DRAFT FINAL

TECHNICAL MEMORANDUM #7

ESI PHASE III -- HYDROGEOLOGIC CHARACTERIZATION AND INVESTIGATION OF CONTAMINANT DISTRIBUTION IN GROUNDWATER

FOR THE EXPANDED SITE INVESTIGATION -- FORMER FIRE TRAINING AREA MARSHALL ARMY AIRFIELD, FORT RILEY, KANSAS AND NEARBY OFF-POST PROPERTIES

26 April 1996

Prepared for
United States Army Engineer District, Kansas City
601 East 12th Street
Kansas City, Missouri 64106-2896
DACA41-92-D-0001

Prepared by
Louis Berger & Associates, Inc.
1819 H Street, N.W., Suite 900
Washington, D.C. 20006

Louis Berger & Associates, Inc.
100 Halsted Street, East Orange, New Jersey 07019
Tel 973.678.1960 • Telex 138.152 • Fax 973.672.4284
ENGINEERS • PLANNERS • SCIENTISTS • ECONOMISTS • ARCHAEOLOGISTS

A MEMBER OF THE BERGER GROUP

10 July 1998

Glen Shonkwiler
U.S. Army Engineer District, Kansas City
ATTN: CENWK-EP-EA
601 East 12th Street
Kansas City, MO 64106-2896

RE: Draft Final Technical Memorandum # 7, ESI Phase III - Hydrogeologic Characterization and Investigation of Contaminant Distribution in Groundwater for the Expanded Site Investigation - Former Fire Training Area, Marshall Army Airfield, Fort Riley, Kansas.
Contract No. DACA41-92-D-0001

Dear Mr. Shonkwiler: Glen

Enclosed are two copies of the Draft Final Technical Memorandum # 7 dated 26 April 1996 for the Former Fire Training Area, Marshall Army Airfield, Fort Riley, Kansas. Copies are also being forwarded to Fort Riley and the other parties on the attached distribution list.

This document has been checked and coordinated during Berger's internal review prior to this submittal.

Should you have any questions, please call me at (973) 678-1960 Extension 737.

Sincerely,

LOUIS BERGER AND ASSOCIATES, INC.

Susan E. Knauf
Project Director

F:\HOME\SKNAUF\RILEY\TECHMEMO.LTR
Enclosures (2)

copy:

Directorate of Environment & Safety
(6 copies)
AFZN-ES-L (Attn: Mike Greene)
Bldg 407 Pershing Court (1st Floor)
Fort Riley, KS 66442-6016

Bob Koke (2 copies)
Federal Facilities/Special Emphasis Section
Superfund Division
U.S. Environmental Protection Agency, Region VII
726 Minnesota Avenue
Kansas City, Kansas 66101

Randy Carlson (2 copies)
Bureau of Environmental Remediation
Kansas Department of Health and Environment
Forbes Field, Building 740
Topeka, Kansas 66620-7500

U.S. Army Environmental Center
(2 copies)
ATTN: ENAEC-IR-P/Joe King
Aberdeen Proving Ground, MD 21010-5401

Tracy Cooley (2 copies)
Burns & McDonnell
9400 Ward Parkway
Kansas City, MO 64114

LBA: Harris Cheema
File JH1125

DRAFT FINAL

TECHNICAL MEMORANDUM #7

ESI PHASE III -- HYDROGEOLOGIC CHARACTERIZATION AND INVESTIGATION OF CONTAMINANT DISTRIBUTION IN GROUNDWATER
FOR THE EXPANDED SITE INVESTIGATION -- FORMER FIRE TRAINING AREA MARSHALL ARMY AIRFIELD, FORT RILEY, KANSAS AND NEARBY OFF-POST PROPERTIES

26 April 1996

Prepared for
United States Army Engineer District, Kansas City
601 East 12th Street
Kansas City, Missouri 64106-2896
DACA41-92-D-0001

Prepared by
Louis Berger & Associates, Inc.
1819 H Street, N.W., Suite 900
Washington, D.C. 20006

Technical Memorandum #7/FFTA-MAAF ESI

ESI Phase III - Hydrogeologic Characterization and Investigation of Contaminant Distribution in Groundwater

26 April 1996

1.0 Overview

The Expanded Site Investigation (ESI) of the Former Fire Training Area - Marshall Army Airfield (FFTA-MAAF), Fort Riley, and the Nearby Off-Post Properties is being implemented in accordance with the Draft Final Sampling and Analysis Plan (SAP) dated 24 May 1994. To date, both Phase I and Phase II activities of the ESI have been completed.

Phase I was initiated in June 1994 and included periodic sampling of groundwater wells (both on-post and off-post), installation and sampling of one piezometer adjacent to the Kansas River, off-post soil gas and groundwater screening surveys, monthly measurements of groundwater elevations, and geophysical surveys to characterize the subsurface geology.

Phase II was initiated in August 1994 and included activities to evaluate the hydrogeologic characteristics as well as the vertical and horizontal extent of contaminant migration in the off-post areas. Specifically, Phase II included an expanded area of investigation for the groundwater screening survey, installation and sampling of four monitor wells in the off-post area, soil sampling in the off-post area, and collection of deep alluvial groundwater screening samples. Each of these activities were described in detail as part of Technical Memoranda #1, #2, #4, #5, and #6.

This technical memorandum briefly summarizes the findings of the investigations conducted at MAAF to date, including preliminary findings of the initial SI (October 1993) and of the ESI including data collected between June 1994 and January 1995. [These data are also presented in more detail in the Draft Final SI Report for MAAF (19 December 1995)]. Additionally, groundwater monitoring and elevation data have been collected after January 1995 including April 1995, August 1995 and December 1995. This additional data have been compared with the data presented in the Draft Final SI Report, and noteworthy differences are identified and described in this memorandum. Based on the results of the ESI to date, this technical memorandum presents additional Phase III activities.

The purpose of Phase III investigations is to collect additional data to support preliminary risk evaluations, which requires the use of "definitive data," as defined by EPA (<u>Data Quality Objectives Process for Superfund, Interim Final Guidance</u>, EPA 540-R-93-071, September 1993).

[Collection of groundwater screening samples for field analyses with laboratory verification is considered by EPA to be "screening data with definitive confirmation" whereas collection of groundwater samples from permanent wells for laboratory analyses is considered "definitive data."] The results of Phase III will also allow for preliminary identification and screening of potential remedial alternatives for groundwater contamination at the site. The work outlined in this Technical Memorandum will be conducted in accordance with the Comprehensive Basic Documents for the Site Investigations at Fort Riley, Kansas which includes the Quality Assurance Project Plan (QAPP as revised in January 1995) and the Monitoring Well Installation Plan (MWIP as revised in August 1994).

2.0 Summary of ESI Results

The results of the ESI for both Phase I and Phase II are presented below by media and by activity. [These data are also presented in more detail in the Draft Final SI Report for MAAF (19 December 1995)]. These results are also compared with data obtained during the SI conducted at the site in September through November 1993, which have been previously presented in the ESI SAP (24 May 1994).

Generally, geologic materials underlying the site consist of thick alluvial deposits (60 to 70 feet thick) along the Kansas River; the alluvial deposits are composed primarily of sands and gravels with some silt and clay lenses. The bedrock is described as light gray, soft, weathered limestone. The depth to groundwater is on average 15 to 18 feet below ground surface and predominant flow is in a northerly direction with slight eastern or western flow components, depending on the season and recent precipitation. A more detailed description of the site hydrogeologic setting is provided in the Draft Final SI Report for MAAF (19 December 1995).

Monthly Groundwater Elevation Measurements. Groundwater elevations were recorded and gradients were prepared using data from the seven on-post monitoring wells for the months of October 1993, January 1994, March 1994, and for June through August 1994. By September 1994, one piezometer was installed on-post by the Kansas River and four groundwater monitoring wells were installed off-post north of the FFTA. Therefore, monthly groundwater measurements from September 1994 through January 1995 included the seven on-post groundwater monitoring wells, one on-post piezometer, and four off-post monitor wells. The tabular results for the recorded groundwater elevations described above are presented in Table 1. Additional groundwater elevation data were collected from these 12 locations monthly through April 1995, and then as part of additional groundwater sampling in August and December 1995.

The data for October 1993 and January 1994 were presented in the ESI SAP. The October 1993 data were collected at a time when depth to groundwater was approximately 10 feet due to regional flooding in July 1993. Indeed, the interior of the racetrack (located north of FFTA) remained inundated with water through the fall of 1993. Figure 1 depicts the October 1993 groundwater elevation data and shows that, at the site, there is a strong westward component to the otherwise northern direction of groundwater flow. Since October 1993, groundwater levels have receded to depths of approximately 17 feet beneath the surface. Further, the groundwater flow direction and gradient has remained similar from January 1994 through December 1995. As examples, the groundwater elevation maps for January 1994, September 1994 and January 1995 are presented as Figures 2 through 4. Although the September 1994 map is based on more data points (one piezometer and four monitoring wells) than the January 1994 map, both figures show a general groundwater flow direction to the north with a northeast component on the eastern portion of the site and a northwestern component on the western portion of the site. The more recent data collected in January 1995, April 1995 and August 1995, however, indicate a more predominant northeast groundwater flow direction. In contrast however, data collected in December 1995 indicate a distinct north-northwesterly flow direction.

Soil Gas and Groundwater Screening Surveys. Soil gas and groundwater screening surveys were performed as part of three separate events: the SI in the fall of 1993, Phase I of the ESI in June and July 1994, and Phase II of the ESI in August 1994 through January 1995. Each of these consisted of the following:

- SI - 58 locations on-post, soil gas and groundwater screening samples
- Phase I ESI - 238 locations off-post for soil gas samples; 90 locations off-post for groundwater screening samples
- Phase II ESI - 154 locations off-post for groundwater screening samples

The results of the SI were presented in the ESI SAP; results of Phase I were presented in Technical Memorandum #1, and results of Phase II were presented in Technical Memoranda #2 and #6. As illustrated in prior comparisons of the data, the results of the soil gas surveys in the SI and Phase I of the ESI correlated well with the results of the groundwater screening. Specifically, the soil gas and groundwater screening samples detected the same types of contaminants in the same areas and the magnitude of the detections were similar. Following the SI and Phase I of the ESI, Phase II included only groundwater screening samples since they provided data on direct measurements of the media of concern.

All groundwater screening samples were analyzed in the field using a gas chromatograph. Through all stages of the groundwater screening survey, a minimum of 10% of the samples were transported to an off-site laboratory for chemical analyses. A detailed correlation of laboratory versus field data is not presented here. Comparisons of field and laboratory detections are presented in the ESI SAP and in Technical Memorandum #1. The results of the groundwater screening data meet EPA's criteria for field screening data with definitive confirmation, which are appropriately used to characterize the extent and magnitude of contamination at the site.

An overview of the results of the ESI groundwater screening survey is presented in Figure 5. This figure identifies all the locations where there were detections of chlorinated VOCs. In general, there were few detections of non-chlorinated VOCs, which would be indicative of migration of petroleum hydrocarbons. The primary contaminants detected were tetrachloroethylene (PCE), trichloroethylene (TCE) and cis and trans 1,2-dichloroethylene (1,2-DCE).

Separate isoconcentration contours were developed for PCE, TCE and 1,2-DCE. In addition, isoconcentration contours were developed for total chlorinated VOCs. In compiling the isoconcentration contours, data from all groundwater screening sampling events were used (SI, Phase I and II ESI). However, it is important to note that these data were collected over a period in excess of 15 months. Thus, a direct comparison does not account for temporal variations or migration of contaminants over time. Nonetheless, the composite isoconcentrations provide an overview of the locations with detected concentrations of VOCs and the relative magnitude of the detections.

The isoconcentrations for PCE, TCE, 1,2-DCE and total chlorinated VOCs are presented in Figures 6, 7, 8 and 9, respectively. The detections of chlorinated VOCs occur in an area downgradient of the FFTA, extending from the FFTA across the racetrack property in a north-northeast direction. Detections were also recorded in agricultural fields located to the north of the racetrack property. The direction of detections away from the FFTA is consistent with the general groundwater flow direction for the site. In general, the pattern of detections are similar for each contaminant; however, detections in the area of the racetrack and in the agricultural fields further to the north are not contiguous. For the remainder of this technical memorandum, the total chlorinated VOCs isoconcentrations will be used to illustrate areas of groundwater screening detections.

Geophysical Survey Results. The ESI included a seismic reflection survey and electrical resistivity soundings to characterize depth to bedrock, the topography of the underlying bedrock surface, and geologic layering (if any) in the alluvial materials. The results of the geophysical surveys consist principally of a projected bedrock contour map (Figure 10). This map was presented in Technical Memorandum #5, which included an attachment describing the results of the interpretation of the geophysical data. The results of the geophysical surveys were used to plan collection of deep alluvial groundwater screening samples, as discussed below.

Deep Alluvial Groundwater Screening Samples. As described in the Addendum to Technical Memorandum #5, the USACE Site Characterization Analysis Penetrometer System (SCAPS) rig was used to collect deep alluvial groundwater screening samples and cone penetrometer (CPT) and electrical resistivity data. The groundwater screening samples were analyzed for chlorinated VOCs in the field, with a duplicate at each location also analyzed in the laboratory.

The locations of the SCAPS samples are depicted on Figure 10. CPT and resistivity data were used to assist in identifying geologic layers from the surface to the top of bedrock and to provide stratigraphic and depth-to-bedrock data to calibrate the August 1994 geophysical results. The CPT data showed that there were no low permeability layers present from the water table to the top of bedrock.

The deep alluvial groundwater screening samples were collected from depths of 53 to 73 feet. Chlorinated VOCs were detected at CPT locations CP-2, CP-4, CP-5, CP-6, and CP-9. There was one detection of 1,2-DCE at 1.1 μg/l and four detections of TCE ranging from 1.0 to 2.8 μg/l. The SCAPS groundwater screening samples indicate that DNAPL is not present at the site since the concentrations detected are greater than five orders of magnitude below their respective limits of solubility, as shown below:

Locations	Detections (μg/l)	Specific Gravity [a]	Solubility in Water (ppb-ug/l)[a]
CP-9	TCE - 2.7	1.46	1,100,000
CP-2	1,2-DCE - 1.1	1.28	6,300,000
CP-4 [b]	TCE - 2.8	1.46	1,100,000
CP-5	TCE - 1.2	1.46	1,100,000
CP-6	TCE - 1.0	1.46	1,100,000

(a) Reference *Handbook: Responding to Discharges of Sinking Hazardous Substances*, EPA/540/2-87/001, September 1987, Appendix F.

(b) detected in the 53 foot sample, not the 72 foot sample.

Periodic Groundwater Sampling. During the ESI, groundwater samples were collected at the following locations: seven on-post monitor wells (FP-93-01 through -07); nine of the off-post residential wells (N-1, M-1, R-1, R-2, R-3, F-1, F-2, I-1 and B-1); one on-post piezometer (FP-94-12PZ); and four off-post monitor wells (FP-94-08 through FP-94-11). The monitor well results represent "definitive data," as outlined by EPA's Data Quality Objectives for Superfund sites. Groundwater samples were collected during the months of October 1993, July/August 1994, October 1994, January 1995, April 1995, August 1995 and December 1995. An overview of each sampling event is provided below:

- October 1993 - the seven on-post monitor wells and six of the off-post residential wells (N-1, M-1, R-1, F-1, F-2 and B-1) were sampled.

- July/August 1994 - the seven on-post wells and eight of the private wells were sampled (same wells as October 1993 with the addition of R-2 and R-3, which were not sampled during October due to the regional flooding).

- October 1994 - same as July/August 1994.

- January 1995 - four off-post monitor wells and one on-post piezometer had been installed and were added to the sampling of the seven on-post monitor wells and the private wells; four of the private wells (wells R-1, R-2, F-1 and F-2) were shut down for the winter by their owners and could not be sampled.

- April 1995 - all available wells were sampled with the exception of F-2 which was not reopened from the winter by the owner.

- August 1995 - all available wells were sampled with the exception of F-2 which was not reopened from the winter by the owner.

- December 1995 - the seven on-post wells, one piezometer, four off-post monitor wells, four private wells (R-1, R-2, F-1 and F-2 were out of service for the winter and could not be sampled), one irrigation well and the supply well located at MAAF were sampled.

All samples were analyzed for volatile organic compounds (VOCs) using EPA Method 8240 or 8260, semi-volatile organic compounds (SVOCs) using EPA Method 8270, total petroleum hydrocarbons (TPH) - gasoline and diesel fractions (TPH-GRO and TPH-DRO, respectively) using EPA Method 8015 modified, and priority pollutant (PP) metals using EPA Methods 6010 and 7000 Series. The primary contaminants detected are chlorinated VOCs -- 1,2-DCE, PCE and TCE. These were the same compounds identified in the groundwater screening samples. An overview of the positive detections in the on-post wells is presented in Table 2. Positive detections in the off-post wells are presented in Table 3. These tables do not include the results of the April 1995 or later sampling.

Isoconcentration maps for PCE, TCE and 1,2-DCE based on the October 1993 data were presented in the ESI SAP. Isoconcentration maps for PCE, TCE and 1,2-DCE based on the July 1994 data are presented in Section 1.0 of the Comparative Data Summary Report for the site (7 December 1994). Isoconcentration maps for PCE, TCE, 1,2-DCE and total chlorinated VOCs based on the October 1994 data are attached as Figures 11 through 14, respectively. Overall, R-1 is the most downgradient well with detected concentrations of VOCs, and the detected concentrations are higher than other wells closer to the site. Since R-1 could not be sampled in January 1995, isoconcentrations from that round of sampling are misleading and are not presented. The discussion below addresses the October 1994 findings.

