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SEMIANNUAL MONITORING REPORT
OPERABLE UNIT NO. 5 – SITE 2

FIRST HALF 1997 (JAN – JUN 97)

MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0367

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DQOs	Data Quality Objectives
ES&E	Environmental Science & Engineering
µg/L	micrograms per liter
MCB	Marine Corps Base
MCLs	maximum contaminant levels
MDL	method detection limit
mg/L	milligrams per liter
NCWQS	North Carolina Water Quality Standards
NFESC	Naval Facilities Engineering Service Center
OU	Operable Unit
PVC	Polyvinyl Chloride
ROD	Record of Decision
SOP	Standard Operating Procedure
TCL	target compound list
TDS	total dissolved solids
TOC	top-of-casing
TSS	total suspended solids
USEPA	U.S. Environmental Protection Agency
VOCs	volatile organic compounds

1.0 INTRODUCTION

The following semiannual monitoring report presents sampling procedures and analytical findings, from monitoring program activities at Operable Unit (OU) No. 5 (Site 2), Marine Corps Base (MCB) Camp Lejeune, North Carolina. This report describes activities completed at Site 2 during the second quarter of calendar year 1997 and presents recommendations concerning the monitoring program.

1.1 Report Organization

This semiannual monitoring report is comprised of four text sections. Section 1.0 describes sampling program procedures and methodology. Section 1.0 also provides groundwater elevation data, groundwater flow direction, and various field observations. Analytical results and findings are presented in Section 2.0. A discussion of previous analytical findings versus the most recent results is also included within Section 2.0. Section 3.0 presents recommendations intended to improve the sampling program at Site 2. Finally, references used during preparation of this report are included in Section 4.0. All tables, figures, and attachments are provided after the text portion of this report.

1.2 Semiannual Sampling Program

The semiannual sampling event commenced on April 24, 1997 and continued through April 26, 1997. The sampling program consisted of groundwater collection and analysis from one intermediate and seven shallow monitoring wells at Site 2. Figure 1-1 depicts the locations of both shallow and intermediate monitoring wells.

Prior to sampling, two newly installed monitoring wells were developed to remove fine-grained material from the well screens and to establish interconnection with the surrounding geologic formation. Well construction records for 02-GW12 and 02-GW03IW are provided in Attachment A. Shallow monitoring well 02-GW12 and intermediate monitoring well 02-GW03IW were installed in the shallow aquifer and developed using a Waterra™ pump. The Waterra™ pump was used to rapidly raise and lower dedicated 1/2-inch polyethylene tubing upon which a check valve and surge block were secured. The combined action of pumping and surging groundwater is meant to dislodge and remove fine particles from the well screen and sand pack. Three to five well volumes were removed from intermediate well 02-GW03IW during development, until the groundwater was essentially sediment free. Shallow monitoring well 02-GW12 could not be sufficiently developed because less than one foot of water was in the well. Measurements of pH, specific conductance, and temperature were recorded periodically to confirm groundwater parameter stabilization. Groundwater measurements compiled during development of 02-GW03IW are provided in Attachment B.

During the sampling event, a low flow purge and sampling technique was employed. The sampling methodology was developed in response to standard operating procedures (SOPs) issued by the U.S. Environmental Protection Agency (USEPA - Region IV, 1996). Prior to groundwater purging, water level and total depth measurements from each monitoring well were recorded. Water level and well depth measurements were used to calculate the volume of water necessary to purge each well. Table 1-1 provides a summary of monitoring well construction details.

A peristaltic pump, with the intake set two to four feet above the bottom of the well was used to purge each of the monitoring wells. While purging groundwater, a flow rate of less than

0.25 gallons per minute was maintained. Groundwater samples were obtained directly from the pump discharge. Dedicated sections of polyethylene and silicon pump-head tubing were used during purge and sampling activities at each monitoring well. A minimum of three well volumes were purged from each monitoring well prior to sampling. Measurements of pH, specific conductance, dissolved oxygen, temperature, and turbidity were recorded to ensure that groundwater characteristics had stabilized before sampling. These measurements were recorded in a field logbook and are provided in Table 1-2.

Groundwater samples were collected to assess whether contamination, detected during previous investigative activities, was present or had migrated to the deeper portion of the surficial aquifer. Based upon previous monitoring results and decision documents, the contaminants of concern were volatile organic compounds (VOCs). Groundwater samples were analyzed for target compound list (TCL) volatile organics and preserved at the time of collection with hydrochloric acid. Table 1-3 provides a summary of requested analyses and groundwater samples submitted during the monitoring event. Groundwater samples were analyzed using USEPA Method 8260, as provided in Table 1-3, and Level III Data Quality Objectives (DQOs). DQO Level III is equivalent to the Naval Facilities Engineering Service Center (NFESC) Level C, as specified in the "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Programs" document. Table 1-4 provides the various analytical method detection limits and comparative state and federal groundwater quality standards.

A trip blank was prepared prior to the sampling event, placed in the sample storage container, and kept with the investigative samples throughout the sampling event. The trip blank was then packaged for shipment with the environmental samples and sent for analysis. The trip blank was used to determine if samples had been cross-contaminated during storage and transportation to the laboratory.

Sample information, such as well number, sample identification, time and date of sample collection, samplers, analytical parameters, and required laboratory turn around time was recorded in a field logbook and on sample labels. Chain-of-custody documentation, provided in Attachment C, accompanied the groundwater samples to the laboratory. Chain-of-custody forms were compared to the monitoring plan; this comparison was used to verify that appropriate laboratory analyses had been requested. Upon receipt of the laboratory analytical results, a further comparison was performed to verify that each sample was analyzed for the requested analyses. Sample tracking documentation is provided as Attachment D. The sample designation format used during the monitoring program at Site 2 is provided in Attachment E.

1.3 Groundwater Elevation and Flow Direction

Static water level measurements were collected after all well sampling activities had been completed. Measurements were recorded from top-of-casing (TOC) reference points marked on all monitoring well casings. Groundwater measurements were recorded to the nearest 0.01-foot using an electric measuring tape. Table 1-5 provides a summary of water level measurements collected on August 8, 1996, November 6, 1996, and April 26, 1997. Figure 1-2 depicts the static elevations and approximate flow direction of groundwater at Site 2, based upon the most recent groundwater elevations. Shallow groundwater at Site 2 generally flows north-northeast toward Overs Creek, a tributary of Northeast Creek. A drainage ditch that lies on both sides of the MCB, Camp Lejeune Railroad appears to have some affect upon groundwater flow particularly in the northern and central portions of the study area. To the east of monitoring well 02-GW09, a sloped embankment that runs

parallel to the rail grade begins to become more pronounced. This rapid change in surface elevation may explain the more easterly component of groundwater flow from 02-GW09.

Localized groundwater flow, depicted in Figure 1-2, should be considered an approximate interpretation of available elevation data. The older monitoring wells installed at Site 2 have begun to show signs of subsurface deterioration. The poor condition of these older monitoring wells and the recorded water level measurements suggest that the groundwater elevation data may be unreliable. As a result, groundwater contours were estimated over portions of the study area.

1.4 Field Observations

The following field observations were noted during the most recent sampling event. Recommendations regarding the field observations which follow are presented in Section 3.0.

In addition to groundwater sampling efforts at Site 2, several supplemental field activities were accomplished. These additional activities included the abandonment of several monitoring wells and the installation of two new monitoring wells, 02-GW12 and 02-GW03IW (refer to Figure 1-1). Installation of the new monitoring wells proceeded according to the recommendations presented in previous monitoring reports.

Upon completion of shallow monitoring well 02-GW12, it was noted that the static water level was lower than what was anticipated. Groundwater was encountered at 4.0 feet below ground surface during installation of the pilot test boring. The water level had decreased an additional 6 feet 24 hours after installation, measuring approximately 10 feet below ground surface. The water level was again recorded 48 hours after installation; it had decreased to a depth of approximately 21 feet below ground surface. Although shallow monitoring well 02-GW12 produced a sufficient amount of water during groundwater sampling activities, it was purged dry almost immediately due to the low volume of water contained in the well.

The observed static water level decrease in 02-GW12 may indicate the presence of a shallow perched groundwater zone at Site 2. Perched groundwater results from a layer or lens of lower permeability within more permeable materials. Water moving downward through the unsaturated zone is intercepted by the lower permeable material and accumulates on top of the lens and a layer of saturated soil will form above the main water table. Water can move laterally above the less permeable layer to the edge and then seep downward toward the main water table. As noted in the well construction log for shallow monitoring well 02-GW12 (refer to Attachment A), a layer of silt is present beginning at approximately 12.8 feet below ground surface and extending to a depth of 16.0 feet below ground surface. While the silt layer that was encountered was wet, it may not allow for the vertical movement of groundwater. The silt layer may instead act as a retarding layer, causing a perched groundwater zone.

2.0 ANALYTICAL RESULTS AND FINDINGS

The section which follows presents analytical results and findings from groundwater monitoring performed at Site 2 during the second quarter of 1997. Semiannual sampling activities at Site 2 entailed the collection of groundwater samples from seven shallow monitoring wells and one intermediate monitoring well (refer to Table 1-3 and Figure 1-1). Analytical results from the monitoring program at Site 2 are provided in the paragraphs which follow and summarized in Table 2-1. All positive VOC detections are provided in Table 2-2. Attachment F provides all analytical results from the sampling event.

One trip blank accompanied the groundwater samples during field collection, shipment, and laboratory analysis. No VOCs were detected in trip blank 02-TB01-97B. Analytical results from the trip blank are presented in Table 2-3.

2.1 Shallow Groundwater

Groundwater conditions within the upper and lower portions of the surficial aquifer were evaluated through collection and analysis of samples obtained from seven shallow monitoring wells and one intermediate monitoring well at Site 2 (refer to Table 1-1 for well construction details). The discussion which follows presents not only the most recent analytical results, but a comparison of those results versus previous investigative results.

