires remediation, as well as the reasonable evaluation of potential remedial approaches, requires an understanding of the horizontal and vertical limits of the contaminated media. The following questions relate to an understanding of the extent of contamination.

a. What is the vertical profile of contamination in the soil?

A vertical profile of soil contamination will serve the development of a contaminant migration model mentioned in Section 5.1, and coupled with cleanup criteria, will allow a reasonably accurate estimate of the volume of soil requiring remediation. Additional field sampling will be necessary to define the vertical contamination profile.

b. What is the horizontal extent of soil TCE contamination?

The accuracy of the estimated area and volume of soil requiring remediation will improve to the extent that additional field sampling is implemented to expand the data base.

c. What is the horizontal extent of groundwater contamination?

The horizontal extent of groundwater contamination is important to the development of potential remedial actions. Improving the definition of the horizontal extent of groundwater contamination requires the additional installation of permanent or temporary wells for the collection of groundwater samples.

d. What is the direction of groundwater flow?

The groundwater flow direction is important to an assessment of the degree to which available data define the contaminant plume and to the development of potential remedial actions. This effort requires the installation of at least three monitoring wells to define the flow direction. Permanent wells may later serve to monitor the success of remediation efforts.

e. What is the source of contamination in the storm-water?

Existing facility utility drawings, onsite investigation, and other techniques (dye testing, for example) need to be pursued to identify the source of the contamination in the storm water. Additional efforts for mitigating storm-water contamination may be defined once the contaminant source has been identified.

5.4 ENGINEERING PROPERTIES

The evaluation of potential remedial technologies for remediation of contaminated media requires an understanding of the media properties affecting the applicability of the potential technologies. The following questions relate to pertinent properties of the contaminated media.

a. What are the engineering properties of the subsurface soil?

   Properties such as permeability, total organic carbon content, grain-size distribution, lithology, etc., have a role in the assessment of various technologies that may be applied for remedial purposes. Definition of the properties requires the collection of samples for laboratory testing or collection of data in the field during operations such as well installation, or the conduct of field tests such as slug tests.

b. What are the characteristics of the aquifer?

   Aquifer characteristics such as flow direction, thickness, hydraulic conductivity, the presence of impervious layers, etc., aid in the development of contaminant migration models, defining the extent of contamination, and evaluating potential remedial technologies. The data can be collected during field activities such as well installation or in-field tests.

5.5 RECOMMENDATIONS

For the reasons cited in the preceding sections, the following additional activities are recommended.

a. The development of a conceptual model to define site-specific source/path/recepter relationships.

b. The installation of at least three monitoring wells. These wells will offer the opportunity to develop a vertical soil contaminant profile, establish the groundwater flow direction, collect additional groundwater samples, define the subsurface lithology, and define several aquifer characteristics.

c. The consideration of installing of temporary monitoring wells to better define the extent of groundwater contamination.

d. The collection of surface soil samples for risk assessment purposes and to improve the definition of the extent of contamination.

e. The determination of the RCRA (Resource Conservation and Recovery Act) characteristics of the soil for possible use in evaluating disposal options.

f. The performance of slug tests to determine the aquifer's conductivity.

g. The development of a human health and environmental risk assessment to verify the risk-based need to remediate the soil and/or groundwater.

h. The performance of a storm sewer evaluation to include the investigation of the physical condition of storm sewers discharging to MH-1 utilizing a television camera to view the internal condition of pipes, and the investigation of the sources of flow into MH-1 utilizing dye testing or other technique to verify the connection of sources originating inside or near Building 292.

i. The performance of a treatability study to evaluate the effectiveness of vapor extraction for the insitu treatment of contaminated soil and groundwater.

REFERENCES

HNUS (Halliburton NUS Environmental Corporation), 1995, Abbreviated Field Sampling Plan for Subsurface Investigation, Former Drum Loading Area, Building 292, Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland.

Master Shore Station Development Plan, 1991, Part IV, Section 6, Area Development Plan, Area 12 - Utilities, Sanitary Sewerage and Storm Drainage Systems, Sheet 12 of 16, drawing No. 670,579, revised 11/1/91.