Figures 11 through 14 show that chlorinated VOCs have migrated from the site towards the north-northeast, in the direction of groundwater flow. The areas of contamination based on these isoconcentration maps are largely overlapping for the different contaminants. Isoconcentration maps depict a similar pattern for the July 1994 and October 1993 samplings as well as the April 1995, August 1995 and December 1995 events. However, the concentrations at specific sampling locations have varied with time, as described in the following paragraph.

Table 4 presents a compilation of the 1,2-DCE, PCE and TCE data for the four sampling rounds through January 1995. These results are described below with an additional description of applicable findings from subsequent sampling events in April, August and December 1995. The most drastic changes with time were seen in well FP-93-04 for 1,2-DCE. The concentration in FP-93-04 has decreased from 4,100 μg/L in October 1993 to 3.3 μg/L in January 1995 and was not detected in December 1995. There were also decreases in concentrations in well FP-93-02. These would include 1,2-DCE concentrations decreasing from 76 μg/L in October 1993 to 5.5 μg/L in January 1995 and 14 μg/L in December 1995 with a slight increase to 140 μg/L in April 1995. PCE concentrations decreased from 210 μg/L in October 1993 to 16 μg/L in January 1995. Similar to 1,2-DCE, PCE increased in April 1995 to 320 μg/L, however, decreased to 52 μg/L in December 1995. Additionally, there was an increase in R-1 for 1,2-DCE. Changes for R-1 concentrations would include 1,2-DCE increasing from 98 μg/L in October 1993 to 290 μg/L in October 1994, and PCE increasing from 160 μg/L in October 1993 to 380 μg/L in October 1994. When reviewing data from on-post wells (FP-93-04 and FP-93-05), it is important to note that the pilot test study (removing VOCs from soils at the site using bioventing and soil vapor extraction technologies) was initially conducted between October 1994 and January 1995, with operations continuing through August 1995. The actual or potential impact of the pilot study on groundwater concentrations at the site has not been fully evaluated at this time.

3.0 Issues

Based on the data collected for the ESI, the following issues are identified:

- Improved Characterization of Shallow Groundwater Flow Direction and Gradient. The groundwater data collected to date indicate that groundwater flows in a north-northeast direction on the eastern portion of the site and in a north-northwest direction on the western portion of the site. The presence of a northwestern component of groundwater flow contrasts with the north-northeast trending pathway of contaminant migration indicated by the results of Phase I and II groundwater screening. The appearance of a northwest flow component on the western portion of the site in the groundwater gradient maps is due to the consistently low groundwater elevation measured at FP-94-12PZ, located near the Kansas River. The piezometer located by the river clearly shows that groundwater elevations decrease toward the river; however, there are insufficient data points at present to determine where the presence of the river begins to influence the otherwise northeast groundwater flow direction. This was confirmed by correlating the elevation data from FP-94-12PZ with the Kansas River gaging data. The correlation indicated that the water level measured in this piezometer is directly dependent upon the elevation of the river. In preparing the groundwater gradient maps presented in the Draft Final SI Report (and this memo), changes in groundwater elevations between the piezometer near the river and wells near the FFTA were presumed to be linear. The result is that the presence of the river appears to be effecting the northeast groundwater flow direction immediately west of the site, deflecting the groundwater flow direction to the northwest. In actuality, the changes in groundwater elevations between the site and the river may not be linear, with changes in groundwater elevations occurring more rapidly in the immediate vicinity of the river. In this instance, the groundwater flow direction across the FFTA and downgradient of the FFTA would be more uniform in direction. Determining the direction of groundwater flow across the site and downgradient of the site is critical for predicting contaminant migration and for performing an initial screening of remedial alternatives.

- Vertical Distribution Characterization. The screening of remedial alternatives relies on defining the extent of both horizontal and vertical contamination. Extensive data have been collected to determine the horizontal extent of groundwater contamination, using both "screening data with definitive confirmation" as well as "definitive data." To date, the extent of vertical contamination was evaluated with the SCAPS rigs. This data shows that, while DNAPL is not present, some dissolved phase chlorinated compounds may be present at depths of 50 to 70 feet. [The deep alluvial samples were collected with a driven probe that relies on the creation of an impermeable seal between the natural materials and the probe rods as the probe tip is being advanced to the sampling depth. Because the natural materials at the site are predominantly sands, the seal between the probe rods and the sands will not be as effective as the seals occurring in materials comprised of higher percentages of silts and clays. Therefore, the detections of low concentrations of organic compounds in the deep alluvial materials (particularly as noted for some gasoline compounds which are lighter than water -- toluene, ethylbenzene and xylenes) may be attributable to carry-through as a result of advancing the probe through a zone of shallow contamination.] Existing monitor wells are installed to depths of 30 feet or less. Therefore, additional data are needed between depths of 30 feet and the top of bedrock to determine whether contaminants occur at depth in the alluvial materials and to define the thickness of alluvial materials potentially requiring remediation based on "definitive data."

- Determination of Aquifer Characteristics. Phase II groundwater screening survey results indicate that contaminants have migrated greater than 2,000 feet north of the FFTA. To estimate the migration rate and perform an initial screening of remedial alternatives, it is necessary to determine aquifer flow characteristics and other associated physical and chemical parameters that may impact contaminant migration.

- Shallow Horizontal Characterization. There are seven monitoring wells installed on-post and four monitoring wells installed off-post, all screened in the shallow alluvial materials. Contamination has been delineated within the shallow alluvium primarily by groundwater screening; this has been augmented by the sampling of private wells and monitor wells. Additional monitoring wells need to be installed in the off-post area to confirm the groundwater screening results and define the extent of contamination. As mentioned previously, the groundwater screening results are considered "screening data." In contrast, chemical data from samples collected from monitor wells, the piezometer and private wells are considered "definitive data," the level of data considered acceptable by the EPA for use in risk assessments. Therefore, the additional wells are needed to provide "definitive data" from the area of contamination that has been delineated based on groundwater screening samples.

4.0 Proposed Actions

The following actions are proposed to address each issue identified above. Where additional sampling is recommended, a separate figure is presented to illustrate the proposed sampling locations relative to other site features (Figures 15 through 18). These figures are followed by a single figure that presents all proposed sampling locations on a single site sketch (Figure 19).

Improved Characterization of Shallow Groundwater Flow Direction and Gradient.

It is proposed that five additional piezometers be installed to clarify the groundwater flow north and west of the FFTA. These locations are depicted on Figure 15 and are presented with the October 1994 groundwater gradient map. All locations are established to provide groundwater elevation information in the area between the site and the river, resulting in an improved characterization of groundwater flow across the site. Specifically, four of the piezometers (FP-96-13PZ through -16PZ) will be located to the west and northwest of the site. The data from these points will determine whether the deflection of the groundwater gradient from the northeast to the northwest occurs in an area downgradient of the site or is located in closer proximity to the river. The remaining piezometer, FP-96-17PZ, is located upgradient of the site so that groundwater gradients across the FFTA can be tied to both this new piezometer and existing well FP-93-07. All five proposed locations presented in this section are located on Fort Riley property. Groundwater elevations at these five locations will be measured monthly along with the established monitor wells and piezometer.

The five piezometers, FP-96-13PZ through FP-96-17PZ, will be installed as driven well points (as outlined in the MWIP) or using Geoprobe equipment. Standard Operating Procedures for installations of piezometers using the Geoprobe equipment are included as an attachment to this technical memorandum. With either installation technique, the piezometers will be 1-inch in diameter and will be installed with ten-foot screens with approximately six feet of screen below the typical groundwater elevation as determined from the nearest existing monitoring point. The piezometers will be constructed of schedule 40 PVC if installed with Geoprobe or with stainless steel well screen attached to steel riser rods if installed as driven well points.

Characterization of Vertical Contaminant Distribution

Three clusters of monitoring points will be established to determine the vertical groundwater flow regime. They will be located at monitor wells FP-93-04, FP-93-02 and FP-96-21 (proposed as part of this technical memorandum): FP-93-04 is located at the source of contamination, FP-93-02 is an existing on-post monitoring well downgradient of the site with detections of chlorinated VOCs, and FP-96-21 is located at the leading edge of the current delineated VOC plume and is downgradient of well R-1, which historically has the highest concentrations of TCE, 1,2-DCE and PCE. [The intermediate wells will be identified by the shallow well identifier with the suffix "b" added to the end and the year of installation modified (i.e., FP-96-02b, FP-96-04b and FP-96-21b); the deep wells will have the same identifiers as the intermediate wells with the suffix "c" added to them.] Upon review of the data collected from these wells, a determination will be made whether or not additional clusters will be installed. If the results do not provide enough data to clearly define vertical migration of contamination, one additional cluster will be installed at location FP-94-11 for the following reason: FP-94-11 is located in an area with detections of chlorinated VOCs based on groundwater screening and groundwater sampling of the well and is located along the plume length at a distance approximately midway between FP-93-02 and FP-96-21. The locations of all four clusters are included on Figure 16.

Each cluster will consist of three monitor wells: a shallow (20-30 ft), an intermediate (40-50 ft), and a deep (60-70 ft) well, installed in three separate boreholes in close proximity to each other. At each location, a shallow well either exists or is proposed in this technical memorandum; therefore, the vertical characterization will require only the installation of the intermediate and deeper monitoring points at each location. The deepest well at each location will be set on top of bedrock, with a 4 to 6-inch sump at the bottom of the well screen set into bedrock. All wells will have 10-foot well screens.

In order to minimize the potential for cross-contamination between each monitoring zone in the alluvium, the cable tool drilling method will be utilized with concurrent driving of continuous steel temporary casing. Cable tool methods do not employ the use of liquids and therefore the investigation-derived waste generated would consist only of soil cuttings removed from the borings. Steel temporary casing driven, more or less, concurrently with advancement of drilling tools forms a relatively tight contact seal with surrounding formation materials and effectively precludes the vertical movement of formation water. All temporary steel casing is ultimately removed.

The wells within the clusters will be developed and sampled at the same time and for the same chemical parameters as all existing shallow alluvial wells. These parameters are as follows: volatile organic compounds (VOCs) using EPA Method 8260, semi-volatile organic compounds (SVOCs) using EPA Method 8270, total petroleum hydrocarbons (TPH) using EPA Method 8015 Modified (TPH analyses include Gasoline Range Organics, TPH-GRO, for the gasoline fraction and Diesel Range Organics, TPH-DRO, for the diesel fraction), and priority pollutant (PP) metals using EPA Methods 6010 and 7000 series. Sampling will be conducted at all installed locations for at least the first two rounds of continued monthly sampling. Additional sampling of the clusters will be reevaluated following their second sampling event.

Shallow Horizontal Characterization

An additional seven monitoring wells are proposed to be installed in the shallow alluvium areas to verify the groundwater screening results and define the horizontal extent of contamination with "definitive data." These seven wells are depicted on Figure 17. The locations of these wells have been presented with total chlorinated VOC concentrations in groundwater to illustrate the locations of the proposed wells with respect to anticipated extent of contamination. The overall objective of the well placement is to generate lines of groundwater data approximately perpendicular to the plume at different distances from the FFTA. As a note, the January, August and December 1995 groundwater sampling data identified VOCs in FP-94-09, indicating that the width of the contaminant plume is greater than that depicted in Figure 17, extending further to the west.

The installation of additional shallow, alluvial wells will establish the centerline of the plume (from approximately south to north) as well as assess lateral spreading (longitudinal dispersion-from approximately east to west) of the plume away from the centerline. All wells will be installed in the shallow alluvial materials (i.e., screened across the upper ten feet of the water table with a 15 foot screen length).

Monitoring well FP-96-18 and FP-96-19 will be installed 250 feet east and 200 feet west of FP-94-11, respectively. These wells are located within the boundaries of the shallow groundwater contaminant plumes, as depicted on Figure 17. FP-96-18, FP-96-19 and FP-94-

11 lie in a line approximately perpendicular to the north-northeast trending migration of the contaminant plume.

Monitoring wells FP-96-20 and FP-96-21 will be installed along the line formed by FP-94-09 and FP-94-10. FP-96-20 will be located along the anticipated western edge of the established shallow contaminant plumes; and FP-96-21 will be located at the midpoint between FP-94-09 and FP-94-10, which is located within the groundwater contaminant plumes. Wells FP-96-20 and FP-96-21, along with FP-94-09, form a line of monitoring points approximately perpendicular to and across the detected groundwater contamination.

Monitoring wells FP-96-22, FP-96-23, and FP-96-24 are located near Phase II groundwater screening locations performed in accordance with Technical Memorandum #6 which had detections of chlorinated VOCs. Monitor well FP-96-22 is located south of Phase II groundwater screening locations 127 and 128 which had chlorinated solvent detections below threshold limits and is located directly south of the irrigation well, I-1. FP-96-24 is located north of Phase II groundwater screening location 100, which had chlorinated solvent detections above threshold limits and south of location 101. FP-96-23 is located directly north of location 105 which had chlorinated solvent detections below threshold limits. Presently wells FP-96-22, FP-96-23 and FP-96-24, following sampling, are expected to indicate that they are beyond the current plume of contamination exceeding MCLs and KALs. However if chemical sampling of these wells reveal that the plume has migrated further, then additional wells may need to be installed to delineate the extent of contamination.

The groundwater monitoring wells will be constructed of 2"-diameter materials. The wells will either be installed as driven well points with stainless steel screens and steel riser pipes or as PVC following the standard procedure described in the MWIP, depending on cost. All wells located on the speedway property (FP-96-18 through FP-96-21) will be installed with a flushmount casing. The remaining wells, which are located in a farmer's field, (FP-96-22 through FP-96-24) will be installed with standpipes and protective posts.

Determination of Aquifer Characteristics.

Data on three aquifer tests conducted in the alluvial materials within the boundaries of Fort Riley were examined. The tests were conducted as follows: 1975 - Camp Forsyth (approximately 4 miles west of the site), 1983 - backup supply well at MAAF (approximately 1.3 miles southwest of site), and 1984 to 1989 - Main Post (approximately 3.5 miles west of the site). The data presented aquifer transmissivities ranging from 159,331 to 767,440 gallons per day per foot and storativities ranging from 0.000126 to 0.45. Because of the variability in these data, additional site-specific information will be collected.

The measurement of the aquifer characteristics will consist of slug tests of individual wells and a pumping test of the irrigation well followed by additional pumping tests and/or dye tracer tests, as necessary.

The slug tests will be conducted at six to eight of the existing or newly installed monitoring wells. The exact locations for the tests will be determined upon completion of the prior sections and with the approval of the Army. The slug test results are expected to be more reliable for driven wells points as opposed to wells installed with Hollow Stem Auger (HSA) techniques since there is no constructed filter pack surrounding the well screens for driven wells. Therefore, driven well points will be given more favorable consideration in selecting wells for slug testing. Rising-head slug tests will be conducted in accordance with the procedures described in Berger's Monitoring Well Installation Plan (MWIP) dated 8 August 1994 included as part of the Comprehensive Basic Documents. The results of the slug tests will be used to determine the hydraulic conductivity and the heterogeneity of the aquifer. The results of the slug tests will also be compared with data on aquifer characteristics collected for the alluvial materials at MAAF, Main Post and Camp Forsyth. The values of the hydraulic conductivities will then be used to estimate the capture zone of each monitoring well.

The irrigation well to the north of the FFTA pumps large volumes of water for periods of several days at a time. Therefore, groundwater levels around and at varying distances from the irrigation well will be monitored during irrigation pump operation as well as following cessation of pumping until static groundwater levels are achieved. Data will be collected by installing six temporary piezometers in the vicinity of I-1 as depicted on Figure 18. Three piezometers will be located 75 feet from I-1, to the east, west and south. The remaining three will be located at greater distances from I-1 to the southeast and south. These piezometers will be installed using the Geoprobe equipment or HSA techniques, depending on costs. Groundwater levels will be measured during the period prior to operation of the irrigation well, during well operation, and after the irrigation well stops pumping (i.e., until the well reaches the static water level). These data will be used to further assess aquifer characteristics in the area of irrigation well.[Note: One of the piezometers is located at proposed shallow alluvial well FP-96-22; if FP-96-22 is installed prior to the pumping test of the irrigation well, then the piezometer at this location will not be installed.]

The need for additional information on aquifer characteristics will be evaluated following analyses of the slug test data and irrigation well pumping data. For example, a site-specific pumping test may be necessary under conditions that can be more tightly controlled than conditions during pumping of the irrigation well. Also, the lateral and longitudinal dispersivities of the aquifer may need to be estimated from a dye trace test. Dispersivity is the measure of dispersion caused by groundwater flow through different pores at different rates following various flow paths. The tracer test can be conducted in association with the pumping test(s) by introducing the dye into an observation well, located within the cone of depression caused by the pumping, and measuring the concentration of dye over time in the well being pumped. The tracer test can also be conducted under non-pumping conditions. The need for additional pumping tests and/or a dye tracer test and the specifics of such a tests (including the type of dye) will be presented in a separate memo, as necessary.

In addition to the aquifer characteristics, other physical and chemical parameters must be determined to estimate the contaminant migration rate and the effectiveness of a remedial system. Soil samples collected during the monitoring well installation (FP-96-18, FP-96-19 and FP-96-21) will be analyzed for grain size, total organic carbon content, total and effective porosity, and bulk density. Soil samples will be collected from five feet above the groundwater table, one foot above the water table and one foot below the water table.

5.0 Overview of Phase III Activities

A brief overview of the tasks outlined in this technical memorandum is provided below. A summary of all proposed installations is provided in Figure 19.