A total of four volatile organic compounds (VOCs) were detected among samples obtained from six of the seven shallow monitoring wells and the one intermediate monitoring well at Site 2. As depicted in Figure 2-1, the majority of VOC detections were limited to the southern portion of the study area. Chlorobenzene, ethylbenzene, toluene, and xylenes were detected at maximum concentrations of 2.0, 170, 7.0, and 1,600 micrograms per liter (µg/L) in the sample obtained from monitoring well 02-GW03. None of the VOC concentrations exceeded Federal Maximum Contaminant Levels (MCLs). Concentrations of ethylbenzene and xylenes in the sample obtained from 02-GW03, however, exceeded applicable North Carolina Water Quality Standards (NCWQS). Analytical results from the sampling event and a comparison of those results versus applicable groundwater standards are provided in Table 2-1.

The VOCs ethylbenzene and xylenes have consistently been detected in samples obtained from monitoring well 02-GW03 at concentrations exceeding the applicable state standards. Figures 2-2 and 2-3 depict ethylbenzene and total xylene concentrations in samples obtained from 02-GW03 since inception of monitoring program activities at Site 2. The same VOCs were identified in the Record of Decision as contaminants of concern in groundwater at Site 2 (ROD Baker, 1994a). As depicted in Figures 2-2 and 2-3, ethylbenzene and xylene (total) concentrations in samples obtained from 02-GW03 have increased since July 1996. The most probable explanation for the observed increase is the change in sampling protocol during 1996. Prior to July 1996, groundwater samples at Site 2 were not collected using the low-flow sampling technique described in Section 1.0. Samples acquired using the low-flow purge and sampling method tend to more closely reflect true groundwater conditions.

Benzene, styrene, and 1,1,2-trichloroethane have been detected during prior sampling activities in samples obtained from 02-GW03. Previous analytical results from adjacent monitoring wells have exhibited much lower concentrations of similar VOCs, suggesting that the observed contaminants are concentrated in the immediate vicinity of 02-GW03. During the most recent sampling event,

chlorobenzene and xylenes were detected at 0.5 and 2.0 µg/L in a sample obtained from monitoring well 02-GW07. Xylenes were also detected in the sample obtained from newly installed monitoring well 02-GW12 at a concentration of 15 µg/L. Based upon the potentiometric surface map (refer to Figure 1-2), contaminants may have been transported by groundwater from nearby monitoring well 02-GW03, 02-GW07 and 02-GW12. Analytical data collected to date suggests that a localized area of groundwater contamination exists adjacent to monitoring well 02-GW03. Future samples collected from the southern portion of Site 2 will be required to confirm or disprove the migration of contaminants to 02-GW07 and 02-GW12 from the area surrounding 02-GW03.

Xylenes were detected at a concentration of 4 µg/L in the sample obtained from intermediate monitoring well 02-GW03IW. Intermediate well 02-GW03IW was installed during February 1997 to determine if detected contaminants in samples obtained from 02-GW03, located within 15 feet of 02-GW03IW, had migrated vertically. The intermediate groundwater sample was obtained from a depth interval of 50 to 60 feet below ground surface. Shallow groundwater samples are typically obtained from less than 25 feet below ground surface. The presence of xylenes within the deeper portion of the surficial aquifer suggests that contamination may have begun to migrate vertically. Additional sampling will be needed to confirm the downward movement of contamination, however.

Aside from the detections of VOCs in samples obtained from monitoring wells 02-GW03, 02-GW03IW, 02-GW07 and 02-GW12, only trace concentrations of toluene were detected among the remaining samples. Toluene was detected at concentrations of less than 1.0 µg/L in samples obtained from shallow monitoring wells 02-GW08, 02-GW10, and 02-GW11.

2.2 Deep Groundwater

Previous sampling results from the deeper aquifer (i.e., greater than 90 feet below ground surface) have indicated detections of toluene and xylenes below 1.0 µg/L. During the third sampling quarter of 1995, toluene was detected in a sample obtained from the deeper aquifer at a concentration of 0.3 µg/L. Xylenes were detected at a concentration of 0.1 µg/L during the fourth quarter of 1995. During 1996, there were no detections of any VOCs among samples obtained from the deep aquifer. Although positively detected, the infrequent occurrence and low concentration of VOCs among samples obtained from the deep aquifer suggests that contamination is limited to the shallow aquifer.

Deep monitoring well 02-GW03DW, located adjacent to shallow monitoring well 02-GW03, was recently abandoned because of poor well integrity and suspect groundwater quality resulting from well construction. If future sampling results from intermediate monitoring well 02-GW03IW suggest that VOCs have migrated at concentrations exceeding applicable water quality standards, a replacement deep monitoring well may need to be installed.

3.0 RECOMMENDATIONS

The ROD for Site 2 stipulates that possible off-site migration of contaminants be monitored through groundwater sample collection and analysis (Baker, 1994a). Groundwater monitoring was implemented to ensure that potential human and ecological receptors would not be exposed to known site contaminants. The sections which follow describe recommendations which have been implemented and recommendations which are proposed for future consideration.

3.1 Implemented Recommendations

Detailed information pertaining to the implemented recommendations which follow has been presented within previous monitoring reports. The final disposition of each recommendation is presented here to update information regarding the monitoring program. It is also the intent of this report to provide a thorough listing of recommendations and implemented actions.

3.1.1 Supply Well Sampling

Supply wells HP-616, HP- 646, and HP-647 were eliminated from the monitoring program at Site 2. The supply wells are located more than 1,200 feet from the study area and were sampled for six consecutive quarters with only one positive detection of a VOC. Methylene chloride was detected in a sample obtained from HP-616 at a concentration of 1 µg/L during the third quarter of 1996. Methylene chloride is a common laboratory contaminant which is often introduced during preparation or analysis of the environmental samples. None of the total metal detections in samples obtained from the supply wells exceeded applicable water quality standards. In addition, supply wells at MCB Camp Lejeune are currently sampled as part of an ongoing monitoring program administered by MCB Camp Lejeune. Based upon this information, the identified supply wells were eliminated from the sampling program.

3.1.2 Shallow Monitoring Well Sampling

Monitoring wells 02-GW06 and 02-GW09 were eliminated from the sampling program at Site 2. As depicted in Figure 1-2, the two monitoring wells are not positioned hydraulically downgradient of known contamination at Site 2. Methylene chloride and chloroform, contaminants believed to be the result of laboratory sample preparation, have each been detected twice among samples obtained from 02-GW06 during the previous six quarters of sampling. No other VOCs have been detected in samples obtained from 02-GW06 and 02-GW09 during the six sampling events that have taken place at Site 2. Additional information gained from monitoring wells 02-GW06 and 02-GW09 was not expected to provide relevant data in support of the decision making process. As a result, the identified monitoring wells were eliminated from the sampling program.

3.1.3 Sampling Frequency

The majority of groundwater samples obtained from Site 2 have exhibited little or no contamination during the previous six quarterly sampling events. Only two contaminants, ethylbenzene and xylenes, were consistently detected above state water quality standards. Ethylbenzene and xylenes were detected in the same well, 02-GW03, and at similar concentrations during the 1993 Remedial Investigation (Baker, 1994b). Ethylbenzene was also detected in shallow monitoring well 02-GW03 during the 1984 Confirmation Study (ES&E, 1990). In addition, there is little evidence to suggest that contaminants have migrated from the area immediately surrounding 02-GW03. Based upon this

information, the number of yearly sampling events was reduced from four to two. Semiannual sampling will sufficiently monitor the groundwater conditions at Site 2.

3.1.4 Sample Analyses

The sampling program for Site 2 was modified such that total metal, total dissolved solid, and total suspended solid analyses were eliminated from the program. Although, concentrations of metals and total dissolved solids were detected at concentrations which exceeded applicable North Carolina standards, these analyses were not necessary data requirements. There was no history or evidence to suggest that metal disposal activities may have occurred at Site 2. Soils of the North Carolina coastal plain tend to be naturally rich in metals, especially iron and manganese. It is not uncommon to detect total metal concentrations in groundwater at MCB Camp Lejeune that exceed applicable water quality standards. In addition, the analyses were eliminated because the results were not required to determine VOC migration throughout Site 2.

3.1.5 Monitoring Well Abandonment and Installation

Deep monitoring well 02-GW03DW was situated adjacent to shallow monitoring well 02-GW03. The screened portion of 02-GW03DW was below a semi-confining unit that separates the surficial and Castle Hayne aquifers. As provided in Section 2.0, both ethylbenzene and total xylenes were detected at concentrations exceeding applicable water quality standards in shallow monitoring well 02-GW03. Although ethylbenzene and total xylenes were detected at concentrations below 1.0 µg/L in samples obtained from 02-GW03DW during a previous monitoring event, their presence had not been confirmed. Field observations suggested that bentonite clay, installed during well construction, had begun to enter the screen and sandpack of deep monitoring well 02-GW03DW. The sandpack was presumably clogged with bentonite, limiting the ability of groundwater to enter the well screen. Bentonite clay, as a result, may also have been introduced into groundwater samples obtained from the deep well causing total dissolved solids and metal concentrations to be detected above the North Carolina standards. The bentonite may have falsely biased total metal and dissolved solid results. The results could have reflected naturally occurring metals from the surrounding formation that had adhered to the clay particles by a weak ionic bond.

Based on this information, well 02-GW03DW was abandoned according to accepted procedures. An intermediate well, set immediately above the semi-confining unit, was then installed to replace the deep monitoring well. The intermediate well was situated adjacent to shallow monitoring well 02-GW03 and installed to a depth of approximately 60 feet below ground surface. Groundwater samples collected above the semi-confining layer will be employed to determine if contaminants have migrated from the upper portion of the surficial aquifer to the lower portion of the surficial aquifer. Figures 3-1 and 3-2 depict intermediate well installation activities at Site 2.