EPA (U.S. Environmental Protection Agency), 1995, Distribution Memorandum, Risk-Based Concentration Table - July - December 1995, USEPA, Region III, Roy L. Smith, Ph.D., Senior Toxicologist, October 20.

APPENDIX - REGULATORY/GUIDANCE CONTAMINANT LIMITS

This Appendix presents published media-specific regulatory and guidance contaminant concentration limits for Target Compound List (TCL) volatile organic compound (VOC) contaminants of potential concern. These criteria can be used to "screen" analytical data for the purpose of determining the potential for adverse health and environmental effects resulting from contaminants detected in the environmental media samples collected from the study area.

Table A-1 presents the chemical-specific values for each of several regulation/guidance documents. The following paragraphs offer a brief description of each of the items included in the table.

Risk-Based Concentrations (RBCs) for the consumption of tap water were calculated based on the assumption that water is to be ingested at a rate of 2 liters per day (L/day). The RBC value was calculated using a Target Hazard Quotient (THQ) of 1.0 for noncarcinogenic effects and a Target Risk (TR) of $1x10^{-6}$ for carcinogenic effects.

Risk Based Concentrations (RBCs) are presumptive levels that are calculated using certain exposure assumptions for ingestion of contaminated soil. These concentrations are calculated for a Target Hazard Quotient (THQ) of 1.0 for noncarcinogenic effects and a Target Risk (TR) of $1x10^{-6}$ for carcinogenic effects. Table A-1 presents soil ingestion RBCs for industrial and residential exposure scenarios.

Soil Screening Levels (SSLs) are risk-based concentrations in soil which, if exceeded, can represent a level of contamination that may be considered a potential concern. They are available for three exposure pathways: direct ingestion of soil, inhalation of volatiles and fugitive dust, and migration to groundwater. Values for inhalation and migration to groundwater are presented in Table A-1. SSLs for ingestion are not provided, since they are similar to Region III RBCs. Since SSLs are based on residential exposure assumptions only, they are a conservative approach for assessing potential health effects.

EPA Ambient Water Quality Criteria (AWQC) are nonenforceable guidelines that were developed for pollutants in surface waters pursuant to Section 304(a)(l) of the Clean Water Act. Although AWQC are not legally enforceable, they have been used by many states to develop enforceable water quality standards, and within actions driven by the Comprehensive Environmental Restoration and Compensation Liability Act (CERCLA), are considered as potential applicable or relevant and appropriate requirements (ARARs). AWQC are available for the protection of human health from exposure to contaminants in drinking water, as well