- The installation of the five shallow piezometers is independent of the other tasks. Upon completion of the installation, groundwater levels will be measured monthly (collected simultaneously with all wells being monitored as part this investigation).

- The installation of the initial vertical clusters at three locations is independent of the other tasks. Once completed, groundwater level measurements will be taken monthly (collected simultaneously with all wells being monitored as part this investigation) and groundwater samples will be collected during two consecutive sampling events. The sampling events should be coordinated with the sampling events for the shallow wells. The remaining cluster will be installed if the results indicate a necessity.

- The installation of the seven shallow alluvial monitoring wells is independent of the other tasks. Once installed, groundwater level measurements (collected simultaneously with all wells being monitored as part this investigation) and groundwater samples will be taken in the same manner as described for the well clusters, in coordination with sampling of other shallow wells.

- Slug test locations can be conducted on existing wells independent of other site activities. Temporary piezometers installed for the evaluation of I-1 are independent of other tasks and can begin immediately. The measurement of drawdown in the temporary piezometers is contingent on two to three day continuous use of the well for irrigation. The slug tests and pumping tests will be conducted during times that the irrigation well is not pumping or after it has been determined that pumping of the irrigation well is not impacting groundwater elevations in the wells being tested.

-- End of Text --

ATTACHMENTS

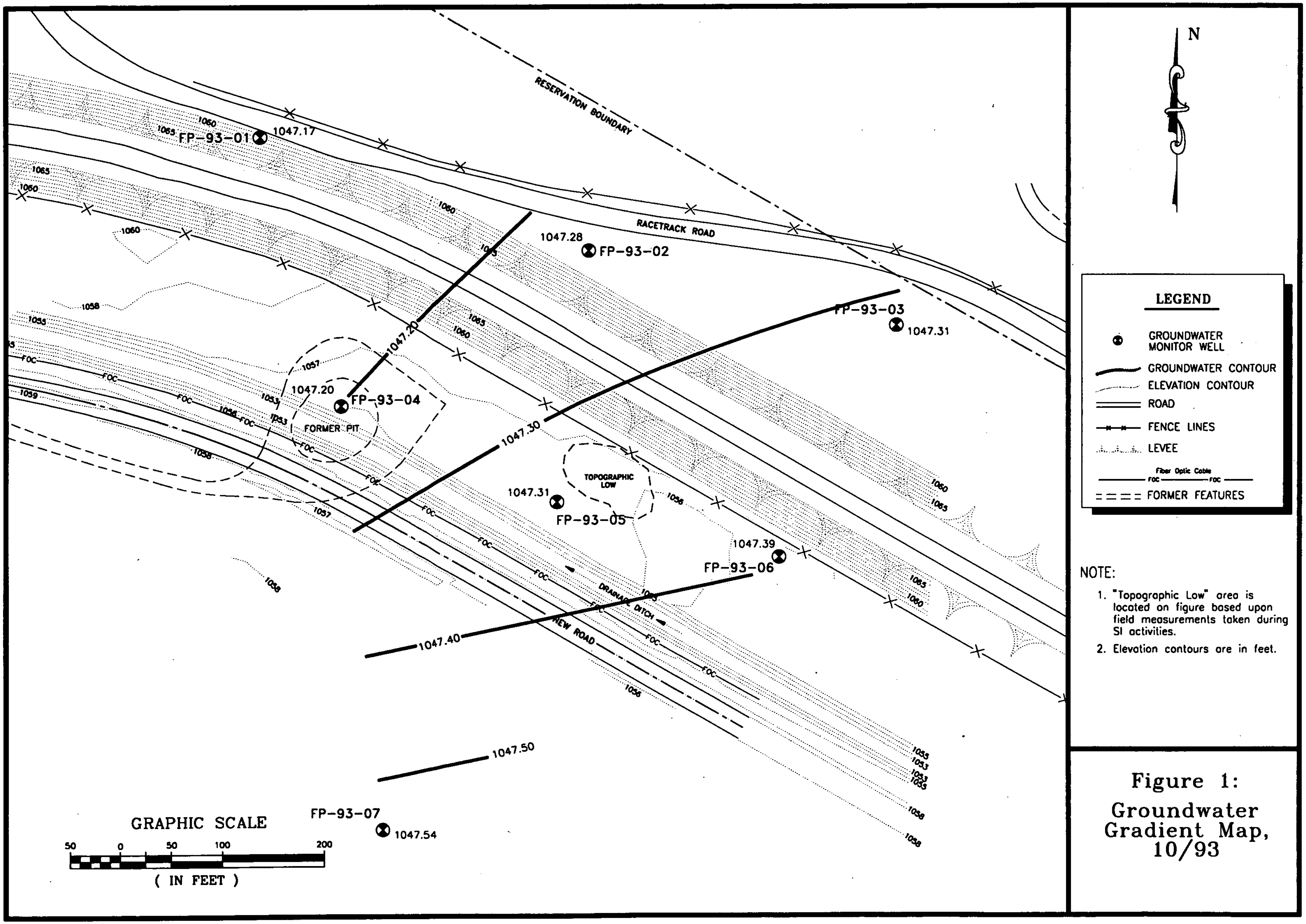
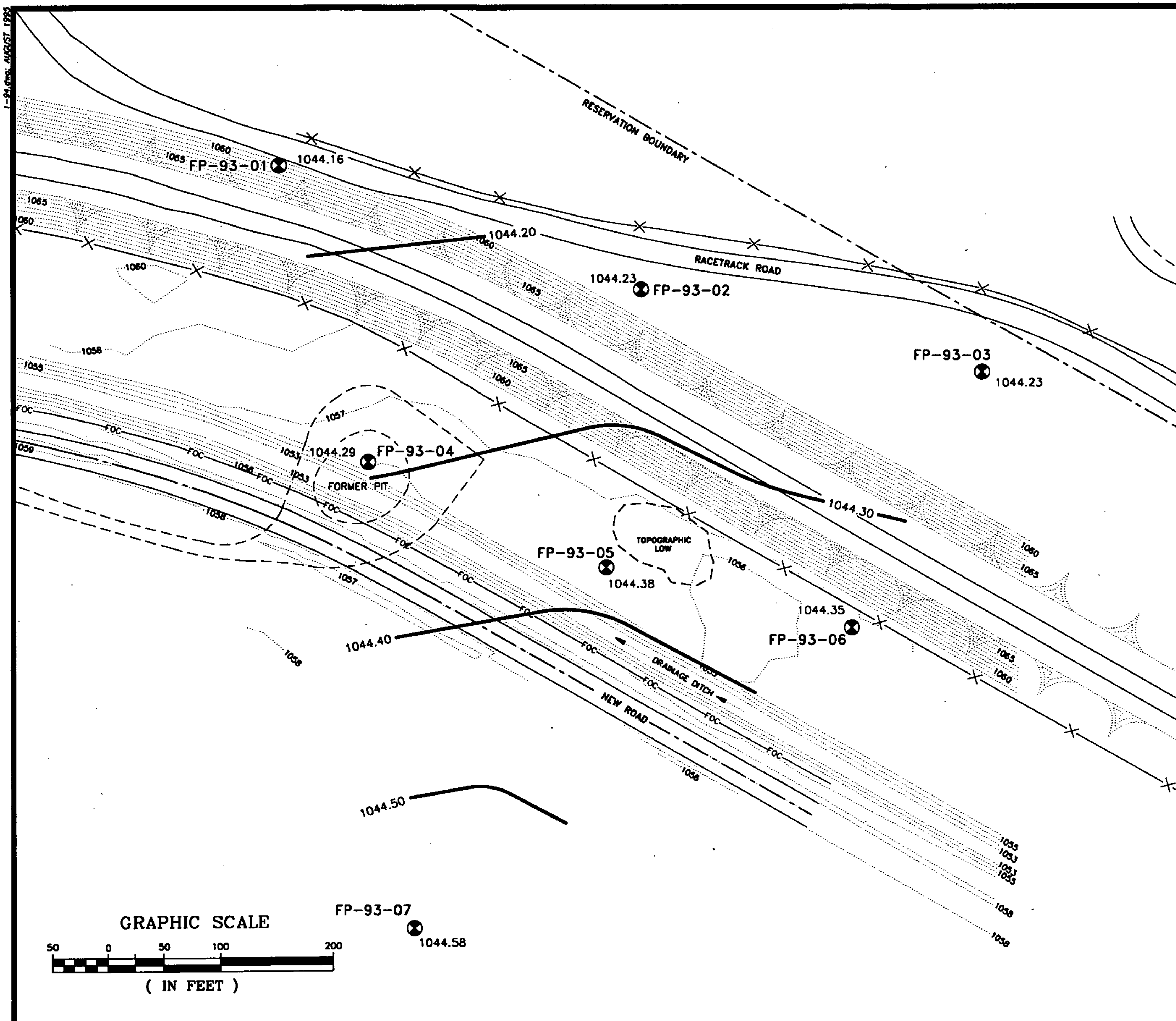


Figure 1: Groundwater Gradient Map, 10/93



NOTE:

1. "Topographic Low" area is located on figure based upon field measurements taken during SI activities.
2. Elevation contours are in feet.