3.1.6 Shallow Monitoring Well Abandonment

Recorded field observations suggested that three of the five monitoring wells installed at Site 2 during 1984 had begun to deteriorate and were clogged with fine-grained material from the surrounding formation. During redevelopment, monitoring wells 02-GW01 and 02-GW04 did not recharge adequately and often the extracted groundwater appeared extremely turbid. Well 02-GW02 was not redeveloped due to an insufficient amount of groundwater in the screened portion of the well casing. As a result of deterioration or obstruction, environmental samples were likely to have been obtained from only a limited interval of the surficial aquifer where groundwater was permitted to

enter the well screen; possibly misrepresenting true groundwater conditions. Based upon this information, monitoring wells 02-GW01, 02-GW02, and 02-GW04 were abandoned according to accepted procedures. The results of shallow monitoring well abandonment are depicted in Figures 3-3 and 3-4.

3.1.7 Well Security and Aesthetics

Shallow monitoring wells that were installed during the 1984 Confirmation Study had begun to show signs of deterioration. The bollards and protective casings of wells 02-GW01 through 02-GW05 had developed peeling paint and rust. In addition, a number of the padlocks used to secure the protective steel covers were either missing or no longer function properly. As recommended, the bollards and well casings were repainted with a weather and rust resistant paint. New padlocks that operate with a universal key were also installed on each of the monitoring wells at Site 2. Figures 3-5 and 3-6 depict typical monitoring well repairs performed at Site 2.

3.2 Proposed Recommendations

Based upon the observations and findings presented in Sections 1.0 and 2.0 of this monitoring report, no significant changes to the monitoring program are currently recommended.

4.0 REFERENCES

Baker Environmental, Incorporated (Baker). 1994a. Record of Decision for Operable Unit No. 5 (Site 2), Marine Corps Base Camp Lejeune, North Carolina. Final. Prepared for the Department of the Navy Atlantic Division Naval Facilities Engineering Command, Norfolk, Virginia.

Baker Environmental, Incorporated (Baker). 1994b. Remedial Investigation Report for Operable Unit No. 5 (Site 2), Marine Corps Base Camp Lejeune, North Carolina. Final. Prepared for the Department of the Navy Atlantic Division Naval Facilities Engineering Command, Norfolk, Virginia.

Bowels, Joseph E., Physical and Geotechnical Properties of Soils, second edition McGraw-Hill Inc., 1984.

Environmental Science & Engineering (ES&E). 1990. Site Summary Report. Final. Prepared for the Department of the Navy Atlantic Division Naval Facilities Engineering Command, Norfolk, Virginia. ESE Project No. 49-02036.

U.S. Environmental Protection Agency, Region IV. May 1996. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual.

TABLES

TABLE 1-1

SUMMARY OF WELL CONSTRUCTION DETAILS
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O&M SUPPORT, CTO - 0367
MCB, CAMP LEJEUNE, NORTH CAROLINA

Monitoring Well Number	Date Installed	Top of Casing Elevation (feet, msl)	Ground Surface Elevation (feet, msl)	Boring Depth (feet, bgs)	Well Depth (feet, bgs)	Screen Interval Depth (feet, bgs)	Depth to Sand Pack (feet, bgs)	Depth to Bentonite (feet, bgs)	Stick-Up (feet, ags)
02-GW03	1984	35.40	33.00	NA	25.0	10.0 to 25.0	NA	NA	NA
02-GW03IW	1997	35.34	32.21	70.0	60.0	50.0 to 60.0	45.0	34.0	3.1
02-GW05	1984	33.72	31.80	NA	25.0	10.0 to 25.0	NA	NA	NA
02-GW06	1993	34.40	31.8	12.5	12.5	2.6 to 12.6	1.5	0.5	2.6
02-GW07	1993	34.03	31.6	16.0	13.0	3.0 to 13.0	2.0	1.0	2.4
02-GW08	1993	34.92	31.90	12.5	12.5	2.5 to 12.5	1.5	0.5	3
02-GW09	1993	35.02	32.60	13.0	13.0	3.0 to 13.0	2.0	1.0	2.4
02-GW10	1994	32.28	32.47	15.0	13.5	3.5 to 13.5	2.5	1.5	3.5
02-GW11	1994	35.20	33.94	15.0	14.0	1.0 to 14.0	3.0	2.0	3
02-GW12	1997	34.37	31.52	31.0	23.0	3.0 to 23.0	2.0	1.0	2.8

Notes:

(1) Water Supply Well
msl = Mean sea level
bgs = Below ground surface
NA = Information not available
ags = Above ground surface

TABLE 1-2

SUMMARY OF GROUNDWATER FIELD PARAMETERS
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O&M SUPPORT, CTO-0367
MCB, CAMP LEJEUNE, NORTH CAROLINA

Well Number (Sample Date)	Well Volumes	Field Parameters				
		Dissolved Oxygen (mg/L)	Specific Conductance (µmhos/cm)	Temperature (°C)	pH (S.U.)	Turbidity (N.T.U.)
02-GW03 (04/25/97)	1.0	2.6	211.6	15.3	5.23	3.0
	1.5	2.2	198.9	15.0	5.19	3.6
	2.0	3.2	195.5	14.9	5.17	4.4
	2.5	2.4	190.9	14.9	5.18	4.2
	3.0	2.6	191.0	14.8	5.20	3.7
02-GW03IW (04/25/97)	1.0	1.8	745.0	17.5	6.13	8.7
	1.5	1.9	773.0	17.3	6.24	3.1
	2.0	1.6	779.0	17.5	6.37	1.2
	2.5	1.4	782.0	17.6	6.31	2.4
	3.0	1.5	785.0	17.5	6.32	2.3
02-GW05 (04/25/97)	1.0	2.5	324.0	16.1	5.16	10.8
	1.5	2.0	318.3	16.3	5.21	3.3
	2.0	1.8	319.1	16.1	5.19	3.0
	2.5	1.9	316.9	16.0	5.20	2.1
	3.0	1.9	317.1	16.1	5.20	2.6
02-GW06 (04/25/97)	0	1.6	289.8	20.8	4.16	16.7
	1.0	2.6	280.8	21.4	4.16	25.0
	2.0	2.0	294.8	21.4	4.25	4.0
	3.0	1.4	289.8	21.4	4.35	5.7
02-GW07 (04/25/97)	1.0	1.3	258.8	17.1	5.26	16.6
	1.5	1.2	205.6	16.7	5.21	5.2
	2.0	1.1	163.8	16.7	5.30	5.6
	2.5	1.3	164.9	16.8	5.27	13.8
	3.0	1.2	162.3	16.5	5.27	12.7
02-GW08 (04/25/97)	1.0	2.3	164.8	16.7	4.81	13.4
	1.5	2.0	170.1	15.8	4.97	11.1
	2.0	2.1	170.3	15.7	4.92	16.1
	2.5	2.2	171.8	15.7	4.90	1.8
	3.0	2.1	173.5	16.0	4.90	1.9
02-GW09 (04/25/97)	0	2.0	339.5	20.0	3.99	4.0
	1.0	2.6	282.2	21.0	4.27	4.0
	2.0	1.8	326.5	20.9	4.27	5.7
	3.0	2.0	364.6	20.8	4.26	3.5

TABLE 1-2 (Continued)

SUMMARY OF GROUNDWATER FIELD PARAMETERS
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O&M SUPPORT, CTO-0367
MCB, CAMP LEJEUNE, NORTH CAROLINA

Well Number (Sample Date)	Well Volumes	Field Parameters				
		Dissolved Oxygen (mg/L)	Specific Conductance (µmhos/cm)	Temperature (°C)	pH (S.U.)	Turbidity (N.T.U.)
02-GW10 (04/25/97)	1.0	1.7	372.9	17.8	6.06	1.2
	2.0	1.8	402.7	17.7	6.29	4.6
	3.0	1.7	415.6	17.5	6.34	7.0
	4.0	1.6	391.3	17.3	6.06	16.8
	5.0	1.5	393.2	17.1	6.01	7.0
	6.0	1.6	396.1	17.2	6.04	6.8
	7.0	1.4	398.3	17.3	6.09	8.5
02-GW11 (04/25/97)	1.0	2.5	210.8	16.5	14.3	1.7
	2.0	2.1	202.7	16.5	14.9	1.7
	3.0	2.0	202.6	16.7	15.6	1.8
	4.0	2.0	205.2	16.6	15.6	1.6
02-GW12 (04/25/97)	1.0	1.9	160.8	16.3	5.80	32.1
	2.0	1.7	162.9	16.2	5.79	30.6
	3.0	1.8	164.3	16.3	5.83	34.1

Notes:

N.T.U. = Nephelometric Turbidity Units
S.U. = Standard Units
µmhos/cm = micro ohms per centimeter
°C = Degrees Centigrade
mg/L = Milligrams per liter

TABLE 1-3

GROUNDWATER SAMPLING SUMMARY
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O&M SUPPORT, CTO-0367
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Location	Media	TCL Volatiles[1]	Sample Identification
02-GW03	GW	X	02-GW03-97B
02-GW03IW	GW	X	02-GW03IW-97B
02-GW05	GW	X	02-GW05-97B
02-GW07	GW	X	02-GW07-97B
02-GW08	GW	X	02-GW08-97B
02-GW10	GW	X	02-GW10-97B
02-GW11	GW	X	02-GW11-97B
02-GW12	GW	X	02-GW12-97B

Notes:

[1] Target Compound List Organics by Environmental Protection Agency (EPA) Method 8260.