TABLE A-1

REGULATORY AND GUIDANCE CONTAMINANT CONCENTRATIONS
BUILDING 292, FORMER DRUM STORAGE AREA
INDIAN HEAD, MARYLAND

	U.S. EPA Region III (1)					EPA - Ambient Water Quality Criteria (2) (AWQCs)	National Primary Drinking Water Standard				State of Maryland
	Risk-Based Concentrations (RBCs)			Soil Screening Levels - Transfers from Soil to:			Maximum Concentration Level (MCL) (3)		Maximum Concentration Level Goal (MCLG) (4)		Maximum Concentration Level (MCL) (5)
	Tap Water	Soil Ingestion									
		Residential	Industrial	Air	Groundwater						
	ug/L	mg/kg	mg/kg	mg/kg	mg/kg	ug/L	ug/L	Status	ug/L	Status	ug/L
CHLOROMETHANE	1.4	49	440	0.063	0.0066	5.7					
BROMOMETHANE	8.7	110	2,900	2	0.1	48					
VINYL CHLORIDE	0.019	0.34	3	0.002	0.01	2					2
CHLOROETHANE	8,600	31,000	820,000	2,600	33						
METHYLENE CHLORIDE	4.1	85	760	7	0.01	4.7	5	F	0	F	
ACETONE	3,700	7,800	200,000	62,000	8						
CARBON DISULFIDE	1,000	7,800	200,000	11	14						
1,1-DICHLOROETHENE	0.044	1.1	9.5	0.04	0.03	0.057	7	F	7	F	7
1,1-DICHLOROETHANE	810	7,800	200,000	980	11	0.38					
1,2-DICHLOROETHENE (TOTAL)	55	700	18,000				70	F	70	F	
CHLOROFORM	0.15	100	940	0.2	0.3	5.7	100/80	P	0	P	
1,2-DICHLOROETHANE	0.12	7	63	0.3	0.01						5
2-BUTANONE	1,900	47,000	1,000,000								
1,1,1-TRICHLOROETHANE	1,300	7,000	180,000	980	0.9	3,100	200	F	200	F	200
CARBON TETRACHLORIDE	0.16	4.9	44	0.2	0.03	0.25	5	F	0	F	5
BROMODICHLOROMETHANE	0.17	10	92	1,800	0.3	0.27	100/80	P	0	P	
1,2-DICHLOROPROPANE	0.16	9.4	84	11	0.02	0.52	5	F	0	F	5
CIS-1,3-DICHLOROPROPENE											
TRICHLOROETHENE	1.6	58	520	3	0.02	2.7	5	F	0	F	5
DIBROMOCHLOROMETHANE											
1,1,2-TRICHLOROETHANE	0.19	11	100	0.8	0.01	0.6	5	F	3	F	5
BENZENE	0.36	22	200	0.5	0.02	1.2	5	F	0	F	5
TRANS-1,3-DICHLOROPROPENE											
BROMOFORM	2.4	81	720	46	0.5	4.3					
4-METHYL-2-PENTANONE	2,900	6,300	160,000								
2-HEXANONE											
TETRACHLOROETHENE	1.1	12	110	11	0.04	0.8	5	F	0	F	5
1,1,2,2-TETRACHLOROETHANE	0.052	3.2	29	0.4	0.001	0.17					
TOLUENE	750	16,000	410,000	520	5	6,800	1,000	F	1,000	F	1,000
CHLOROBENZENE	39	1,600	41,000	94	0.6	680	100	F	100	F	100
ETHYLBENZENE	1,300	7,800	200,000			3,100	700	F	700	F	700
STYRENE	1,600	16,000	410,000	1,400	2		100	F	100	F	100
XYLENE (TOTAL)	12,000	160,000	1,000,000	320	74		10,000	F	10,000	F	10,000

(1) U.S. EPA Region III, 1995, Communication from Roy L. Smith, Senior Toxicologist, to RBC Table Mailing List.
(2) 40 CFR 131.36
(3) 40 CFR 141.61
(4) 40 CFR 141.50
(5) COMAR 26.04.01.07
F = Final
P = Proposed

as from ingestion of aquatic biota and the consumption of drinking water. AWQC are also available for the protection of freshwater and saltwater aquatic life. AWQC may be considered for actions that involve groundwater treatment and/or discharges to surface waters. AWQC for the contaminants of concern at the site presented in Table A-1 are protective of human health from exposure to contaminants via ingestion of water as well as aquatic biota.

National Primary Drinking Water Standards were promulgated as a result of The Safe Drinking Water Act (SDWA) and define Maximum Contaminant Levels (MCLs) (40 CFR Part 141). MCLs are enforceable standards (i.e., concentrations) for contaminants in a public drinking water supply system. They consider not only health factors, but also the economic and technical feasibility of removing a contaminant from a water supply system. Under the National Primary Drinking Water Standards, EPA has also proposed Maximum Contaminant Level Goals (MCLGs) for several organic and inorganic compounds in drinking water. MCLGs are nonenforceable guidelines that do not consider the technical feasibility of contaminant removal. Secondary MCLs (40 CFR Part 143) are not enforceable but are intended as guidelines for contaminants that may adversely affect the aesthetic quality of drinking water, such as taste, odor, color, and appearance, and may deter public acceptance of drinking water provided by public water systems. MCLs and MCLGs may be important considerations in connection with remedial actions involving groundwater.

Maryland Water Quality Standards include maximum contaminant levels (MCLs) for organic and inorganic chemicals in public drinking water supplies, which may be appropriate and relevant for groundwater contamination. The Code of Maryland Regulations (COMAR) provides the MCLs for inorganic chemicals in drinking water in Section 26.04.01.07 and the MCLs for organic chemicals in drinking water in Section 26.04.01.07. These state MCLs are presented for the contaminants of potential concern at the site.