Figure 2: Groundwater Gradient Map, 1/94

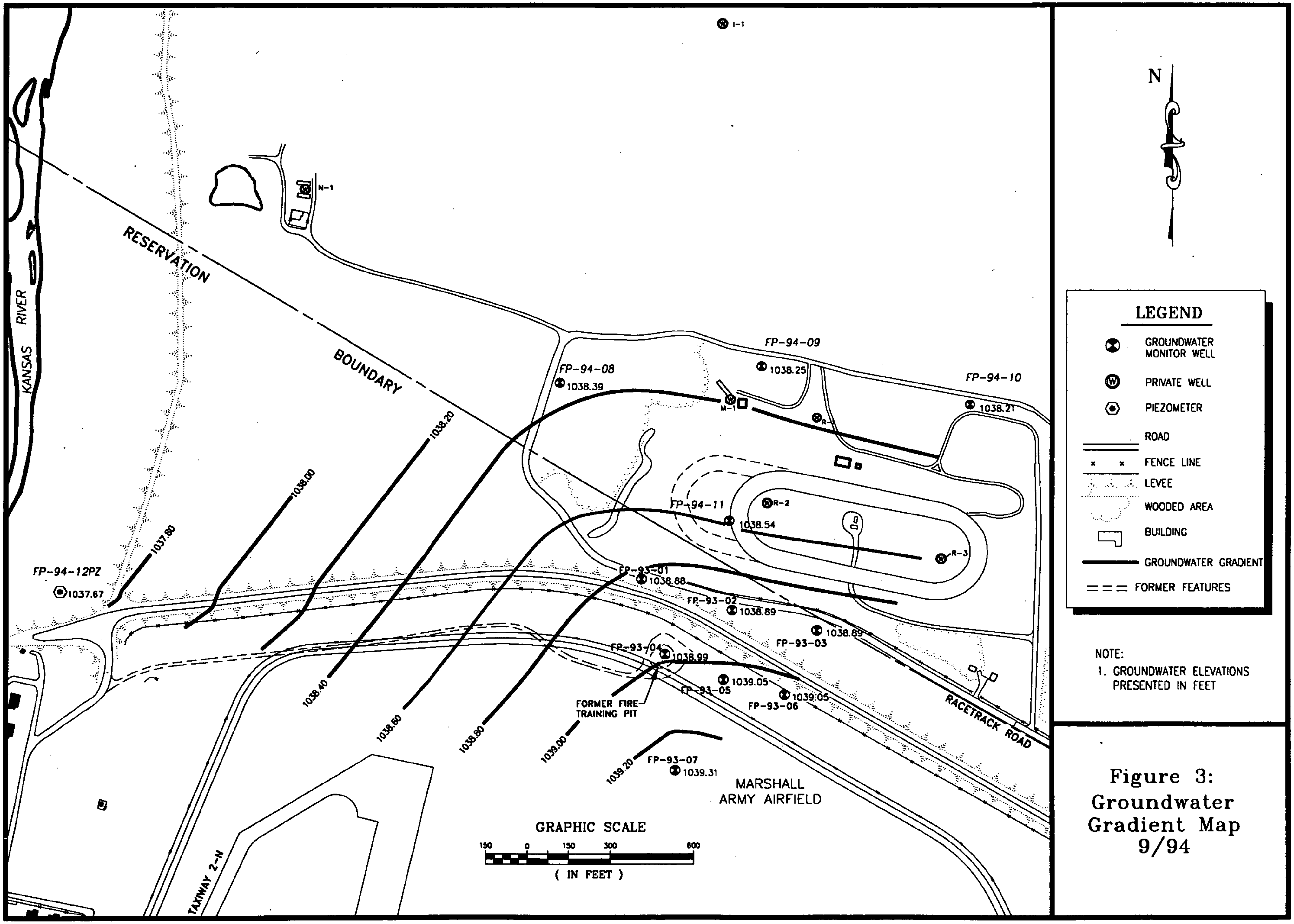


Figure 3: Groundwater Gradient Map 9/94

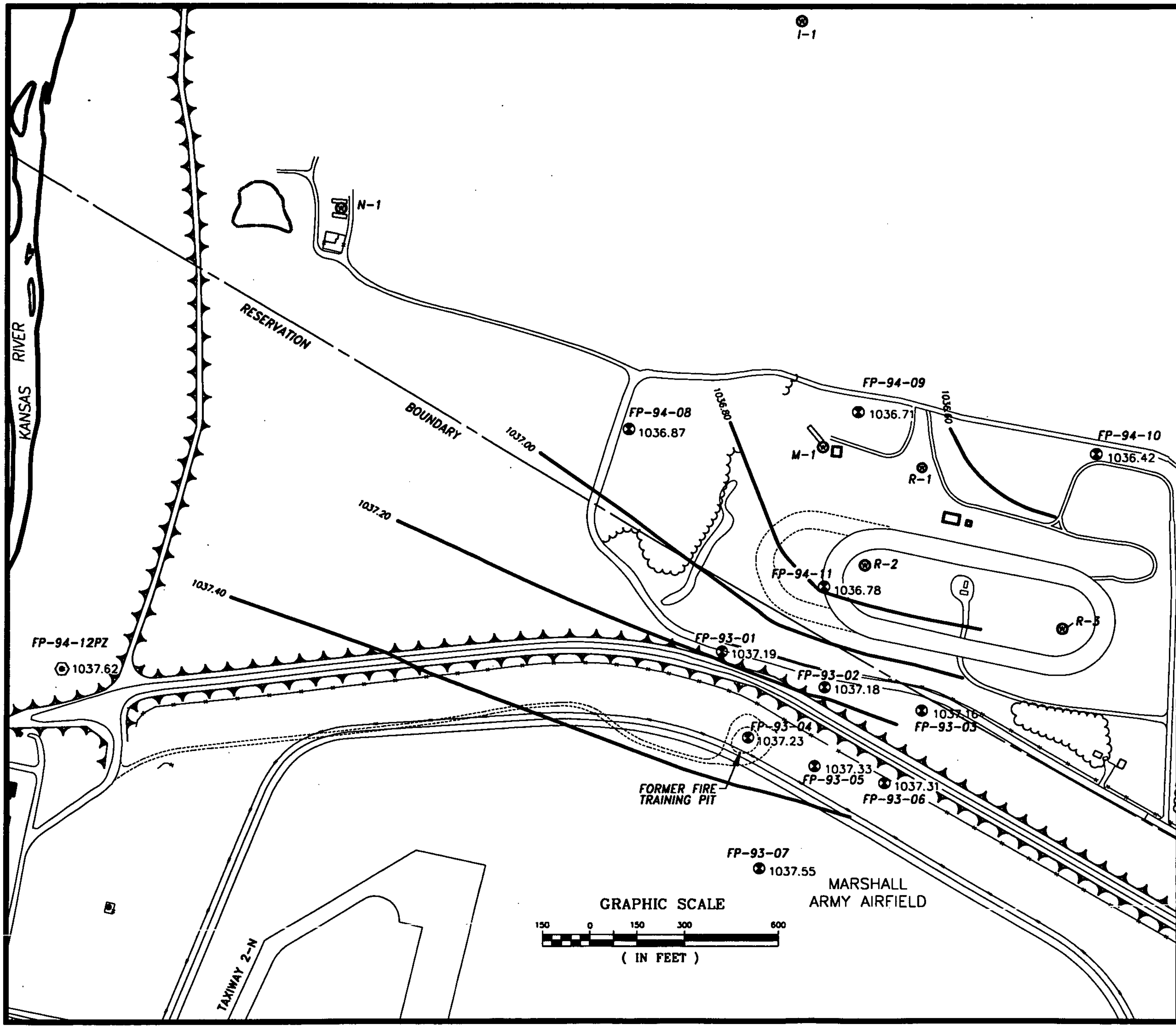


Figure 4: Groundwater Gradient Map, 1/95

ESI-OVER.dwg; AUGUST 1995

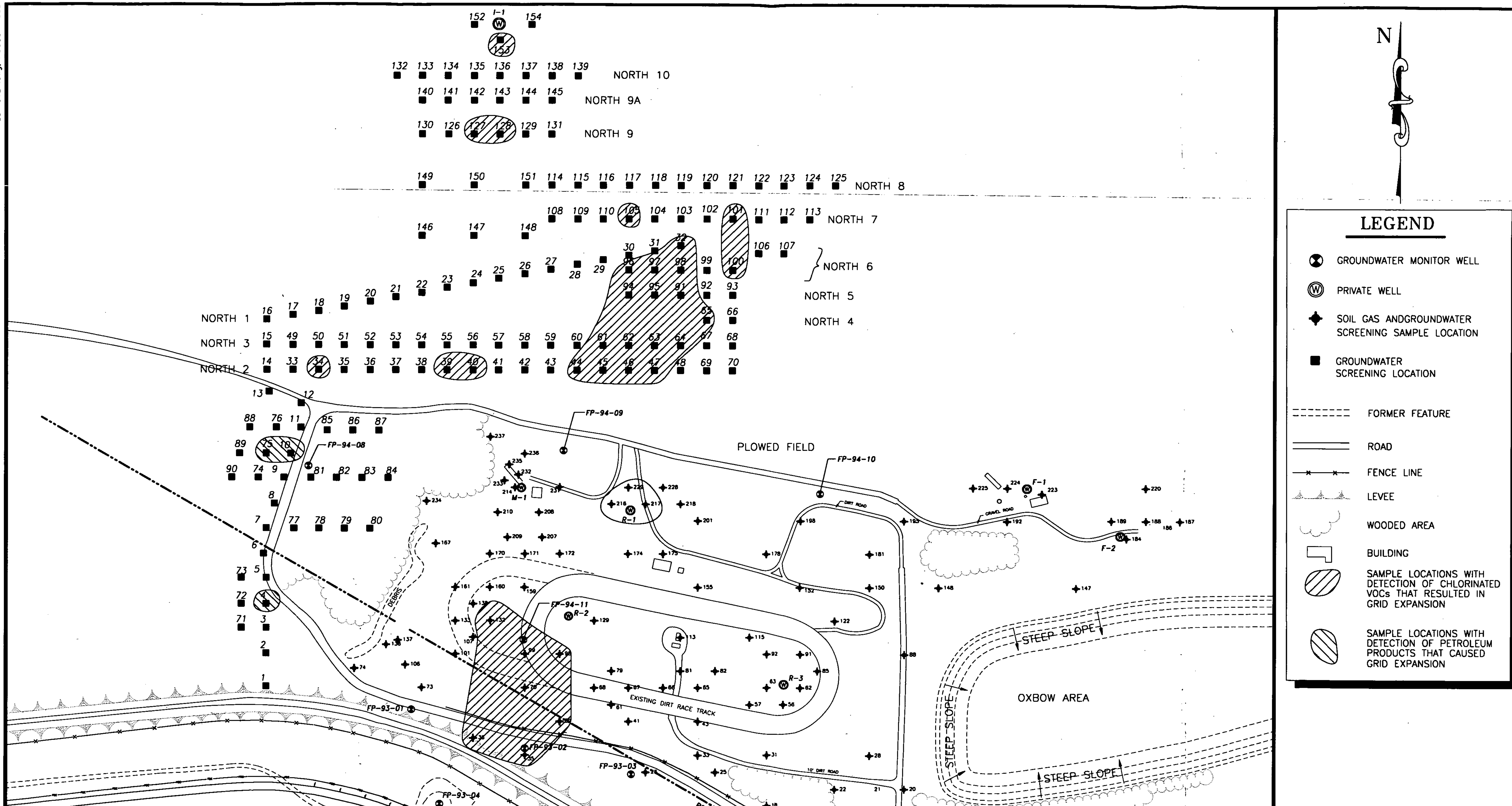
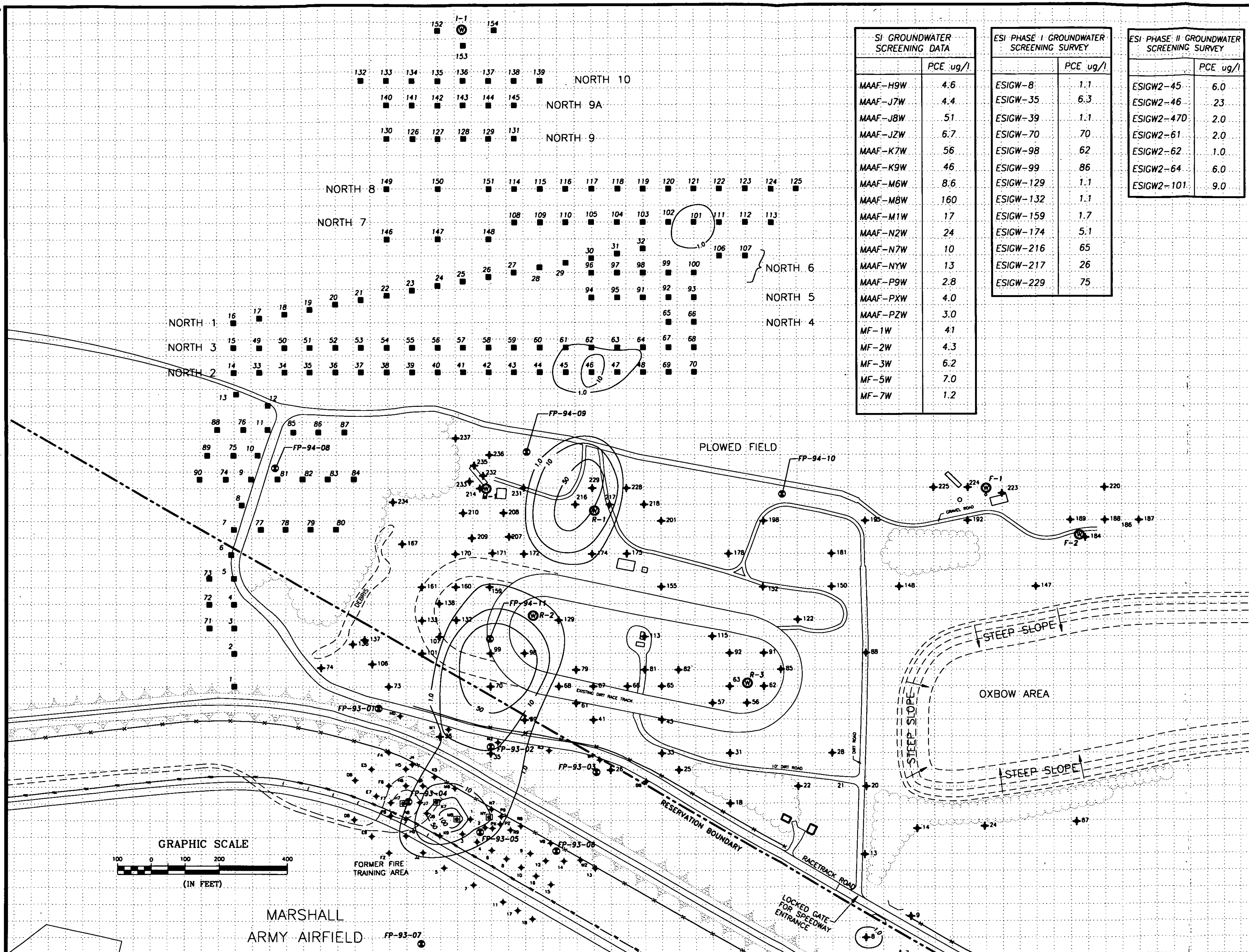


Figure 5:
Overview of ESI
Groundwater Screening
Results, 6/94–1/95



SI GROUNDWATER SCREENING DATA	PCE ug/l
MAAF-H9W	4.6
MAAF-J7W	4.4
MAAF-J8W	51
MAAF-JZW	6.7
MAAF-K7W	56
MAAF-K9W	46
MAAF-M6W	8.6
MAAF-M8W	160
MAAF-M1W	17
MAAF-N2W	24
MAAF-N7W	10
MAAF-NYW	13
MAAF-P9W	2.8
MAAF-PXW	4.0
MAAF-PZW	3.0
MF-1W	41
MF-2W	4.3
MF-3W	6.2
MF-5W	7.0
MF-7W	1.2

ESI PHASE I GROUNDWATER SCREENING SURVEY	PCE ug/l
ESIGW-8	1.1
ESIGW-35	6.3
ESIGW-39	1.1
ESIGW-70	70
ESIGW-98	62
ESIGW-99	86
ESIGW-129	1.1
ESIGW-132	1.1
ESIGW-159	1.7
ESIGW-174	5.1
ESIGW-216	65
ESIGW-217	26
ESIGW-229	75

ESI PHASE II GROUNDWATER SCREENING SURVEY	PCE ug/l
ESIGW2-45	6.0
ESIGW2-46	23
ESIGW2-47D	2.0
ESIGW2-61	2.0
ESIGW2-62	1.0
ESIGW2-64	6.0
ESIGW2-101	9.0

N

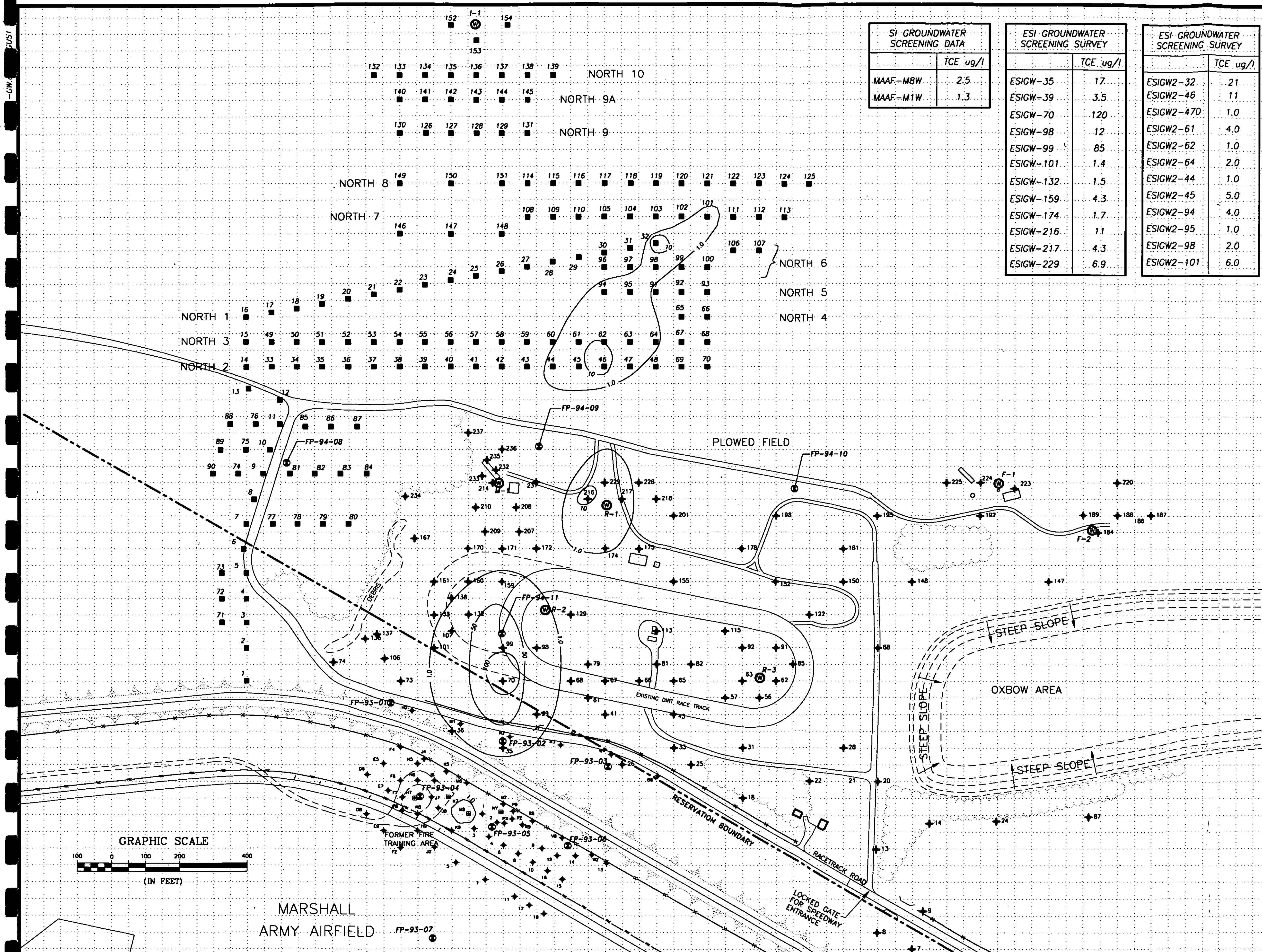
LEGEND

- GROUNDWATER MONITOR WELL
- PRIVATE WELL
- SOIL GAS AND GROUNDWATER SCREENING SAMPLE LOCATION
- GROUNDWATER SCREENING LOCATION
- SOIL GAS SAMPLE LOCATION
- SOIL, SOIL GAS AND GROUNDWATER SCREENING SAMPLE LOCATION
- ROAD
- FORMER FEATURE
- FENCE LINE
- LEVEE
- WOODED AREA
- BUILDING
- PCE CONTOUR

NOTE:

1. CONCENTRATION CONTOURS ARE IN ug/l.

Figure 6: Tetrachloroethylene (PCE) Isoconcentration Contours Using Groundwater Screening SI-Phase I & Phase II & ESI-Phase I & Phase II Results, 9/93-1/95



SI GROUNDWATER SCREENING DATA	
	TCE ug/l
MAAF-M8W	2.5
MAAF-M1W	1.3

ESI GROUNDWATER SCREENING SURVEY	
	TCE ug/l
ESIGW-35	17
ESIGW-39	3.5
ESIGW-70	120
ESIGW-98	12
ESIGW-99	85
ESIGW-101	1.4
ESIGW-132	1.5
ESIGW-159	4.3
ESIGW-174	1.7
ESIGW-216	11
ESIGW-217	4.3
ESIGW-229	6.9

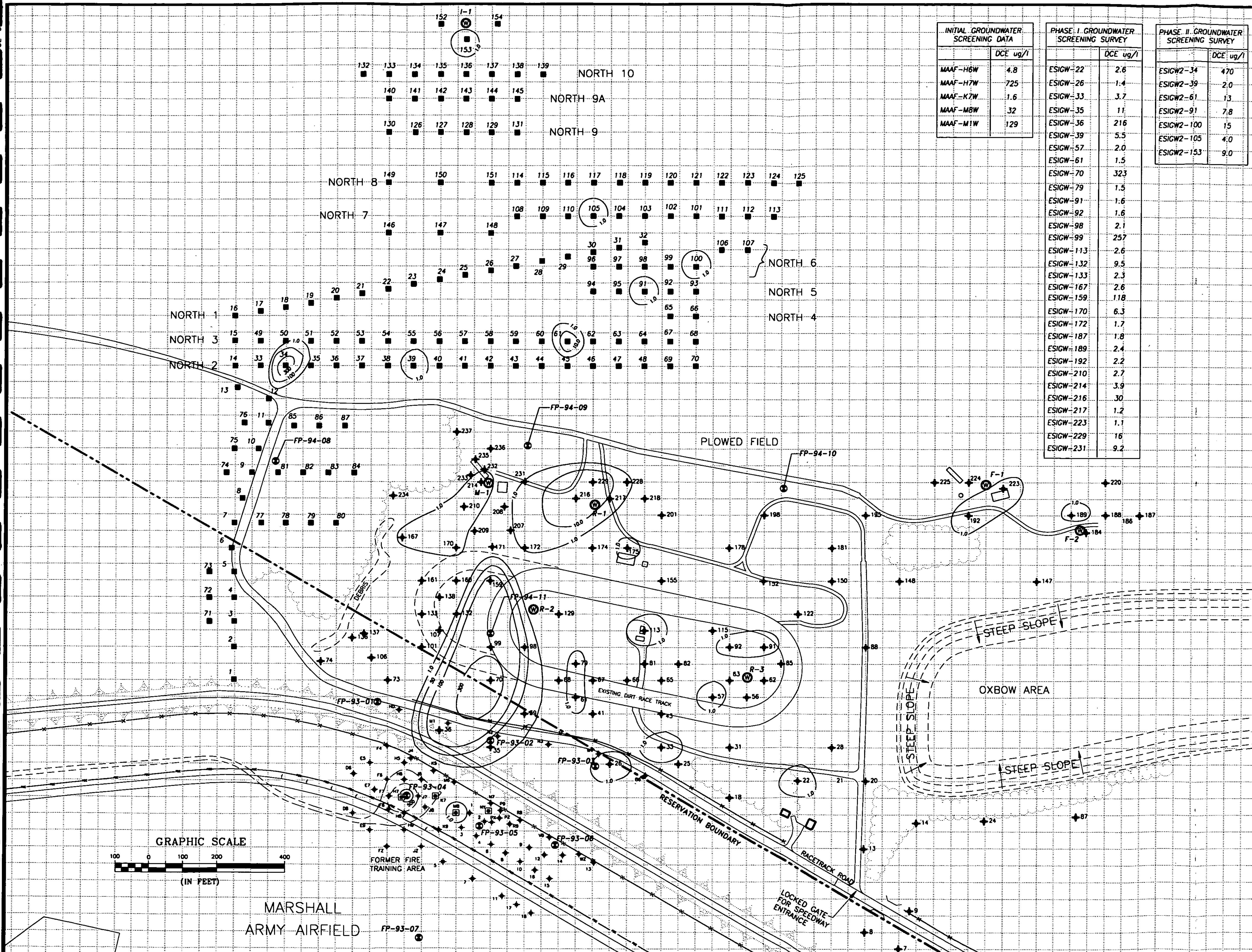
ESI GROUNDWATER SCREENING SURVEY	
	TCE ug/l
ESIGW2-32	21
ESIGW2-46	11
ESIGW2-47D	1.0
ESIGW2-61	4.0
ESIGW2-62	1.0
ESIGW2-64	2.0
ESIGW2-44	1.0
ESIGW2-45	5.0
ESIGW2-94	4.0
ESIGW2-95	1.0
ESIGW2-98	2.0
ESIGW2-101	6.0

LEGEND

- GROUNDWATER MONITOR WELL
- PRIVATE WELL
- SOIL GAS AND GROUNDWATER SCREENING SAMPLE LOCATION
- GROUNDWATER SCREENING LOCATION
- SOIL GAS SAMPLE LOCATION
- SOIL, SOIL GAS AND GROUNDWATER SCREENING SAMPLE LOCATION
- FORMER FEATURE
- ROAD
- FENCE LINE
- LEVEE
- WOODED AREA
- BUILDING

NOTE:
1. CONCENTRATION CONTOURS ARE IN ug/l.