X = Requested Analysis

TABLE 1-4

ANALYTICAL METHOD DETECTION LIMITS
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O&M SUPPORT, CTO-0367
MCB, CAMP LEJEUNE, NORTH CAROLINA

Parameter	Analytical Method	MDL	NCWQS	MCL
Volatile Organics µg/L:				
Chloromethane	8260	0.5	NA	NA
Vinyl Chloride	8260	0.5[1]	0.015	2
Bromomethane	8260	0.5	NA	NA
Chloroethane	8260	0.5	NA	NA
1,1-dichloroethene	8260	0.5	7	7
Acetone	8260	2	700	NA
Carbon Disulfide	8260	2	700	NA
Methylene Chloride	8260	0.5	5	5
1,2-dichloroethene (Total)	8260	0.5	70	70
1,1-dichloroethane	8260	0.5	700	NA
2-butanone	8260	2	NA	NA
Chloroform	8260	0.5[1]	0.19	100
1,1,1-trichloroethane	8260	0.5	200	200
Carbon Tetrachloride	8260	0.5[1]	0.3	5
Benzene	8260	0.5	1	5
1,2-dichloroethane	8260	0.5[1]	0.38	5
Trichloroethene	8260	0.5	NA	5
1,2-dichloropropane	8260	0.5	0.56	5
Bromodichloromethane	8260	0.5	0.6	100
Cis-1,3-dichloropropene	8260	0.5	NA	NA
4-methyl-2-pentanone	8260	2	NA	NA
Toluene	8260	0.5	1000	1000
Trans-1,3-dichloropropene	8260	0.5[1]	0.2	NA
1,1,2-trichloroethane	8260	0.5	NA	5
Tetrachloroethene	8260	0.5	0.7	5
2-hexanone	8260	2	NA	NA
Dibromochloromethane	8260	0.5	NA	NA
Chlorobenzene	8260	0.5	50	100
Ethylbenzene	8260	0.5	29	700

TABLE 1-4 (Continued)

ANALYTICAL METHOD DETECTION LIMITS
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O&M SUPPORT, CTO-0367
MCB, CAMP LEJEUNE, NORTH CAROLINA

Parameter	Analytical Method	MDL	NCWQS	MCL
Xylene, Total	8260	0.5	530	10000
Styrene	8260	0.5	100	100
Bromoform	8260	0.5[(1)]	0.19	100
1,1,2,2-tetrachloroethane	8260	0.5	NA	NA

Notes:

[(1)] Method Detection Limit greater than North Carolina Water Quality Standard

MCL = Federal Maximum Contaminant Level. Maximum permissible level of a contaminant in water which is delivered to any user of a public water system. (U.S. Environmental Protection Agency - Drinking Water Regulations and Health Advisories.)
MDL = Method Detection Limit
NA = standard not available
NCWQS = North Carolina Water Quality Standards. Values Applicable to Groundwater (North Carolina Administrative Code, Title 15A, Subchapter 2L).
µg/L = micrograms per liter or parts per billion

TABLE 1-5

SUMMARY OF WATER LEVEL MEASUREMENTS
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O&M SUPPORT, CTO-0367
MCB, CAMP LEJEUNE, NORTH CAROLINA

Well Identification	Reference Elevation [1]	SWL (08/08/96)	SWE (08/08/96)	SWL (11/06/96)	SWE (11/06/96	SWL (04/26/97)	SWE (04/26/97)
02-GW03	35.40	15.17	20.23	6.76	28.67	7.49	27.91
02-GW03IW	35.34	NA	NA	NA	NA	27.95	7.39
02-GW05	33.72	15.48	18.24	9.37	24.35	8.18	25.54
02-GW06	34.40	2.79	31.61	3.85	30.55	4.96	29.44
02-GW07	34.03	3.97	30.06	4.78	29.25	6.62	27.41
02-GW08	34.92	3.18	31.74	3.88	31.04	5.32	29.60
02-GW09	35.02	3.60	31.42	4.95	30.07	6.20	28.82
02-GW10	32.28	4.99	27.29	NR	NR	5.96	26.32
02-GW11	35.20	6.23	28.97	6.84	28.36	7.62	27.58
02-GW12	34.37	NA	NA	NA	NA	24.64	9.73

Notes:

[1] Top of well casing in feet above mean sea level (msl)
NA = Not Applicable
NR = Not recorded
SWL = Static water level taken from top of well casing
SWE = Static water elevation in feet above msl

TABLE 2-1

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - APRIL 1997
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O&M SUPPORT, CTO-0367
MCB, CAMP LEJEUNE, NORTH CAROLINA

Fraction (units)	Detected Contaminants	Comparison Criteria		Concentration Range		Location(s) of Maximum Detection	Detection Frequency	Detections Above	
		NCWQS	MCL	Min.	Max.			NCWQS	MCL
Volatile Organics	Toluene	1,000	1,000	0.5	6.0	02-GW03	4/8	0	0
	Chlorobenzene	50	100	0.5	2.0	02-GW03	2/8	0	0
	Ethylbenzene	29	700	170	170	02-GW03	1/8	1	0
	Xylene (Total)	530	10,000	2	1,600	02-GW03	4/8	1	0

Notes:

- Concentrations presented in micrograms per liter (µg/L) or parts per billion.

MCL - Federal Maximum Contaminant Level. Maximum permissible level of a contaminant in water which is delivered to any user of a public water system (U.S. Environmental Protection Agency - Drinking Water Regulations and Health Advisories).

NA - Not applicable

NCWQS - North Carolina Water Quality Standards (North Carolina Administrative Code, Title 15A, Subchapter 2L).

NE - Not Established

TABLE 2-2

POSITIVE DETECTIONS IN GROUNDWATER
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O&M SUPPORT, CTO-0367
MCB, CAMP LEJEUNE, NORTH CAROLINA
VOLATILES ORGANICS

SAMPLE ID	02-GW03-97B	02-GW03IW-97B	02-GW05-97B	02-GW07-97B	02-GW08-97B	02-GW10-97B	02-GW11-97B	02-GW12-97B
DATE SAMPLED	04/25/97	04/25/97	04/25/97	04/25/97	04/25/97	04/25/97	04/25/97	04/25/97
VOLATILES (ug/L))								
TOLUENE	7	0.5 U	0.5 U	0.5 U	0.6	0.5	0.5	0.5 U
CHLOROBENZENE	2	0.5 U	0.5 U	0.5	0.5 U	0.5 U	0.5 U	0.5 U
ETHYLBENZENE	170	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
XYLENE (TOTAL)	1600	4	0.5 U	2	0.5 U	0.5 U	0.5 U	15

U = Not detected
ug/L = microgram per liter

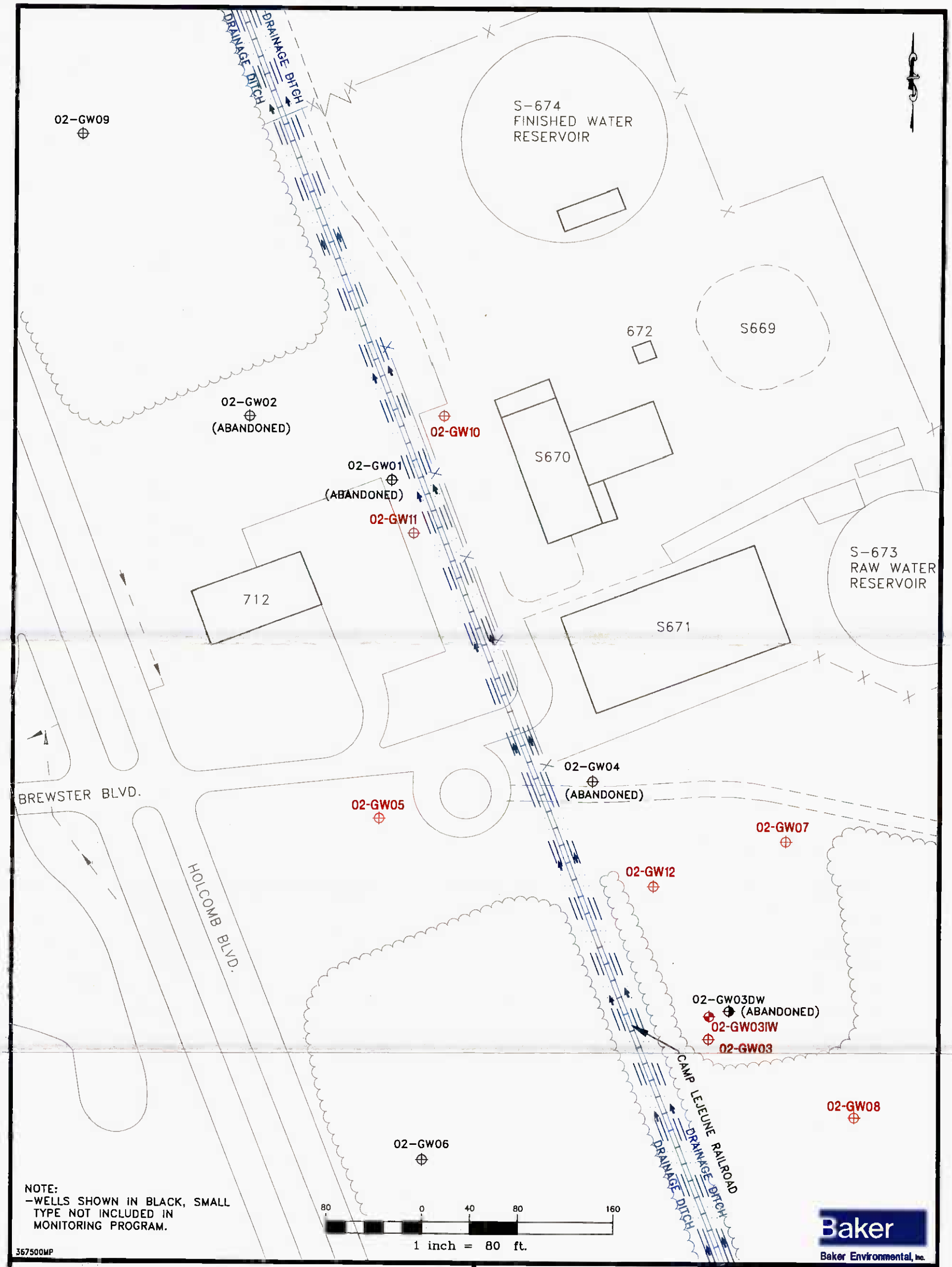
TABLE 2-3

TRIP BLANK ANALYTICAL RESULTS
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O&M SUPPORT, CTO-0367
MCB, CAMP LEJEUNE, NORTH CAROLINA
VOLATILES ORGANICS