Figure 7: Trichloroethylene (TCE) Isoconcentration Contours Using Groundwater Screening SI-Phase I & Phase II & ESI-Phase I & Phase II Results, 9/93-1/95



INITIAL GROUNDWATER SCREENING DATA	
	DCE ug/l
MAAF-H6W	4.8
MAAF-H7W	725
MAAF-K7W	1.6
MAAF-M8W	32
MAAF-M1W	129

PHASE I GROUNDWATER SCREENING SURVEY	
	DCE ug/l
ESIGW-22	2.6
ESIGW-26	1.4
ESIGW-33	3.7
ESIGW-35	11
ESIGW-36	216
ESIGW-39	5.5
ESIGW-57	2.0
ESIGW-61	1.5
ESIGW-70	323
ESIGW-79	1.5
ESIGW-91	1.6
ESIGW-92	1.6
ESIGW-98	2.1
ESIGW-99	257
ESIGW-113	2.6
ESIGW-132	9.5
ESIGW-133	2.3
ESIGW-167	2.6
ESIGW-159	118
ESIGW-170	6.3
ESIGW-172	1.7
ESIGW-187	1.8
ESIGW-189	2.4
ESIGW-192	2.2
ESIGW-210	2.7
ESIGW-214	3.9
ESIGW-216	30
ESIGW-217	1.2
ESIGW-223	1.1
ESIGW-229	16
ESIGW-231	9.2

PHASE II GROUNDWATER SCREENING SURVEY	
	DCE ug/l
ESIGW2-34	470
ESIGW2-39	2.0
ESIGW2-61	13
ESIGW2-91	7.8
ESIGW2-100	15
ESIGW2-105	4.0
ESIGW2-153	9.0

N

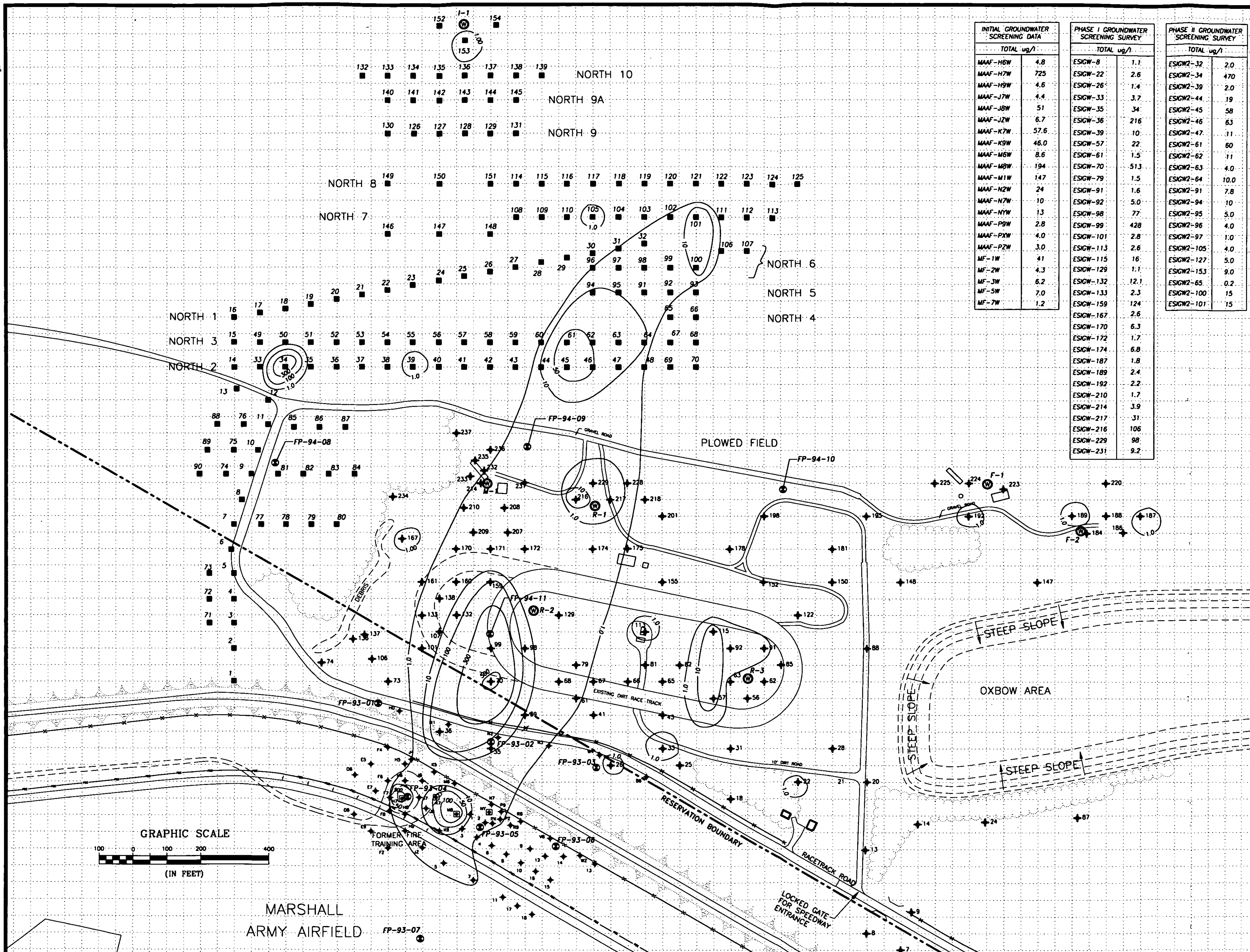
LEGEND

- GROUNDWATER MONITOR WELL
- PRIVATE WELL
- SOIL GAS AND GROUNDWATER SCREENING SAMPLE LOCATION
- GROUNDWATER SCREENING LOCATION
- SOIL GAS SAMPLE LOCATION
- SOIL, SOIL GAS AND GROUNDWATER SCREENING SAMPLE LOCATION
- FORMER FEATURE
- ROAD
- FENCE LINE
- LEVEE
- WOODED AREA
- BUILDING
- DCE CONCENTRATION CONTOUR

NOTE:

1. 1,2-DCE CONCENTRATIONS ARE BASED ON THE SUMMATION OF TRANS-1,2-DCE AND CIS-1,2-DCE DETECTED BY FIELD ANALYSIS.
2. LOCATION ESIGW2-34 WAS RESAMPLED IN JANUARY 1995 AND HAD 3.0 ug/l OF DCE. THE INITIAL SAMPLING AT THIS LOCATION WAS IN AUGUST 1994.
3. CONCENTRATION CONTOURS ARE IN ug/l.

Figure 8: 1,2-Dichloroethylene (1,2-DCE) Isoconcentration Contours Using Groundwater Screening (SI-Phase I & Phase II) & (ESI-Phase I & Phase II) Results, 9/93-1/95



INITIAL GROUNDWATER SCREENING DATA	
TOTAL ug/l	
MAAF-H6W	4.8
MAAF-H7W	725
MAAF-H9W	4.6
MAAF-J7W	4.4
MAAF-J8W	51
MAAF-JZW	6.7
MAAF-K7W	57.6
MAAF-K9W	46.0
MAAF-M6W	8.6
MAAF-M8W	194
MAAF-M1W	147
MAAF-N2W	24
MAAF-N7W	10
MAAF-NYW	13
MAAF-P9W	2.8
MAAF-PXW	4.0
MAAF-PZW	3.0
MF-1W	41
MF-2W	4.3
MF-3W	6.2
MF-5W	7.0
MF-7W	1.2

PHASE I GROUNDWATER SCREENING SURVEY	
TOTAL ug/l	
ESIGW-8	1.1
ESIGW-22	2.6
ESIGW-26	1.4
ESIGW-33	3.7
ESIGW-35	34
ESIGW-36	216
ESIGW-39	10
ESIGW-57	22
ESIGW-61	1.5
ESIGW-70	513
ESIGW-79	1.5
ESIGW-91	1.6
ESIGW-92	5.0
ESIGW-98	77
ESIGW-99	428
ESIGW-101	2.8
ESIGW-113	2.6
ESIGW-115	16
ESIGW-129	1.1
ESIGW-132	12.1
ESIGW-133	2.3
ESIGW-159	124
ESIGW-167	2.6
ESIGW-170	6.3
ESIGW-172	1.7
ESIGW-174	6.8
ESIGW-187	1.8
ESIGW-189	2.4
ESIGW-192	2.2
ESIGW-210	1.7
ESIGW-214	3.9
ESIGW-217	31
ESIGW-216	106
ESIGW-229	98
ESIGW-231	9.2

PHASE II GROUNDWATER SCREENING SURVEY	
TOTAL ug/l	
ESIGW2-32	2.0
ESIGW2-34	470
ESIGW2-39	2.0
ESIGW2-44	19
ESIGW2-45	58
ESIGW2-46	63
ESIGW2-47	11
ESIGW2-61	60
ESIGW2-62	11
ESIGW2-63	4.0
ESIGW2-64	10.0
ESIGW2-91	7.8
ESIGW2-94	10
ESIGW2-95	5.0
ESIGW2-96	4.0
ESIGW2-97	1.0
ESIGW2-105	4.0
ESIGW2-127	5.0
ESIGW2-153	9.0
ESIGW2-65	0.2
ESIGW2-100	15
ESIGW2-101	15

LEGEND

- GROUNDWATER MONITOR WELL
- PRIVATE WELL
- SOIL GAS AND GROUNDWATER SCREENING SAMPLE LOCATION
- GROUNDWATER SCREENING LOCATION
- SOIL GAS SAMPLE LOCATION
- SOIL, SOIL GAS AND GROUNDWATER SCREENING SAMPLE LOCATION
- FORMER FEATURE
- ROAD
- FENCE LINE
- LEVEE
- WOODED AREA
- BUILDING
- TVOC CONCENTRATION CONTOUR

NOTE:

1. TOTAL CHLORINATED VOC CONTOUR ARE IN ug/l.

Figure 9: Total Chlorinated VOC Isoconcentration Contours Using Groundwater Screening (SI–Phase I & Phase II & ESI–Phase I & Phase II) Results, 1/95

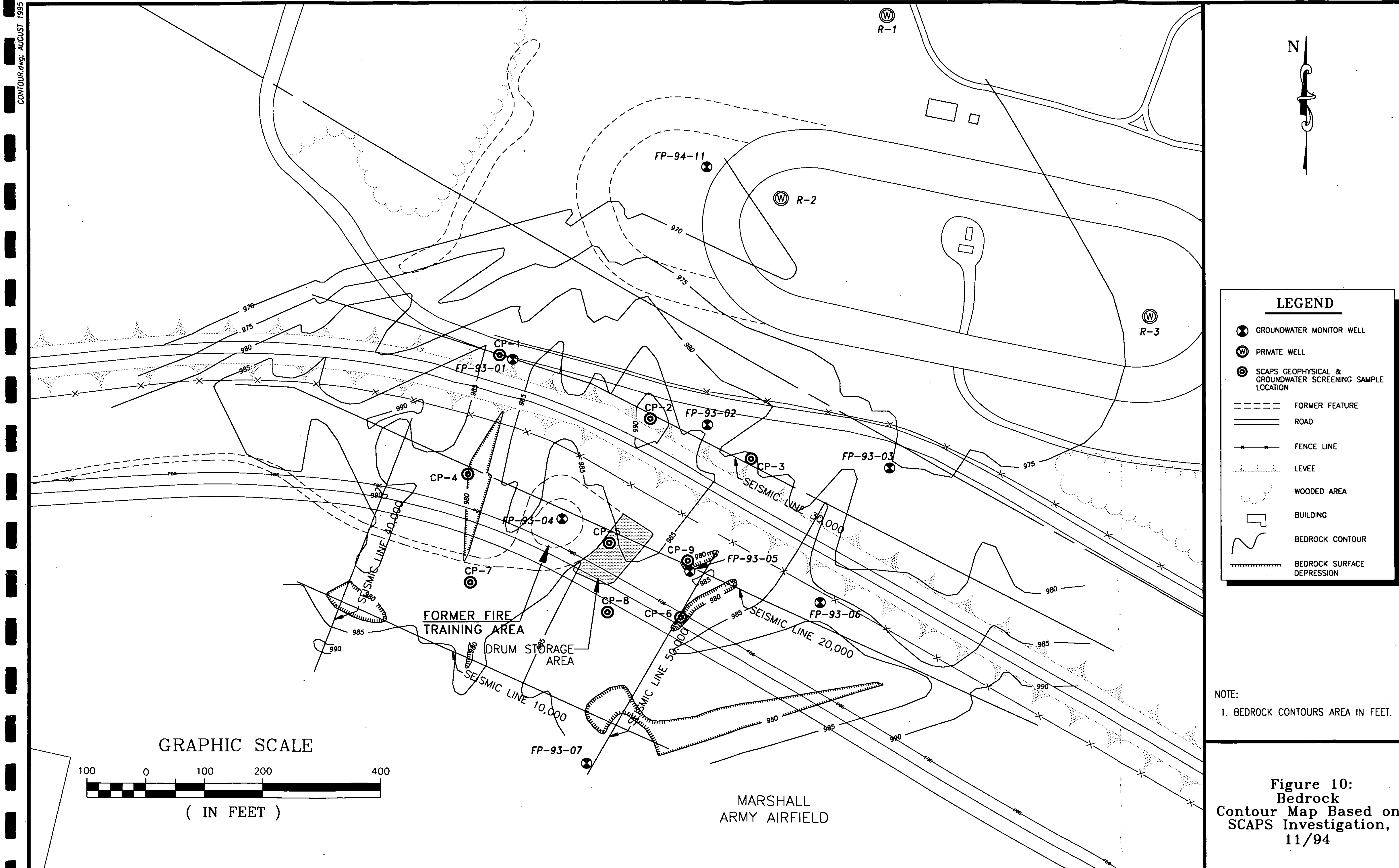
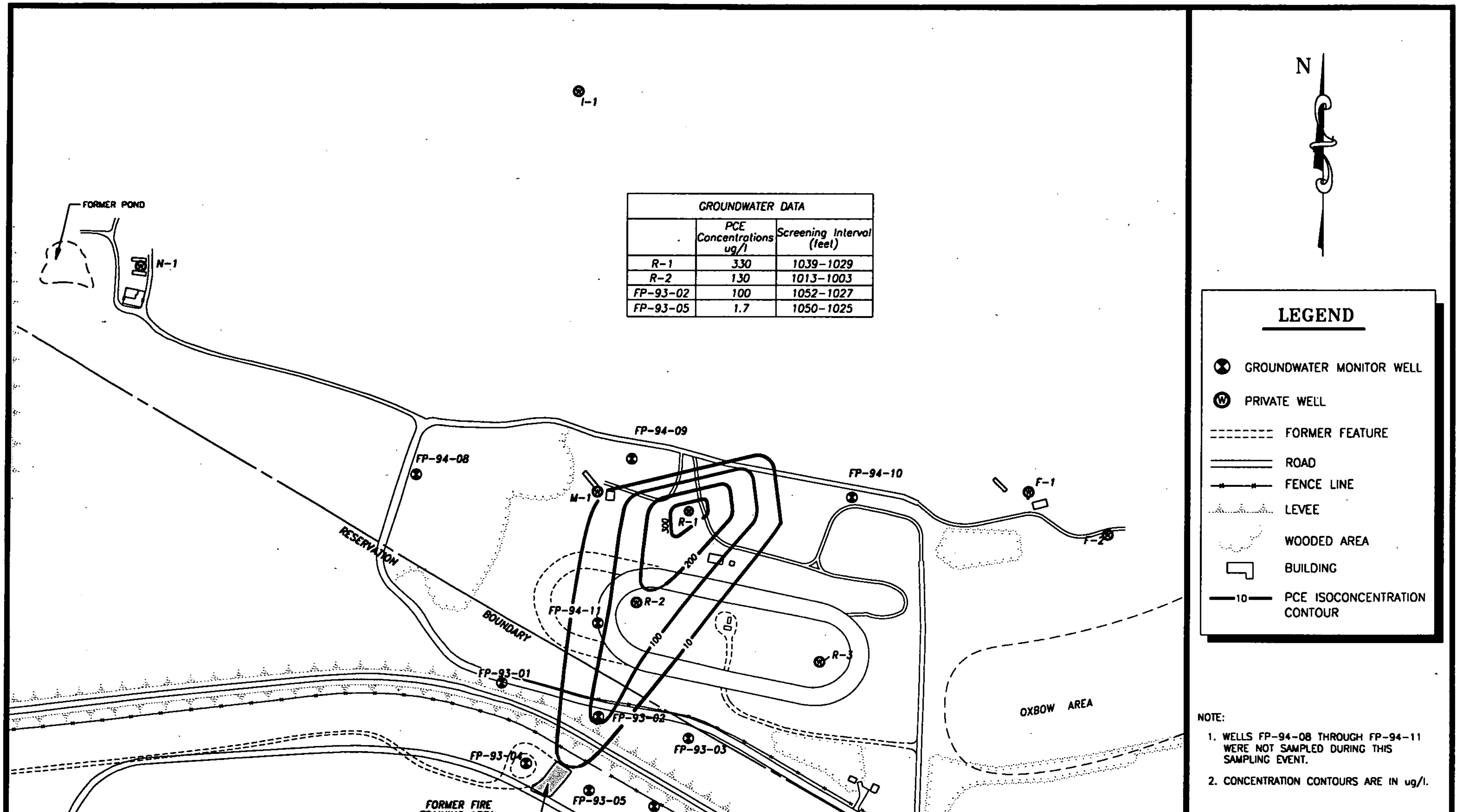


Figure 10: Bedrock Contour Map Based on SCAPS Investigation, 11/94



GROUNDWATER DATA

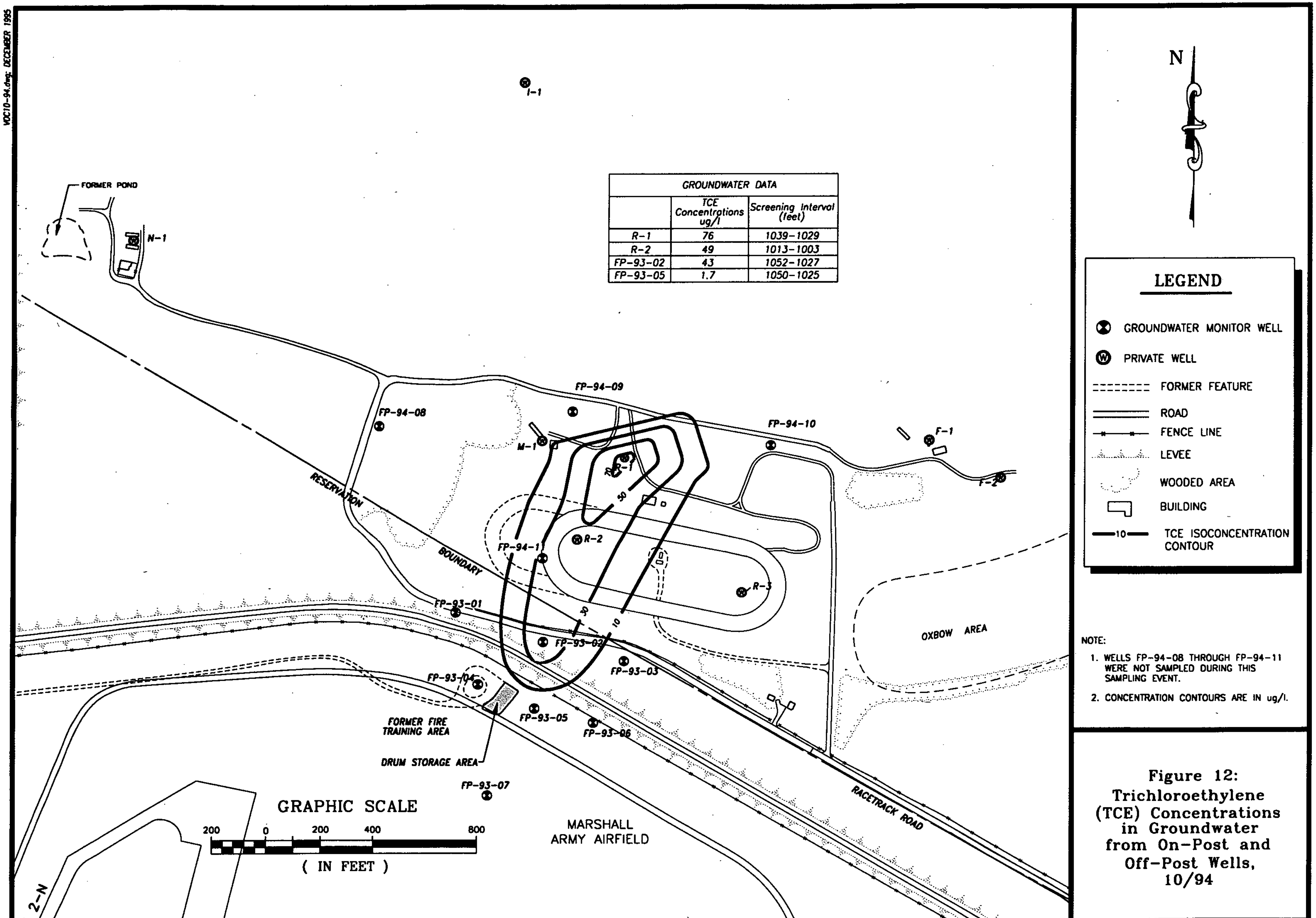
	PCE Concentrations ug/l	Screening Interval (feet)
R-1	330	1039-1029
R-2	130	1013-1003
FP-93-02	100	1052-1027
FP-93-05	1.7	1050-1025

NOTE:

1. WELLS FP-94-08 THROUGH FP-94-11 WERE NOT SAMPLED DURING THIS SAMPLING EVENT.
2. CONCENTRATION CONTOURS ARE IN ug/l.

Figure 11: Tetrachloroethylene (PCE) Concentrations in Groundwater from On-Post and Off Post Wells, 10/94

VOC10-94.dwg; DECEMBER 1995

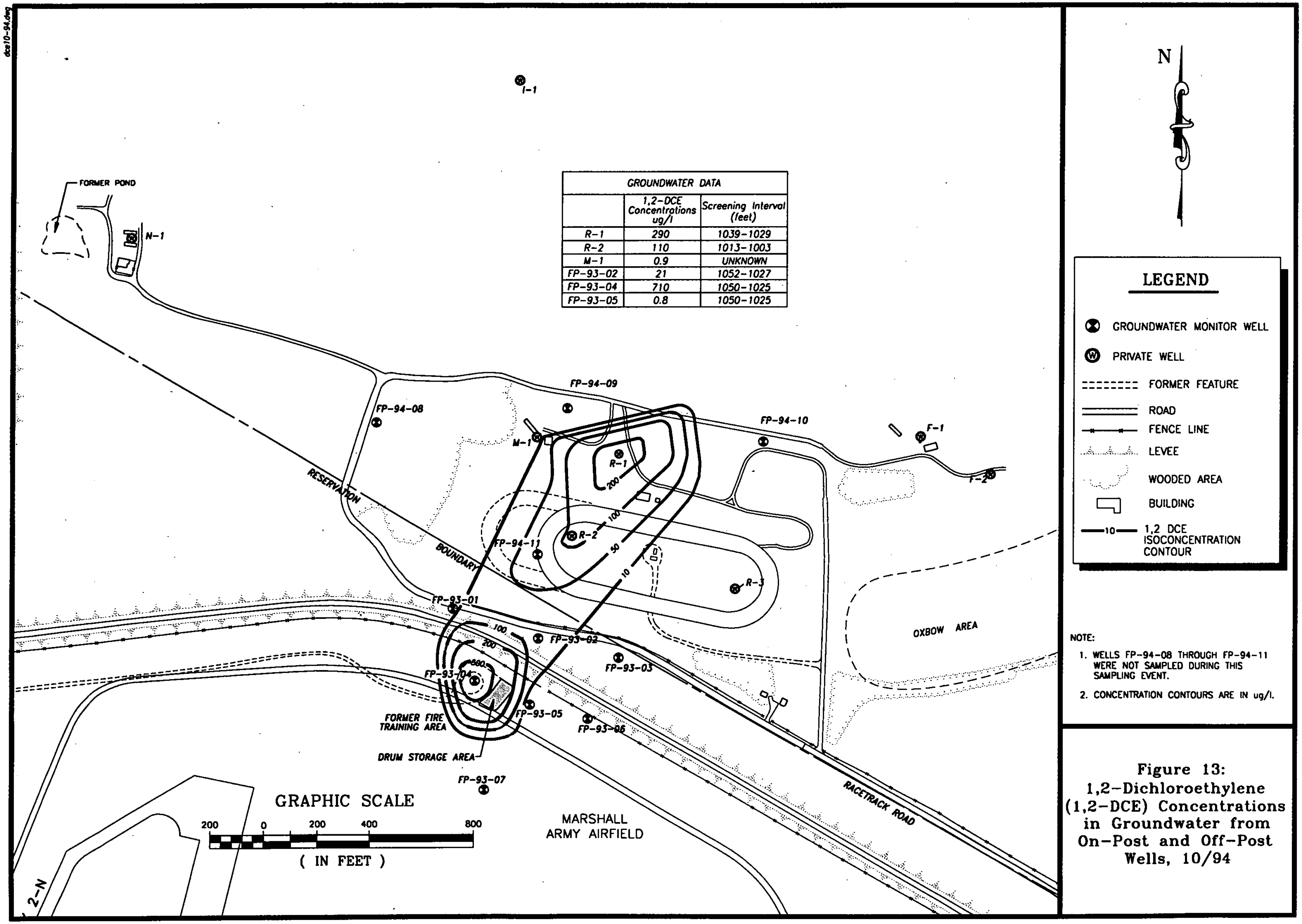


GROUNDWATER DATA		
	TCE Concentrations ug/l	Screening Interval (feet)
R-1	76	1039-1029
R-2	49	1013-1003
FP-93-02	43	1052-1027
FP-93-05	1.7	1050-1025

NOTE:

1. WELLS FP-94-08 THROUGH FP-94-11 WERE NOT SAMPLED DURING THIS SAMPLING EVENT.
2. CONCENTRATION CONTOURS ARE IN ug/l.

Figure 12: Trichloroethylene (TCE) Concentrations in Groundwater from On-Post and Off-Post Wells, 10/94

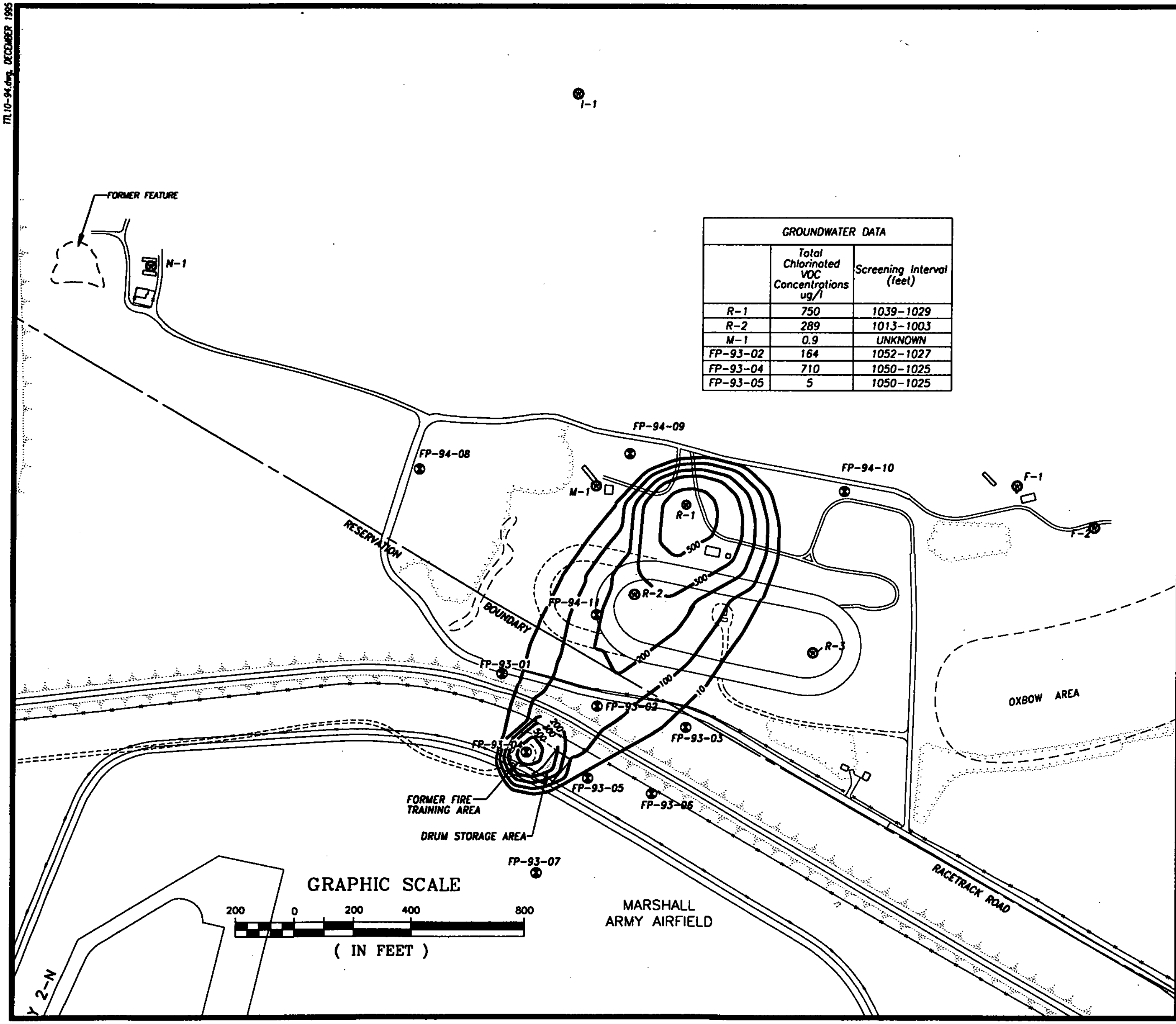


GROUNDWATER DATA

	1,2-DCE Concentrations ug/l	Screening Interval (feet)
R-1	290	1039-1029
R-2	110	1013-1003
M-1	0.9	UNKNOWN
FP-93-02	21	1052-1027
FP-93-04	710	1050-1025
FP-93-05	0.8	1050-1025

Figure 13: 1,2-Dichloroethylene (1,2-DCE) Concentrations in Groundwater from On-Post and Off-Post Wells, 10/94

TTL10-94.dwg, DECEMBER 1995



GROUNDWATER DATA

	Total Chlorinated VOC Concentrations ug/l	Screening Interval (feet)
R-1	750	1039-1029
R-2	289	1013-1003
M-1	0.9	UNKNOWN
FP-93-02	164	1052-1027
FP-93-04	710	1050-1025
FP-93-05	5	1050-1025

Figure 14: Total Chlorinated VOCs Concentrations in Groundwater from On-Post and Off-Post Wells, 10/94