SAMPLE ID	02-TB01-97B
DATE SAMPLED	04/25/97
VOLATILES (ug/L))	
CHLOROMETHANE	0.5 U
BROMOMETHANE	0.5 U
VINYL CHLORIDE	0.5 U
CHLOROETHANE	0.5 U
METHYLENE CHLORIDE	0.5 U
ACETONE	2 U
CARBON DISULFIDE	2 U
1,1-DICHLOROETHENE	0.5 U
1,1-DICHLOROETHANE	0.5 U
1,2-DICHLOROETHENE (TOTAL)	0.5 U
CHLOROFORM	0.5 U
1,2-DICHLOROETHANE	0.5 U
2-BUTANONE	2 U
1,1,1-TRICHLOROETHANE	0.5 U
CARBON TETRACHLORIDE	0.5 U
BROMODICHLOROMETHANE	0.5 U
1,2-DICHLOROPROPANE	0.5 U
CIS-1,3-DICHLOROPROPENE	0.5 U
TRICHLOROETHENE	0.5 U
DIBROMOCHLOROMETHANE	0.5 U
1,1,2-TRICHLOROETHANE	0.5 U
BENZENE	0.5 U
TRANS-1,3-DICHLOROPROPENE	0.5 U
BROMOFORM	0.5 U
4-METHYL-2-PENTANONE	2 U
2-HEXANONE	2 U
TETRACHLOROETHENE	0.5 U
1,1,2,2-TETRACHLOROETHANE	0.5 U
TOLUENE	0.5 U
CHLOROBENZENE	0.5 U
ETHYLBENZENE	0.5 U
STYRENE	0.5 U
XYLENE (TOTAL)	0.5 U

U = not detected
ug/L = micrograms per liter

FIGURES



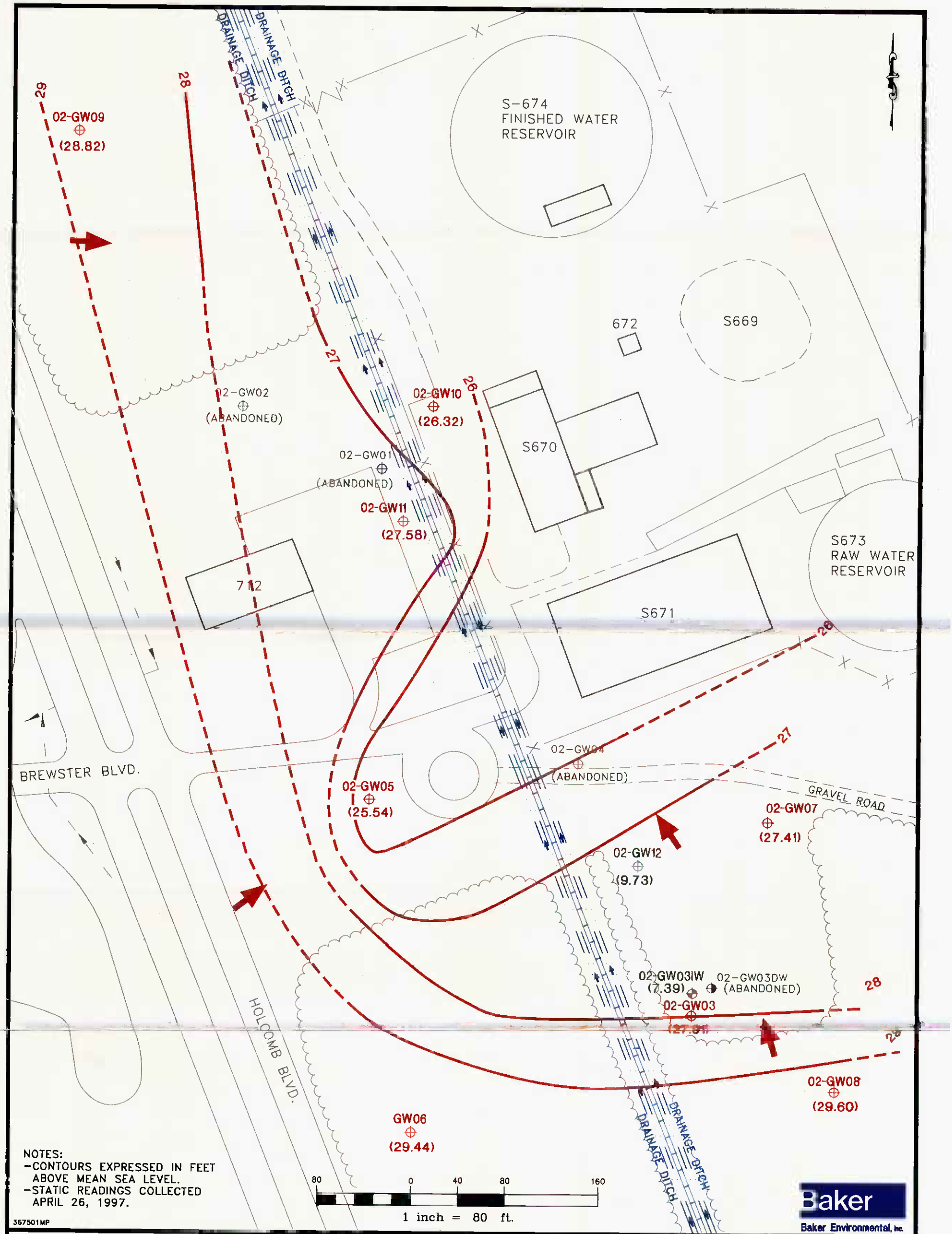
LEGEND

- 02-GW02 — SHALLOW MONITORING WELL
- 02-GW03IW — INTERMEDIATE MONITORING WELL
- 02-GW03DW — DEEP MONITORING WELL
- DIRECTION OF SURFACE WATER FLOW
- RAILROAD
- TREE LINE

SOURCE: LANTDIV, FEB. 1992

FIGURE 1-1
MONITORING WELL LOCATION MAP
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O & M SUPPORT, CTO - 0367

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTES:
- CONTOURS EXPRESSED IN FEET ABOVE MEAN SEA LEVEL.
- STATIC READINGS COLLECTED APRIL 26, 1997.

367501MP

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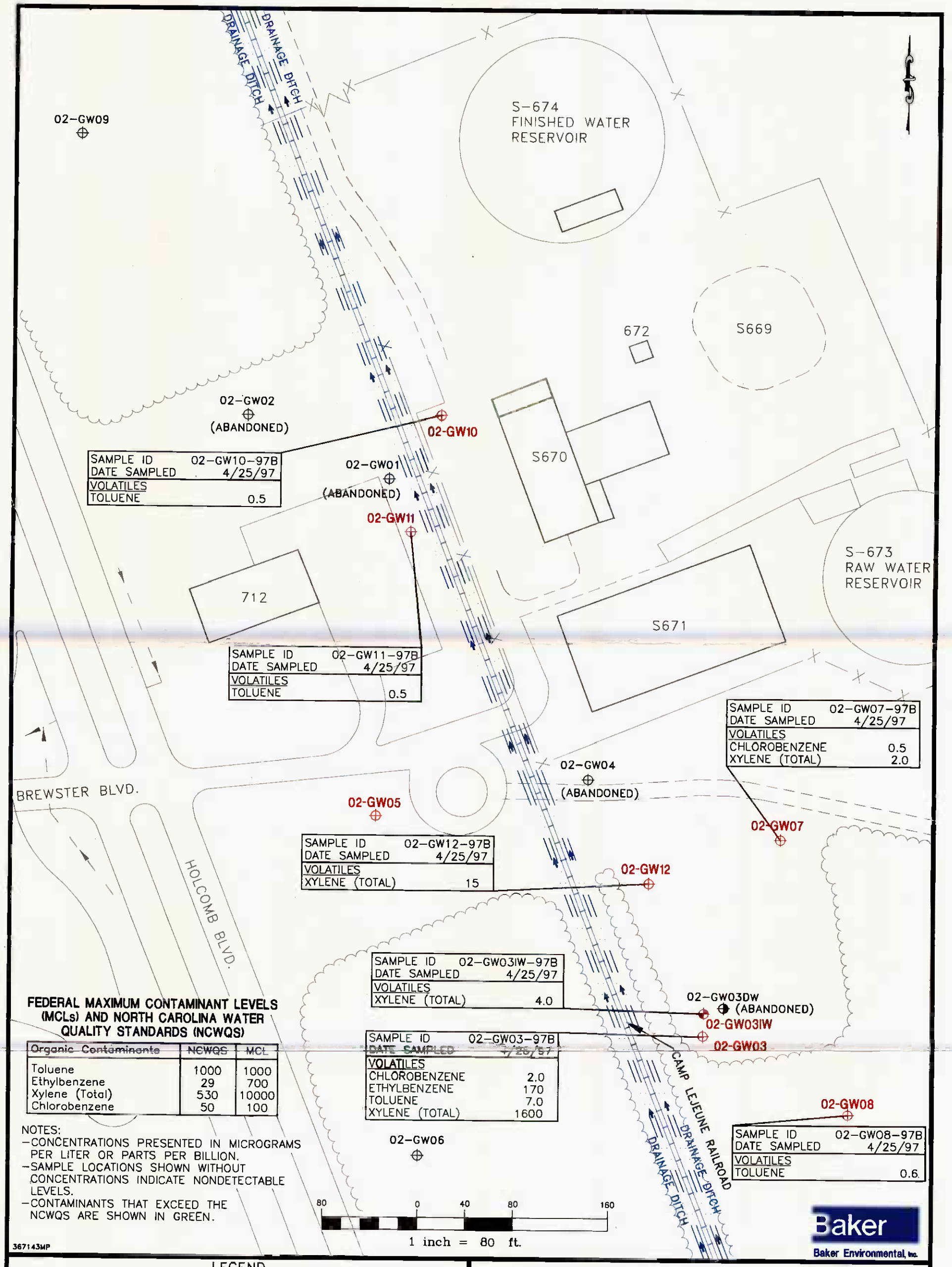
LEGEND

- 02-GW11 — SHALLOW MONITORING WELL
- 02-GW03IW — INTERMEDIATE MONITORING WELL
- 02-GW03DW — DEEP MONITORING WELL
- (28.67) — STATIC GROUNDWATER ELEVATION
- —30— — GROUNDWATER ELEVATION CONTOUR
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW
- DIRECTION OF SURFACE WATER FLOW

SOURCE: LANTDIV, FEB. 1992

FIGURE 1-2
SHALLOW GROUNDWATER CONTOUR MAP
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O&M SUPPORT CTO - 0367
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



FEDERAL MAXIMUM CONTAMINANT LEVELS (MCLs) AND NORTH CAROLINA WATER QUALITY STANDARDS (NCWQS)

Organic Contaminants	NCWQS	MCL
Toluene	1000	1000
Ethylbenzene	29	700
Xylene (Total)	530	10000
Chlorobenzene	50	100

NOTES:
- CONCENTRATIONS PRESENTED IN MICROGRAMS PER LITER OR PARTS PER BILLION.
- SAMPLE LOCATIONS SHOWN WITHOUT CONCENTRATIONS INDICATE NONDETECTABLE LEVELS.
- CONTAMINANTS THAT EXCEED THE NCWQS ARE SHOWN IN GREEN.

367143MP

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LEGEND

- 02-GW02 — SHALLOW MONITORING WELL
- 02-GW03IW — INTERMEDIATE MONITORING WELL
- 02-GW03DW — DEEP MONITORING WELL
- DIRECTION OF SURFACE WATER FLOW
- RAILROAD
- TREE LINE

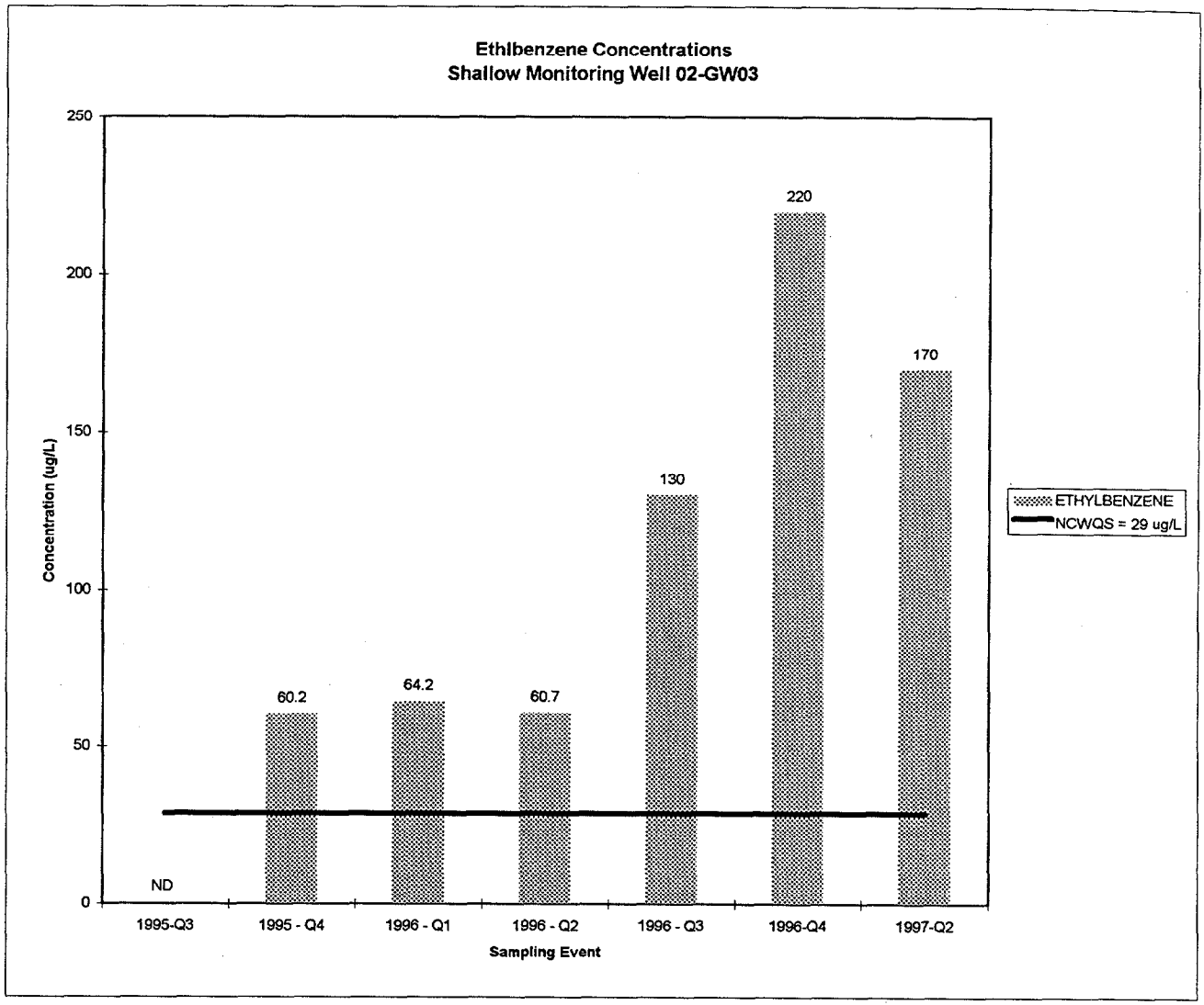
SOURCE: LANTDIV, FEB. 1992

FIGURE 2-1
VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER
OPERABLE UNIT NO. 5 – SITE 2
MONITORING AND O&M SUPPORT, CTO – 0367

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

FIGURE 2-2

ETHYLBENZENE RESULTS FROM 02-GW03
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O&M SUPPORT, CTO-367
MCB, CAMP LEJEUNE, NORTH CAROLINA



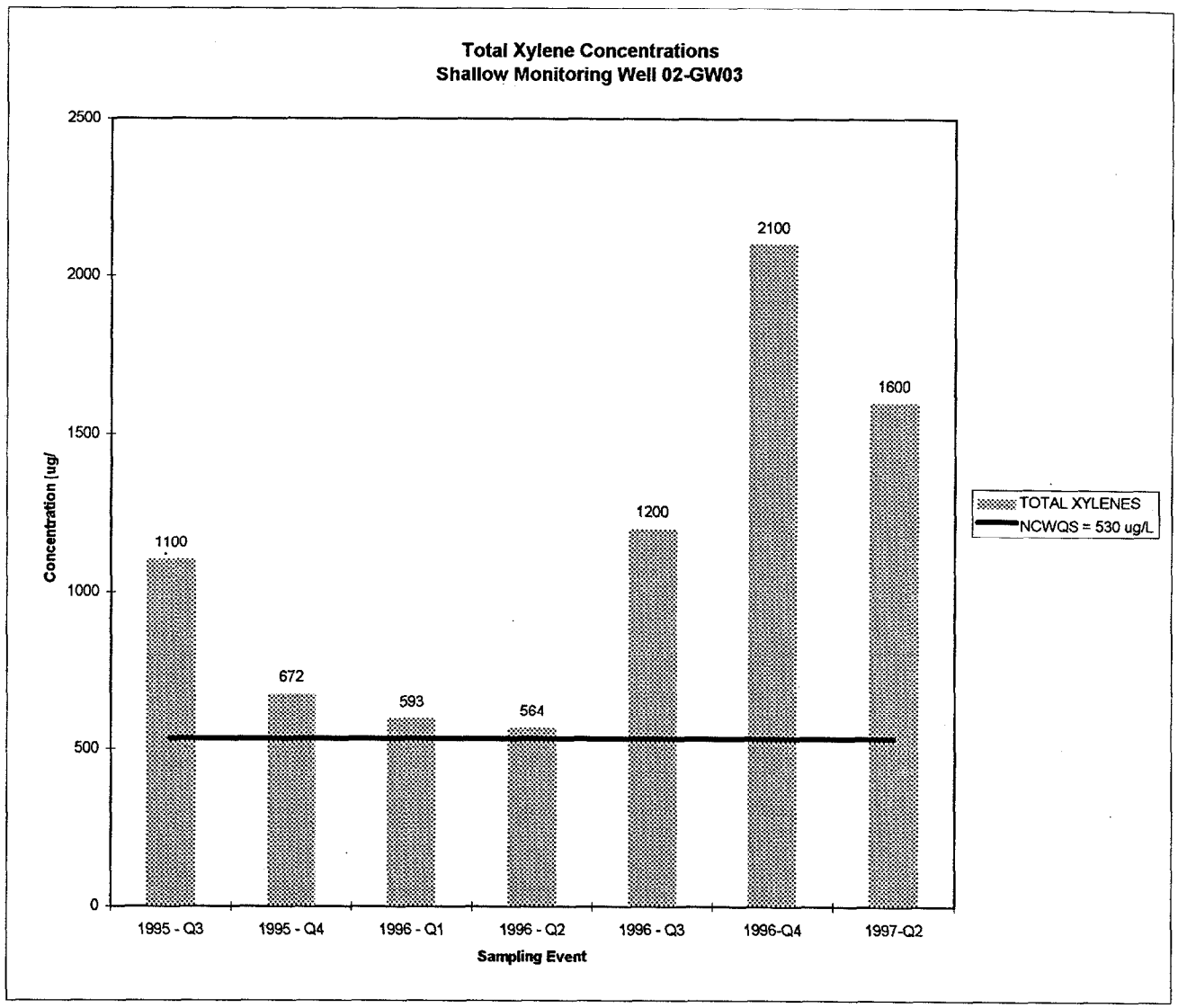
Q1 - Quarter 1 (January - March)
Q2 - Quarter 2 (April - June)
Q3 - Quarter 3 (July - September)
Q4 - Quarter 4 (October - December)

Notes:
Federal Maximum Contaminant Level (MCL) = 700 micrograms per liter (ug/L)
North Carolina Water Quality Standard (NCWQS) = 29 micrograms per liter (ug/L)

Contaminant	Mean Detection (ug/L)	Median Detection (ug/L)	Detection Frequency	Detections Above Standards
ETHYLBENZENE	101	64	6/7	6/7

FIGURE 2-3

TOTAL XYLENE RESULTS FROM 02-GW03
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O&M SUPPORT, CTO-367
MCB, CAMP LEJEUNE, NORTH CAROLINA



Q1 - Quarter 1 (January - March)
Q2 - Quarter 2 (April - June)
Q3 - Quarter 3 (July - September)
Q4 - Quarter 4 (October - December)

Notes:
Federal Maximum Contaminant Level (MCL) = 10,000 micrograms per liter (ug/L)
North Carolina Water Quality Standard (NCWQS) = 530 micrograms per liter (ug/L)

Contaminant	Mean Detection (ug/L)	Median Detection (ug/L)	Detection Frequency	Detections Above Standards
TOTAL XYLENES	1118	1100	7/7	7/7

Figure 3-1 During well installation, 6-1/4-inch hollow stem augers were used as depicted here.