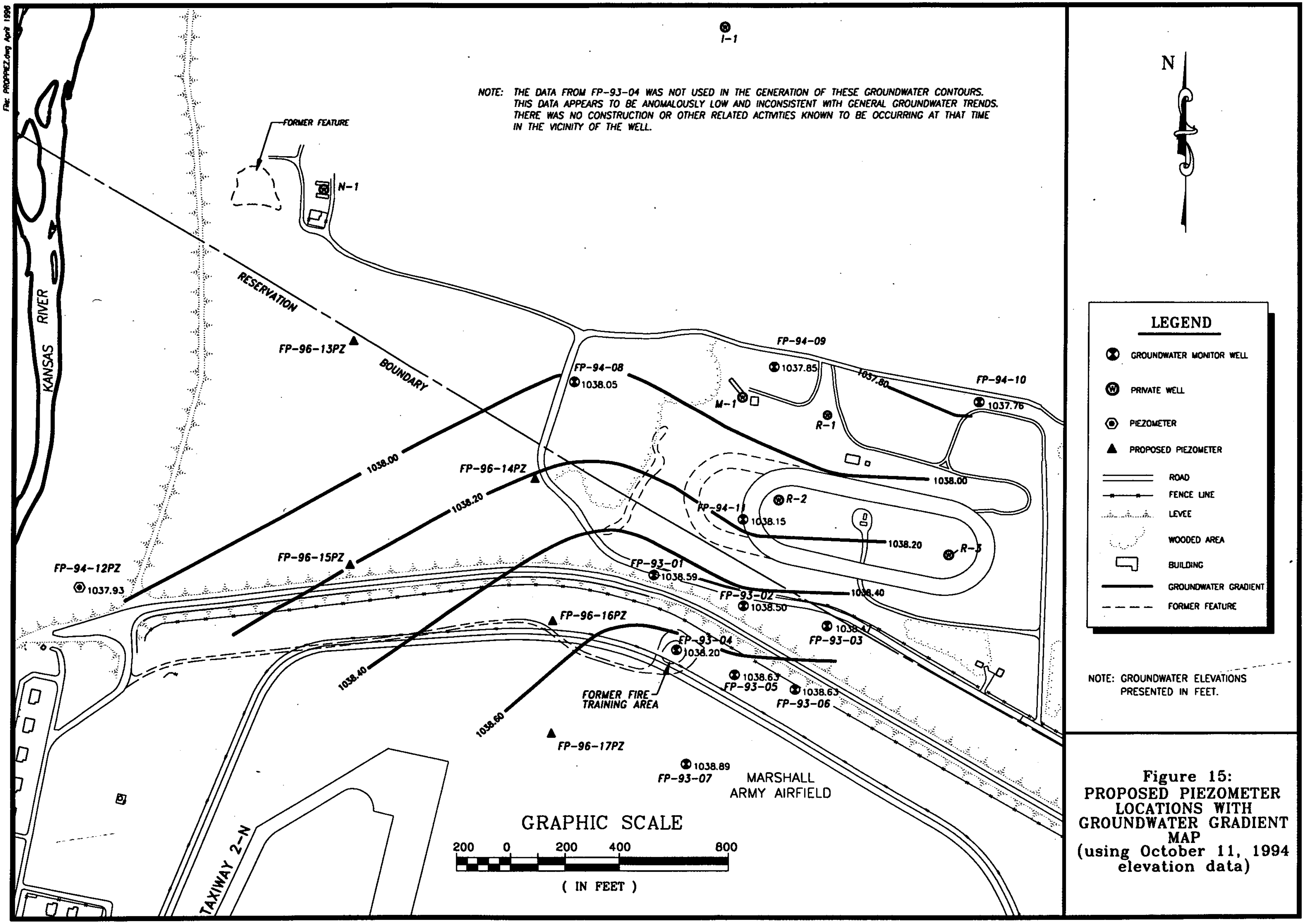
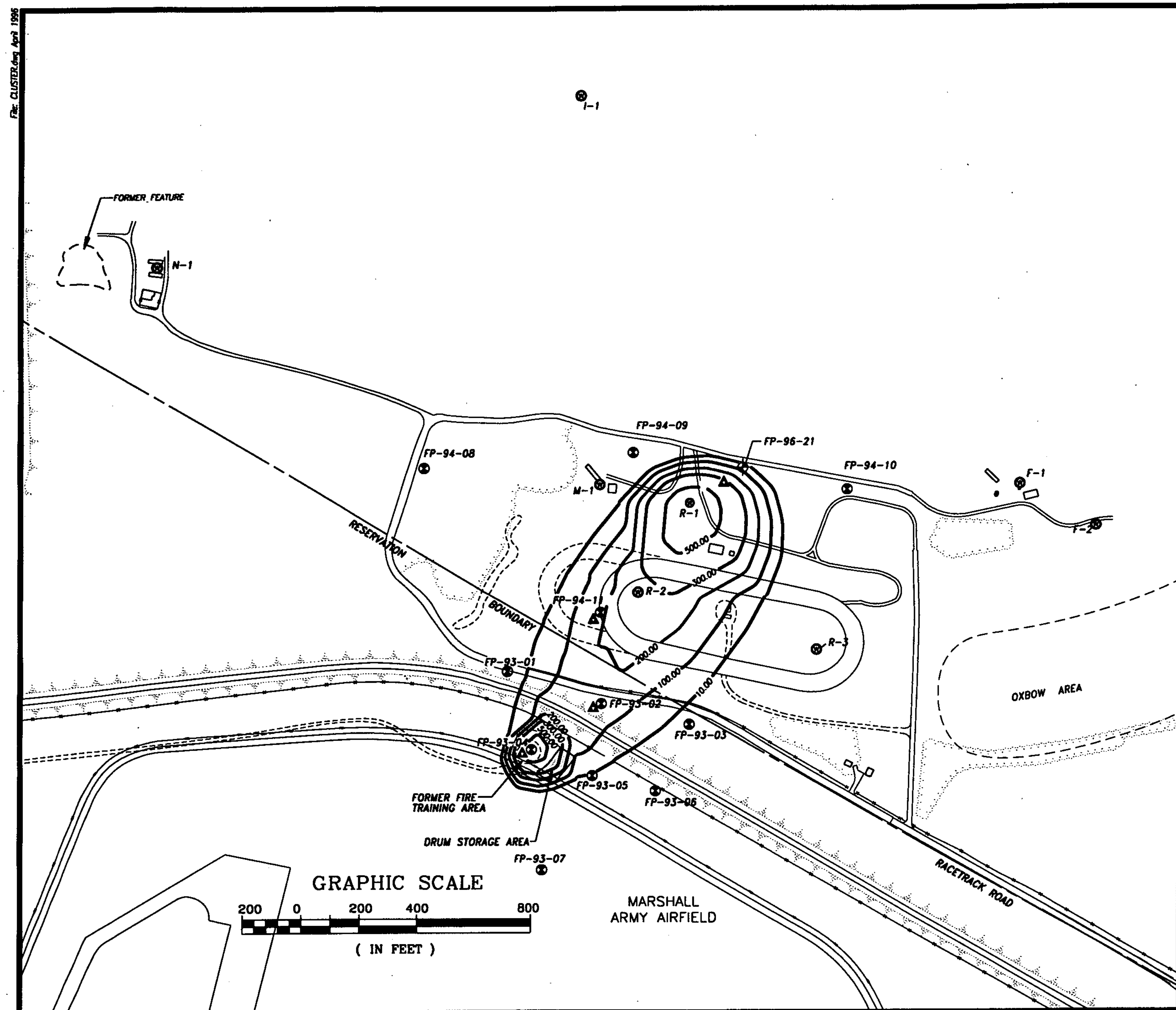


Figure 15: PROPOSED PIEZOMETER LOCATIONS WITH GROUNDWATER GRADIENT MAP (using October 11, 1994 elevation data)



LEGEND

- PROPOSED WELL
- GROUNDWATER MONITOR WELL
- PRIVATE WELL
- PROPOSED CLUSTERS OF WELLS
- ROAD
- FENCE LINE
- LEVEE
- WOODED AREA
- BUILDING
- TOTAL VOC ISOCONCENTRATION CONTOUR (ug/l)
- FORMER FEATURE

NOTE:
CONCENTRATIONS ARE IN ug/l.

Figure 16: PROPOSED CLUSTERS OF WELLS WITH TOTAL VOCs CONCENTRATIONS FROM SHALLOW ALLUVIAL WELLS (using data collected in October 1994)

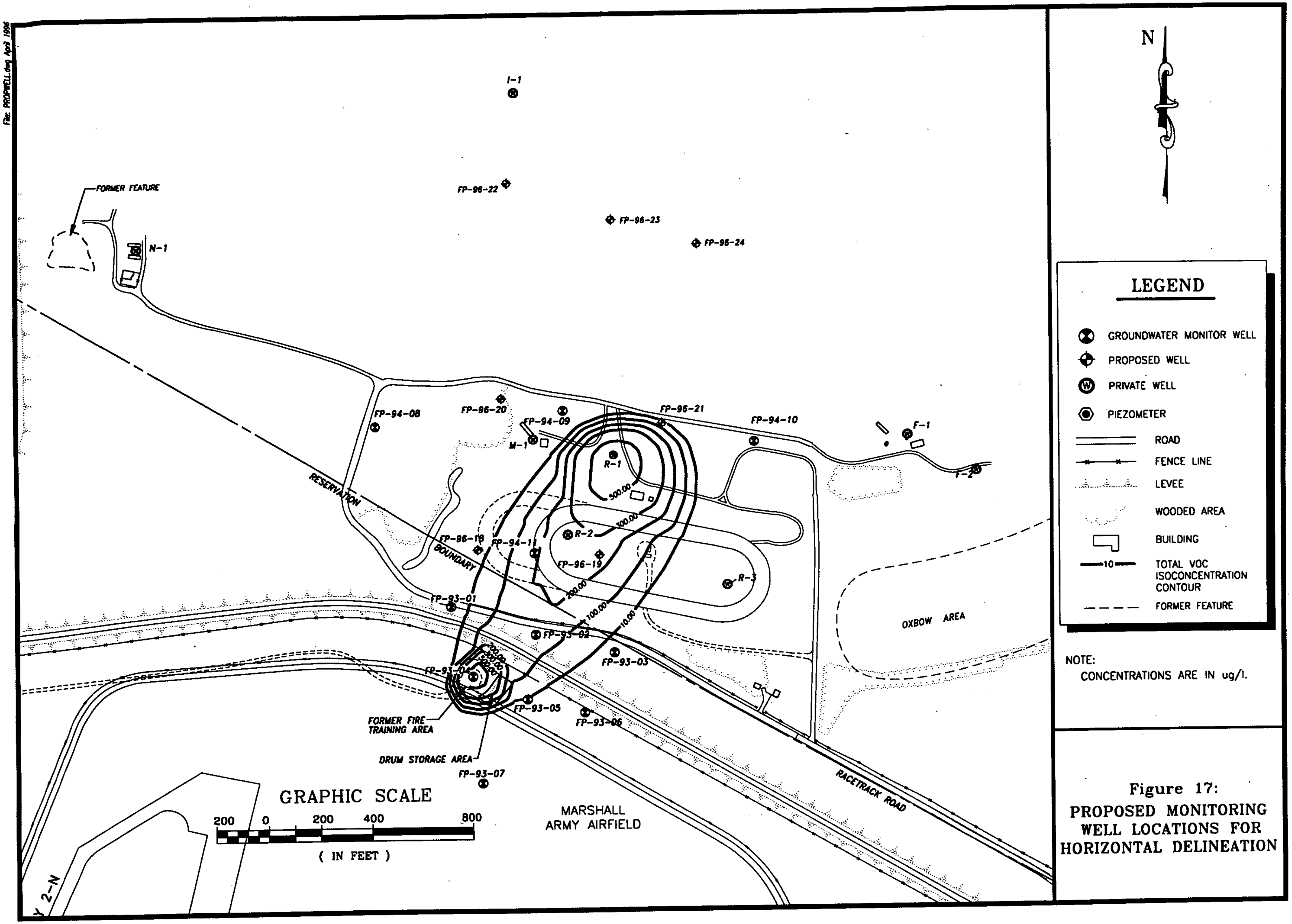


Figure 17:
PROPOSED MONITORING WELL LOCATIONS FOR HORIZONTAL DELINEATION

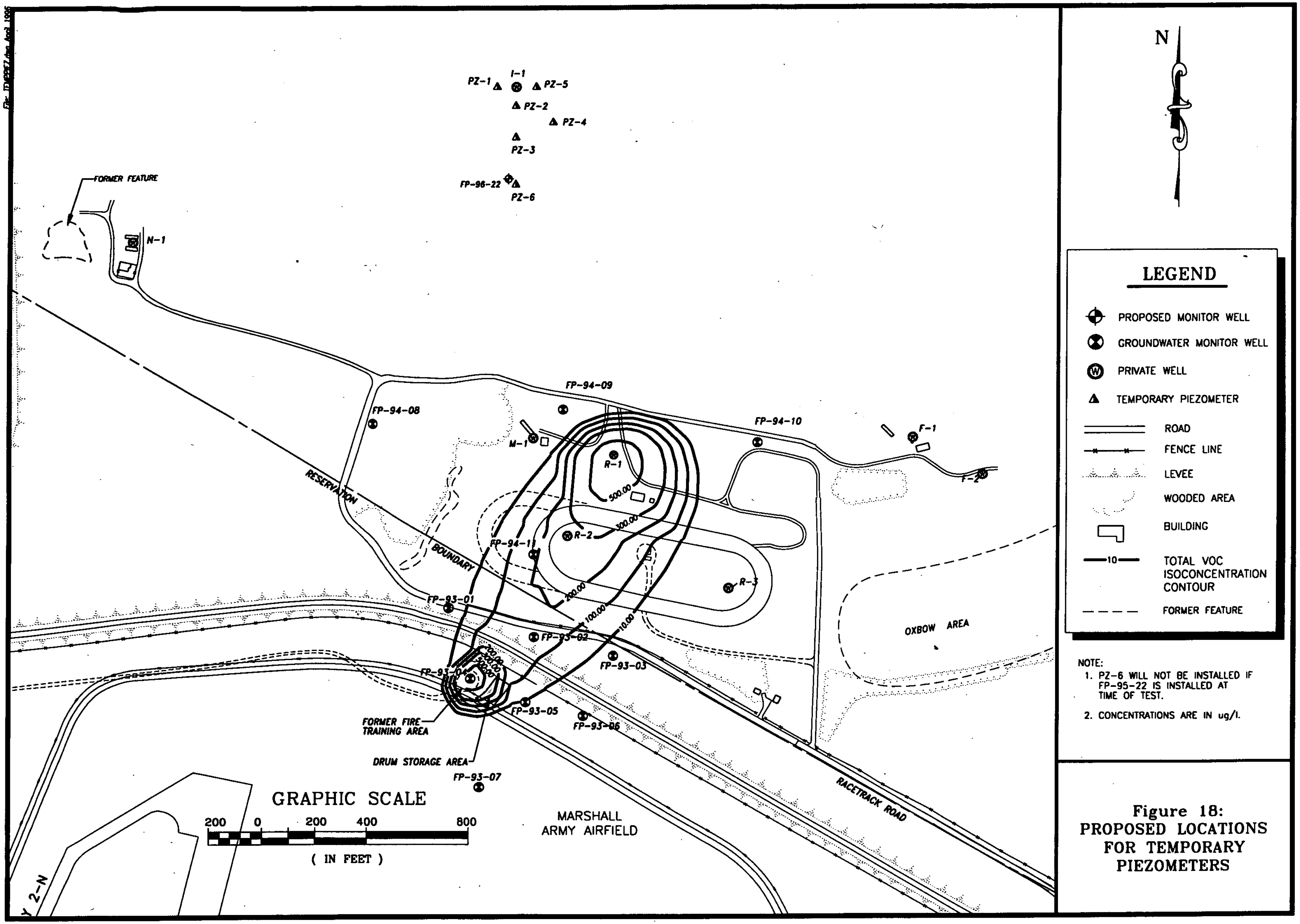
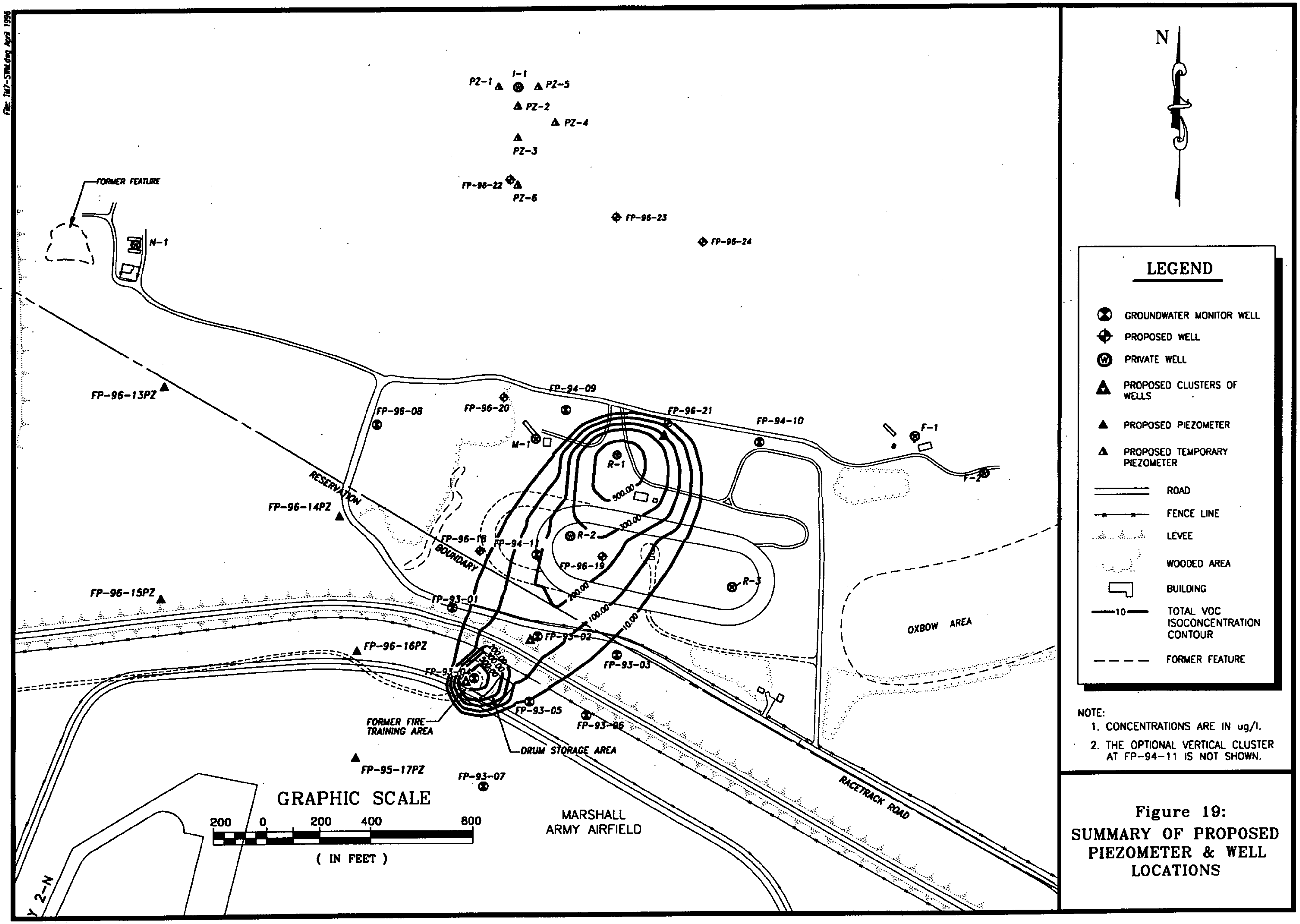


Figure 18: PROPOSED LOCATIONS FOR TEMPORARY PIEZOMETERS



NOTE:
1. CONCENTRATIONS ARE IN ug/l.
2. THE OPTIONAL VERTICAL CLUSTER AT FP-94-11 IS NOT SHOWN.