Figure 3-2 Two-inch polyvinyl chloride (PVC) well materials were used during installation of 02-GW03IW. Well construction materials were added to the annular space between the augers and PVC well.

Figure 3-3 Shallow monitoring well 02-GW02 was constructed during the 1984 Confirmation Study. The well had begun to exhibit signs of subsurface deterioration.

Figure 3-4 The pad, bollars, and protective casing of monitoring well 02-GW02 were removed. Topsoil and grass seed were used to restore the site.

Figure 3-5 Shallow monitoring well 02-GW05 was also installed during the 1984 Confirmation Study. The well had begun to exhibit signs of neglect and deterioration.

Figure 3-6 Peeling paint and rust were removed from the bollars and protective casing of shallow monitoring well 02-GW05. Two coats of weather resistant paint were then applied and a new padlock was installed.

ATTACHMENTS

ATTACHMENT A
WELL CONSTRUCTION RECORDS

Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Long Term Monitoring Site 2
CTO NO.: Ø367 BORING NO.: 2-GW12
COORDINATES: EAST: NORTH:
ELEVATION: SURFACE: TOP OF PVC CASING:

RIG: Mobil B-58	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		3 1/4		2/21/97	31	Heavy Rain	4.0	1400
LENGTH	2.0		5'						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Type II shallow well

SAMPLE TYPE

S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
	2"	PVC Flush Joint		
Riser	2.0"	Schedule 40 PVC	+3	3
Screen	2.0"	Schedule 40 0.01 Slot	3	23

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1	AN							Grout to Surf.
2	S-1	1.83 92%	6 6 3 4			Drk. Gray to Blk. F.G. Sand, some silt. Damp to moist. Loose		6" Benton seal Sand @ 2' bgs
3								
4	S-2	0.25 12%	2 2 1 1			V. Loose Blk. F.G. Sand and silt. wet. Water @ 4.0' bgs	4.0' during drilling	Top of Screen @ 3' bgs
5								
6	S-3	1.42 71%	1/12" 1 4			Roots. Very Loose Blk. F.G. Sand and silt wet.		
7								
8	S-4	1.17 58%	3 5 4 4			Roots. Blk. F.G. Sand @ 8.5' Lt. gray F.G. Sand w/ little silt. wet		
9								
10	S-5	0.25 12%	4 3 6 2			Loose lt. Gray F.G. Sand wet.		

Match to Sheet 2

DRILLING CO.: Parratt-Wolff BAKER REP.: J. Tepsic
DRILLER: Layne Pech BORING NO.: 2-GW12 SHEET 1 OF

Baker
Baker Environmental, Inc

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Long Term Monitoring Site 2
CTO NO.: 0367 BORING NO.: 2-GW12

SAMPLE TYPE
S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston
N = No Sample

DEFINITIONS
SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
RQD = Rock Quality Designation (%)
PID = Photoionization Detector
ppm = parts per million

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevatic (ft. MSI
						Continued from Sheet 1		
11						Loose lt. gray F.G. Sand		
12	S-6	1.83	1/12"			@ 12.8' chg. to lt. gray silt		
13		92%	1 1			Trace clay. wet.		13.4' o 2/22/
14	S-7	1.67	WOH/12"			V. Soft lt. gray silt. Trace clay. wet		
15		0.83	1 1					
16	S-8	2.0	WOH/24"			Same silt to 16.0' then chg. to silt & F.G. sand, wet.		
17		100%						
18	S-9	1.5	1 2			Lt gray F.G. Sand & silt. wet.		
19		75%	3 5					
20	S-10	1.17	8 12			@ 20' Boot Then V. Lt. gray to white variegated F.G. Sand Damp to moist		
21		58%	17 17					
22	S-11	1.17	35/32 29			Lt gray to white F.G. Sand Damp to moist		
23		58%	28			@ 23' Strong Sulphur odor!		Btm. scree @ 23' b
24	S-12	1.0	13 15			Same material as above sltly. coarser.		
25		50%	12 12					
26	S-13	1.0	9 9			Lt. gray F. to med. grain Sand. T. silt. wet. Note: somewhat coarser		
27		50%	6 4					
28	S-14	1.5	3 6			F. to Med. grain Sand, T. Silt. Note: Starting to take on sltly greener color. wet.		
29		75%	10 13					
30	S-15	1.5	4 5 8			F. to med. grain Sand T. Silt Lt. green to gray. wet		

DRILLING CO.: Parratt-Wolff BAKER REP.: J. Tepsic
DRILLER: Layne Pech BORING NO.: 2-GW12 SHEET 2

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Long Term Monitoring Site 2
CTO NO.: 0367 BORING NO.: 2-GW12

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
RQD = Rock Quality Designation (%)
PID = Photoionization Detector
ppm = parts per million

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1	S-15		8			Continued from Sheet		
2						END of Boring 2 31.0 feet bgs		
3								
4								
5								
6								
7								
8								
9								
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
0								

DRILLING CO.: Parratt-Wolff BAKER REP.: J. Tepsic
DRILLER: Layne Peck BORING NO.: 2-GW12 SHEET 3 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Long Term Monitoring Site 2
CTO NO.: Ø367 BORING NO.: 2-GWØ3IW
COORDINATES: EAST: NORTH:
ELEVATION: SURFACE: TOP OF PVC CASING:

RIG: Mobil B-58	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		3 1/4"		2/20/97	68.5	Prtly. Cldy 60's	24.05	2/22/9
LENGTH	2.0		5'		2/21/97	60.0			
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Type II Intermediate well

SAMPLE TYPE
S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC (stick-up)	-3.2	50
Screen	2.0"	Schedule 40 0.01 Slot	50	60

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1	AN					Auger to 40' to begin Sampling.		
2						Drk. Gray to Blk. F. Sand & Silt with organic layer Damp to moist. water @ 4.0' to 5.0' bgs		
3						@ ~ 5'-7' chgs. to Lt. gray F.G. Sand. Trace to Little Silt. wet		
4								
5								
6								
7								
8								
9								
10						Match to Sheet 2		

DRILLING CO.: Parratt-Wolff BAKER REP.: J. Tepsic
DRILLER: Layne Pech BORING NO.: 2-GWØ3IW SHEET 1 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Long Term Monitoring Site 2
CTO NO.: 0367
BORING NO.: 2-GW03IW

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
RQD = Rock Quality Designation (%)
PID = Photoionization Detector
ppm = parts per million

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevatio (ft. MSL
11						Continued from Sheet 1		
12						Lt. gray F.G. Sand		
13						Trace to little		
14						Silt. wet.		
15						H.S.A. to 40'		
16						No Samples.		
17								
18								
19								
20								
21								
22								
23						Water @ 24.05' bgs		
24						on 2/22/97		
25								
26								
27								
28								
29								
30								

DRILLING CO.: Parratt - Wolff
BAKER REP.: J. Tepsic
DRILLER: Layne Pech
BORING NO.: 2-GW03IW SHEET 2

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Long Term Monitoring Site 2
CTO NO.: 0367 BORING NO.: 2-GW03IW

SAMPLE TYPE
S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

DEFINITIONS
SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
RQD = Rock Quality Designation (%)
PID = Photoionization Detector
ppm = parts per million

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
31						Continued from Sheet 1		
32						H.S.A to 40'		
33						No Samples		
34								Bentonite slurry to 34' bgs
35								
36								
37								
38								
39								
40								
41	S-1	1.0'/2.0' 50%	17, 23, 21, 18			Lt. Gray F.G. Sand, Trace Silt. Dense, wet.		
42								
43	S-2	1.58'/2.0' 79%	6, 4, 1, 1			Same material, Except, Note blow counts. "Loose"		
44								
45	S-3	1.83'/2.0' 92%	1, 3, 4, 21			Lt. Gray F.G. Sand, w/ Little Silt. Med. Dense, wet.		Top of Sand @ 45' bgs
46								
47	S-4	2.0'/2.0' 100%	13, 26, 38, 61			Lt. Gray F.G. Sand, w/ Trace Silt. Very Dense, wet		
48								
49	S-5	1.67'/2.0' 83%	21, 23, 33, 32			Same as above		
50								

DRILLING CO.: Parratt-Wolff BAKER REP.: J. Tepsic
DRILLER: Layne Pech BORING NO.: 2-GW03IW SHEET 3 OF 1

Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Long Term Monitoring
CTO NO.: 0367 BORING NO.: 2-GW03IW

SAMPLE TYPE
S = Split Spoon; T = Shelby Tube; R = Air Rotary; D = Denison; A = Auger; W = Wash; C = Core; P = Piston; N = No Sample

DEFINITIONS
SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
RQD = Rock Quality Designation (%)
PID = Photoionization Detector
ppm = parts per million

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
51	S-6	1.17'/2.0 58%	21 33 5%4"			Continued from Sheet 1 Lt. Gray F.G. Sand. Very Dense. wet.		Top of screen @ 50' bgs
52								
53	S-7	1.17'/2.0 58%	21 56/6"			Same as above		
54								
55	S-8	0/2.0 0%	28 35 45 45			No Recovery. Very Dense		
56								
57	S-9	1.08/2.0 54%	20 10 19 25			Lt. Gray F.G. Sand med. Dense. wet		
58								
59	S-10	1.17'/2.0 58%	17 26 35 43			Lt. Gray F. G. Sand. Very Dense, wet.		
60								Btm. of screen @ 60' bgs
61	S-11	1.42/2.0 71%	7 10 35 55/4"			Lt. Gray F.G. Sand w/ Trace silt. Dense, wet.		
62								
63	S-12	0.58/2.0 29%	35 50/4"			Lt. Gray F.G. Sand w/ Trace Silt. Very Dense, wet		
64								
65	S-13	0.5/2.0 25%	66/6"			Lt. Gray F.G. Sand moist Note: subtle chg. in Moisture Content.		
66								
67	S-14	0.33/2.0 17%	52 50/3"			Lt. Gray F.G. Sand. Very Dense. moist to wet.		
68								
69	S-15	0.5/2.0 25%	48 50/4"			Lt. Gray F.G. Sand. Very Dense, wet.		
70								

DRILLING CO.: Parratt-Wolff BAKER REP.: J. Tepsic
DRILLER: Layne Pech BORING NO.: 2-GW03IW SHEET 4 OF 4

ATTACHMENT B
WELL DEVELOPMENT RECORD

Baker

Baker Environmental, Inc.

FIELD WELL DEVELOPMENT RECORD

PROJECT: Monitoring and O&M Program Support, MCB Camp Lejeune, North Carolina

CTO NO.: 367 WELL NO.: 2GW03IW

DATE: 2-26-97

GEOLOGIST/ENGINEER: JEFF TEPSIC

TIME START 1230	**DEVELOPMENT DATA**						
TIME FINISH 1312	TIME	CUMULATIVE VOLUME (gallons)	pH	TEMP (°C)	SPECIFIC COND. (µmhos/cm)	TEMP (°C)	COLOR AND TURBIDITY
INITIAL WATER LEVEL (FT) 26.99	1230	5.0	5.70	17.4	260	17.0	Dk. Gray Very Turbid
TOTAL WELL DEPTH (TD) ≈ 60	1238	10.0	5.43	17.9	320	17.0	Dk. Gray Very Turbid
WELL DIAMETER (INCHES)	1245	15.0	5.20	18.1	455	17.5	Dk. Gray Slightly Less Turbid
CALCULATED WELL VOLUME ≈ 5.2 GAL	1251	20.0	5.18	18.2	500	18.0	Dk. Gray Slightly Less Turbid
BOREHOLE DIAMETER (INCHES)	1258	25.0	5.20	18.0	500	18.0	Dk. Gray Slightly Less Turbid
BOREHOLE VOLUME	1304	30.0	5.20	18.1	500	18.0	Gray Slightly More Clearing
AMOUNT OF WATER ADDED DURING DRILLING NA	1312	35.0	5.19	18.0	500	18.5	Gray Slightly More Clearing
DEVELOPMENT METHOD Check valve with Surge Block							
PUMP TYPE Waterra™							
TOTAL TIME (A) 42 min.							
AVERAGE FLOW (GPM)(B)							
TOTAL ESTIMATED WITHDRAWAL AxB=							
HNU/OVA READING							

ATTACHMENT C
CHAIN-OF-CUSTODY DOCUMENTATION

Baker Environmental, Inc.
Airport Office Park, Bldg. 3
420 Rouser Road
Coraopolis, PA 15108
412-269-6000
412-269-6097 (fax)

CHAIN-OF-CUSTODY RECORD

Lab and BOA #: Weston
Delivery Order #:
Project Number: 367
Project Name: Monitoring
Field Team: Tom Trebilcock
SEND RESULTS TO:

Matrix ~~Sample Number~~	1997 Date	Time	Sample Location	Matrix Type (1) GB (2)	Matrix Type (1) COM (2)	Analytical Methods: VOAs by 8260	Type of Container(s) (3)	Number of Container(s)	General Comments: Sample ID ~~Remarks~~
Blank	4/25	0800		GB		X	G/2		02-TB01-97B
GW	4/25	0845	Site 2	GB		X			02-GW11-97B
GW	4/25	1015		GB		X			02-GW10-97B
GW	4/25	1335		GB		X			02-GW07-97B
GW	4/25	1510		GB		X			02-GW08-97B
GW	4/25	1635		GB		X			02-GW03-97B
GW	4/25	1835		GB		X			02-GW03IW-97B
GW	4/25	1910		GB		X			02-GW12-97B
GW	4/25	2020	↓	GB		X			02-GW05-97B

COC # 36797B01

Relinquished By: R.T. Trebilcock Date: 4/25/97 Time: 1200
Received By: Date: Time:
Shipped by (check one): Hand ☐ Overnight ☐ Other ☐

Relinquished By: Date: Time:
Received By: Date: Time:
Shipped by (check one): Hand ☐ Overnight ☐ Other ☐

Relinquished By: Date: Time:
Received By: Date: Time:
Shipped by (check one): Hand ☐ Overnight ☐ Other ☐

Sample Stored at 4 Degrees C: Yes ☒ No ☐
Chain-of-custody seal on cooler: Yes ☒ Number: No ☐
Analysis turnaround: Priority ☐ ____ hrs. Regular ☒
See Work Order ☐
See Analysis Request Form ☐
Sample Disposal Return to Baker ☐ Lab Disposal ☒
Archive until: (date)

NOTES:
(1) A - Air; GW - Groundwater; L - Leachate; S - Spring; SS - Surface Soil; SB - SubSurface Soil; SW - Surface Water; W - Waste; WP - Wipe; WW - Wastewater
(2) GB - Grab; COM - Composite
(3) P - Plastic; G - Glass

White - Return with analytical results; Yellow - Laboratory Copy; Pink - Field Copy

Courier Name: FedEX
Courier Pickup Number: 355827382 1
File Name:

ATTACHMENT D
SAMPLE TRACKING FORM

Sample Tracking and Chain-of-Custody Documentation - Site 2
Monitoring and O&M Program Support, CTO-367
MCB, Camp Lejeune, North Carolina

MATRIX	SAMPLE ID	DATE SHIPPED	Analysis Requested	Analysis Received	DATE RECEIVED	TURNAROUND TIME	RFW #	COMMENTS
			TCL Volatiles (EPA 8260)	TCL Volatiles (EPA 8260)				
	COC# 36797B01							
Groundwater	02-GW03-97B	4/26/97	X	X	5/21/97	25	9704G370	
	02-GW03IW-97B	4/26/97	X	X	5/21/97	25	9704G370	
	02-GW05-97B	4/26/97	X	X	5/21/97	25	9704G370	
	02-GW07-97B	4/26/97	X	X	5/21/97	25	9704G370	
	02-GW08-97B	4/26/97	X	X	5/21/97	25	9704G370	
	02-GW10-97B	4/26/97	X	X	5/21/97	25	9704G370	
	02-GW11-97B	4/26/97	X	X	5/21/97	25	9704G370	
	02-GW12-97B	4/26/97	X	X	5/21/97	25	9704G370	
	02-TB01-97B	4/26/97	X	X	5/21/97	25	9704G370	
TOTALS			9	9				

ATTACHMENT E
SAMPLE DESIGNATIONS

SAMPLE DESIGNATIONS

In order to accurately identify and differentiate samples collected during the monitoring program, all samples were designated with a unique identification number. The unique sample number identifies the site, the sample media, the sampling station's number, and the quarter in which the sample was collected. The sample designation format is as follows:

Site Number - Sample Station Identifier - Year and Quarter

An explanation of each identifier is provided below:

Site Number	The investigation was conducted at Site 2.
Sample Station Identifier	Each monitoring well has been assigned a unique identification number. The identification number may include the qualifiers "IW" which denotes an intermediate monitoring well and "GW" which denotes groundwater.
Year	The investigation was conducted during 1997.
Quarter	The investigation was conducted during the first quarter. The four quarters of year are identified by the first four letters of the alphabet (i.e., A, B, C and D).

Under this sample designation format the sample number 02-GW03IW-97B refers to:

02-GW03IW-97B	Site 2
02-GW03IW-97B	Groundwater sample.
02-GW03IW-97B	Monitoring well No.3.
02-GW03IW-97B	Intermediate monitoring well.
02-GW03IW-97B	Year 1997.
02-GW03IW-97B	The second quarter (i.e., April through June).

ATTACHMENT F
MONITORING PROGRAM ANALYTICAL RESULTS - FEBRUARY 1997

GROUNDWATER ANALYTICAL RESULTS
APRIL 1997
OPERABLE UNIT NO. 5 - SITE 2
MONITORING AND O&M SUPPORT, CTO-0367
MCB, CAMP LEJEUNE, NORTH CAROLINA
VOLATILES ORGANICS

SAMPLE ID	02-GW03-97B	02-GW03IW-97B	02-GW05-97B	02-GW07-97B	02-GW08-97B	02-GW10-97B	02-GW11-97B	02-GW12-97B
DATE SAMPLED	04/25/97	04/25/97	04/25/97	04/25/97	04/25/97	04/25/97	04/25/97	04/25/97
VOLATILES (ug/L))								
CHLOROMETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
BROMOMETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
VINYL CHLORIDE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
METHYLENE CHLORIDE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
ACETONE	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
CARBON DISULFIDE	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
1,1-DICHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-DICHLOROETHENE (TOTAL)	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CHLOROFORM	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-DICHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-BUTANONE	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
1,1,1-TRICHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CARBON TETRACHLORIDE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
BROMODICHLOROMETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-DICHLOROPROPANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CIS-1,3-DICHLOROPROPENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TRICHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
DIBROMOCHLOROMETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-TRICHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
BENZENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TRANS-1,3-DICHLOROPROPENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
BROMOFORM	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
4-METHYL-2-PENTANONE	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
2-HEXANONE	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
TETRACHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-TETRACHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TOLUENE	7	0.5 U	0.5 U	0.5 U	0.6	0.5	0.5	0.5 U
CHLOROBENZENE	2	0.5 U	0.5 U	0.5	0.5 U	0.5 U	0.5 U	0.5 U
ETHYLBENZENE	170	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
STYRENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
XYLENE (TOTAL)	1600	4	0.5 U	2	0.5 U	0.5 U	0.5 U	15