Figure 19: SUMMARY OF PROPOSED PIEZOMETER & WELL LOCATIONS

TABLE 1: GROUNDWATER ELEVATIONS FOR THE ESI FFTA-MAAF

Well I.D.	WELL DEPTH (FEET)	SCREEN LENGTH (FEET)	PAD ELEVATION (FEET)	TOP OF PVC/RISER ELEV. (FEET)	GROUNDWATER ELEVATION (FEET)										
					27-Oct-93	6-Jan-94	11-Mar-94	30-Jun-94	28-Jul-94	24-Aug-94	18-Sep-94	11-Oct-94	30-Nov-94	22-Dec-94	19-Jan-95
FP-93-01	25	20	1056.05	1058.94	1047.17	1044.16	1042.24	1040.29	1039.88	1039.43	1038.88	1038.59	1037.74	1037.46	1037.19
FP-93-02	31	25	1057.94	1060.15	1047.28	1044.23	1042.27	1040.31	1039.90	1039.43	1038.89	1038.50	1037.73	1037.45	1037.18
FP-93-03	24	20	1054.59	1057.38	1047.31	1044.23	1042.27	1040.31	1039.91	1039.43	1038.89	1038.47	1037.73	1037.43	1037.16
FP-93-04	31.3	25	1056.03	1058.82	1047.20	1044.29	1042.39	1040.46	1040.07	1039.62	1038.99	1038.20	1037.80	1037.46	1037.23
FP-93-05	31	25	1056.05	1059.11	1047.31	1044.38	1042.27	1040.47	1040.07	1039.64	1039.05	1038.63	1037.88	1037.57	1037.33
FP-93-06	30	25	1056.00	1058.50	1047.39	1044.35	1042.29	1040.47	1040.08	1039.60	1039.05	1038.63	1037.87	1037.57	1037.31
FP-93-07	24	20	1056.62	1059.66	1047.54	1044.58	1042.41	1040.72	1040.31	1039.90	1039.31	1038.89	1038.09	1037.80	1037.55
FP-94-08	22	10	1054.47	1057.42							1038.39	1038.05	1037.42	1037.16	1036.87
FP-94-09	27.5	10	1060.22	1061.12							1038.25	1037.85	1037.18	1036.89	1036.71
FP-94-10	27.2	10	1060.27	1062.52	Wells not in existence during this time period.						1038.21	1037.76	1037.08	1036.78	1036.42
FP-94-11	15.3	10	1048.42	1048.09							1038.54	1038.15	1037.42	1037.14	1036.78
FP-94-12PZ	19.8	10	1053.27	1054.70							1037.67	1037.93	1037.16	1037.28	1037.62

f:\work\berger\ftriley\esi\Table-1

Table 2. Summary of Chemical Detections for ESI Groundwater Data - On-Post Wells, October 1993, July/August 1994, October 1994 and January 1995
(There were no detections in wells FP-93-03 and FP-93-06)

Sample Location	FP-93-01 (a)	FP-93-02				FP-93-04							FP-93-05				FP-93-07 (b)			KNL (+)	KAL (+)	MCL (++)
Sample Identification	FP-93-01-02	MAAF-MW-2	FP-93-02	FP-93-02-02	FP-93-02	MAAF-MW-4	FP-93-04	FP-93-04R-1	FP-93-04-2	FP-93-09-2	FP-93-04	FP-93-08	MAAF-MW-5	FP-93-05	FP-93-05-02	FP-93-05	MAAF-MW-600(c)	MAAF-MW-7	FP-93-07			
Sample Event	Oct-94	Oct-93	Jul/Aug-94	Oct-94	Jan-95	Oct-93	Jul/Aug-94		Oct-94		Jan-95		Oct-93	Jul/Aug-94	Oct-94	Jan-95	Oct-93		Jul/Aug-94			
Volatile Organic Compounds (ug/l)																						
Benzene	<0.4	<10	<4.0	<0.4	<0.4	**64**	<20	<20	**6.0**	**7.0**	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.5	5	5
1,2-Dichloroethylene	<0.5	**76**	**29**	**21**	**5.5**	**4,100**	**820**	**750**	**710**	**690**	**3.3**	**2.8**	<0.5	<0.5	**0.8**	**0.8**	<0.5	<0.5	<0.5	7	70 (d)	70 (d)
Dichloromethane	<0.9	<23	<9.0	<0.9	<0.9	<90	<45	<45	<9.0	**10B**	**1.4B**	<0.9	<0.9	<0.9	<0.9	**1.4B**	<0.9	<0.9	<0.9	5	50	5
Ethylbenzene	<0.7	<18	<7.0	<0.7	<0.7	**190**	**150**	**160**	**100**	**110**	**50**	**46**	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	68	680	700
m &/or p-Xylenes	<0.6	<15	<6.0	<0.6	<0.6	**320**	**560**	**580**	**370**	**380**	**220**	**190**	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	44	440	10,000
ortho-Xylene	**0.7**	<15	<6.0	<0.6	<0.6	**330**	**310**	**350**	**200**	**200**	**150**	**130**	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	44	440	10,000
Tetrachloroethylene	<1.1	**210**	**140**	**100**	**16**	<110	<55	<55	<11	<11	<1.1	<1.1	**1.2**	**3.5**	**1.7**	<1.1	<1.1	<1.1	<1.1	0.7	7	5
Toluene	<0.4	<10	<4.0	<0.4	<0.4	**3,200**	**150**	**150**	**83**	**80**	**2.3**	**1.9**	<0.4	<0.4	**0.8**	<0.4	<0.4	<0.4	<0.4	200	2,000	1,000
Trichloroethylene	<1.1	**21**	**56**	**43**	**4.4**	<60	<30	<30	<6.0	<6.0	**1.9**	**1.8**	**1.2**	**2.4**	**1.7**	<0.6	<0.6	<0.6	<0.6	0.5	5	5
Semi-Volatiles (ug/l)																						
Bis (2-Ethylhexyl) Phthalate	<10	<10	<10	<10	<10	<10	<10	<10	<10	**10**	<10	<10	<10	<10	<10	<10	<10	<10	<10	420	4,200	NAv
2-Methyl Naphthalene	<10	<10	<10	<10	<10	**31**	**14**	<10	<10	**14**	<10	<10	<10	<10	<10	<10	<10	<10	<10	NAv	NAv	NAv
4-Methylphenol	<10	<10	<10	<10	<10	**15**	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	NAv	NAv	NAv
Naphthalene	<10	<10	<10	<10	<10	**73**	**45**	<10	**29**	**38**	**13**	<10	<10	<10	<10	<10	<10	<10	<10	14.3	143	NAv
Total Metals (mg/l)																						
Arsenic	<0.01	<0.01	<0.01	<0.01	<0.01	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.01**	<0.01	NAv	0.05	0.05
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.03**	<0.01	NAv	0.05 (e)	0.1 (e)
Copper	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	**0.03**	<0.02	NAv	1	1.3
Lead	<0.003	<0.003	<0.003	<0.003	<0.003	**0.004**	<0.003	<0.003	<0.003	<0.003	**0.013**	**0.021**	<0.003	<0.003	<0.003	<0.003	**0.017**	**0.01**	**0.003**	NAv	0.05	0.015
Nickel	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	**0.05**	<0.04	NAv	0.15	0.1
Selenium	<0.005	**0.009**	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NAv	0.045	0.05
Silver	<0.01	<0.01	**0.03**	<0.01	<0.01	< 0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.01**	NAv	0.05	NAv
Zinc	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	**0.05**	**0.15**	<0.02	NAv	5	NAv
Water Quality Testing																						
TOC (mg/l)	NA	NA	**26**	NA	NA	NA	**8**	**13**	NA	NA	NA	NA	NA	**3**	NA	NA	NA	NA	**3**	NAv	NAv	NAv
TOX (ug/l)	NA	NA	**144**	NA	NA	NA	**216**	**254**	NA	NA	NA	NA	NA	**12**	NA	NA	NA	NA	**6**	NAv	NAv	NAv
COD (mg/l)	NA	NA	<10	NA	NA	NA	**35**	**32**	NA	NA	NA	NA	NA	**11**	NA	NA	NA	NA	<10	NAv	NAv	NAv
BOD (mg/l)	NA	NA	<5	NA	NA	NA	**8**	**8**	NA	NA	NA	NA	NA	<5	NA	NA	NA	NA	<5	NAv	NAv	NAv
Total Petroleum Hydrocarbons (ug/l)																						
TPH-GRO (ug/l)	<100	<100	<100	<100	<100	**13,000**	**3,600**	**4,400**	**2,200**	**2,100**	**1,900**	**1,800**	<100	<100	<100	<100	<100	<100	<100	NAv	NAv	NAv
TPH-DRO (ug/l)	<100	<100	<100	<100	<100	**1,200 (e)**	<100	<100	<100	<100	**1,090 (f)**	**730 (f)**	<100	<100	<100	<100	<100	<100	<100	NAv	NAv	NAv

Bold values represent detected compounds

Shaded values represent concentrations that are equal to or exceed the MCL and/or the KAL.

The July 1994 samples were collected on 6, 7 and 8 July 1994; volatiles analyses is based on samples recollected in August 1994. The identification in the QCSR for all VOC resamples (July/August 1994) is the well identification followed by "-1R".

B Analyte detected in the associated method blank; result has not been blank corrected.

\+ Kansas Department of Health and the Environment, Bureau of Environmental Remediation, Groundwater Contamination Cleanup Target Concentrations, November 1988.

++ U.S. EPA, Office of Water, Drinking Water Regulations and Health Advisories, May 1995.

(a) FP-93-01 had no detections in October 1993, July/August 1994, or January 1995.

(b) FP-93-07 had no detections in October 1994 or January 1995.

(c) MAAF-MW-600 is a duplicate sample of MAAF-MW-7.

(d) The more conservative value of 70 ug/l from the cis isomer was used for the MCL instead of 100 ug/l from the trans isomer.

(e) The MCL and KAL represent values for both trivalent and hexavalent chromium.

(f) Calculated from a kerosene standard.

NA Not Analyzed

NAv Not Available

< Below Practical Quantitation Limit.

For complete list of analytes determined, see QCSR Site Investigations of High Priority Sites, 17 December 1993; QCSR Periodic Groundwater Monitoring Samples, 11 November 1994; QCSR Periodic Groundwater Monitoring Samples, 8 December 1994; QCSR Periodic Groundwater Sampling, March 1995.

Table 3. Summary of Chemical Detections for

ESI Groundwater Data -- Off-Post Wells, October 1993, July/August 1994, October 1994 and January 1995

Sample Location	N-1				F-1			F-2			B-1				I-1		KNL (+)	KAL (+)	MCL (++)
Sample Identification	N-1	N-1	N-1-02	N-1	F-1	F-1	F-1-02	F-2	F-2	F-2-02	B-1	B-1	B-1-02	B-1	I-1-02	I-1			
Sample Event	Oct-93	Jul/Aug-94	Oct-94	Jan-95	Oct-93	Jul/Aug-94	Oct-94	Oct-93	Jul/Aug-94	Oct-94	Oct-93	Jul/Aug-94	Oct-94	Jan-95	Oct-94	Jan-95			
Volatile Organic Compounds (ug/l)																			
Benzene	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.5	5	5
1,2-Dichloroethylene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	7 (a)	70 (a)	70 (a)
Dichloromethane	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	**0.9B**	<0.9	<0.9	<0.9	5	50	5
m &/or p-Xylenes	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	44 (b)	440 (b)	10,000 (b)
Tetrachloroethylene	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	0.7	7	5
Toluene	<0.4	<0.4	<0.4	<0.4	<0.4	**1.2**	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	**2.2**	200	2,000	1,000
Trichloroethylene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	0.5	5	5
Semi-Volatiles (ug/l)																			
2-Methyl Naphthalene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	NAv	NAv	NAv
Naphthalene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	14.3	143	NAv
Total Metals (mg/l)																			
Arsenic	**0.01**	**0.02**	**0.01**	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.02**	**0.02**	NAv	0.05	0.05
Copper	**0.24**	**0.02**	<0.02	<0.02	**0.02**	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NAv	1.0	1.3
Lead	**0.006**	**0.006**	<0.003	<0.003	**0.015**	<0.003	<0.003	**0.006**	**0.005**	**0.007**	<0.003	**0.004**	<0.003	<0.003	<0.003	<0.003	NAv	0.05	0.015
Selenium	<0.005	<0.005	<0.005	<0.005	**0.009**	<0.005	<0.005	<0.005	**0.006**	<0.005	**0.008**	**0.016**	**0.013**	**0.10**	<0.005	<0.005	NAv	0.045	0.05
Zinc	**0.24**	**0.06**	**0.07**	**0.04**	**0.04**	**0.02**	**0.04**	**0.30**	**1.20**	**0.43**	**0.04**	**0.06**	**0.06**	**0.04**	<0.02	**0.04**	NAv	5	NAv
Total Petroleum Hydrocarbons (ug/l)																			
TPH-GRO (ug/l)	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	**790**	<100	NAv	NAv	NAv
TPH-DRO (ug/l)	<100	<100	<100	<100	<100	<100	<100	**300**	<100	<100	<100	<100	<100	<100	<100	<100	NAv	NAv	NAv

Table 3 (continued) Summary of Chemical Detections for

ESI Groundwater Data -- Off-Post Wells, October 1993, July/August 1994, October 1994 and January 1995

Sample Location	R-1					R-2		R-3				M-1				KNL	KAL	MCL
Sample Identification	R-1	R-1R (VOC); R-1 (rest)	R-1R-1 (VOC); D-1 (rest) (c)	R-1-02	R-5-02 (d)	R-2R (VOC); R-2 (rest)	R-2-02	R-3	R-3-02	R-3-3	R-4-3 (e)	M-1	M-1	M-1-02	M-1			
Sample Event	Oct-93	Jul/Aug-94		Oct-94		Jul/Aug-94	Oct-94	Jul/Aug-94	Oct-94	Jan-95		Oct-93	Jul/Aug-94	Oct-94	Jan-95	(+)	(+)	(++)
Volatile Organic Compounds (ug/l)																		
Benzene	<4.0	<4.0	<4.0	**2.0**	**2.0**	<4.0	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.5	5	5
1,2-Dichloroethylene	**98**	**96**	**64**	**290**	**290**	**88**	**110**	<0.5	<0.5	<0.5	<0.5	**2.2**	<0.5	**0.9**	**0.5**	7 (a)	70 (a)	70 (a)
Dichloromethane	<9.0	<9.0	<9.0	<4.5	<4.5	<9.0	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	5	50	5
m &/or p-Xylenes	<6.0	<6.0	<6.0	<3.0	<3.0	<6.0	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	44 (b)	440 (b)	10,000 (b)
Tetrachloroethylene	**160**	**170**	**150**	**330**	**380**	**140**	**130**	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	0.7	7	5
Toluene	<4.0	<4.0	<4.0	<2.0	<2.0	<4.0	<0.4	**0.5**	**24**	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	200	2,000	1,000
Trichloroethylene	**33**	**29**	**31**	**76**	**78**	**56**	**49**	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	0.5	5	5
Semi-Volatiles (ug/l)																		
2-Methyl Naphthalene	<10	<10	<10	<10	<10	<10	<10	**14**	<10	<10	<10	<10	<10	<10	<10	NAv	NAv	NAv
Naphthalene	<10	<10	<10	<10	<10	<10	<10	**52**	<10	<10	<10	<10	<10	<10	<10	14.3	143	NAv
Total Metals (mg/l)																		
Arsenic	**0.03**	**0.02**	**0.03**	**0.01**	**0.01**	**0.02**	**0.02**	<0.01	<0.01	**0.02**	<0.01	<0.01	<0.01	<0.01	<0.01	NAv	0.05	0.05
Copper	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	NAv	1.0	1.3
Lead	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	NAv	0.05	0.015
Selenium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	**0.006**	<0.005	<0.005	NAv	0.045	0.05
Zinc	**0.04**	<0.02	<0.02	**0.08**	**0.08**	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	**0.34**	**0.09**	**0.06**	**0.05**	NAv	5	NAv
Total Petroleum Hydrocarbons (ug/l)																		
TPH-GRO (ug/l)	<100	**140**	<100	**260**	**240**	<100	**130**	<100	<100	<100	<100	<100	<100	<100	<100	NAv	NAv	NAv
TPH-DRO (ug/l)	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	NAv	NAv	NAv

Table 3 (continued) Summary of Chemical Detections for
ESI Groundwater Data -- Off-Post Wells, October 1993, July/August 1994, October 1994 and January 1995

Sample Location	FP-94-08	FP-94-09	FP-94-10	FP-94-11	KNL (+)	KAL (+)	MCL (++)
Sample Identification	FP-94-01PZ-3	FP-94-02PZ-3	FP-94-03PZ-	FP-94-04PZ-			
Sample Event	Jan-95	Jan-95	Jan-95	Jan-95			
Volatile Organic Compounds (ug/l)							
Benzene	<0.4	<0.4	<0.4	**0.9**	0.5	5	5
1,2-Dichloroethylene	<0.5	**94**	<0.5	**51**	7 (a)	70 (a)	70 (a)
Dichloromethane	**0.9B**	<0.9	<0.9	<0.9	5	50	5
m &/or p-Xylenes	<0.6	<0.6	<0.6	**1.1**	44 (b)	440 (b)	10,000 (b)
Toluene	<0.4	<0.4	<0.4	**2.4**	200	2,000	1,000
Trichloroethylene	<0.6	**1.9**	<0.6	**1.0**	0.5	5	5
Semi-Volatiles (ug/l)							
2-Methyl Naphthalene	<10	<10	<10	<10	NAv	NAv	NAv
Naphthalene	<10	<10	<10	<10	14.3	143	NAv
Total Metals (mg/l)							
Arsenic	<0.01	<0.01	<0.01	**0.01**	NAv	0.05	0.05
Copper	<0.02	<0.02	<0.02	<0.02	NAv	1	1.3
Lead	<0.003	<0.003	<0.003	<0.003	NAv	0.05	0.015
Selenium	<0.005	<0.005	**0.006**	<0.005	NAv	0.045	0.05
Zinc	<0.02	<0.02	<0.02	<0.02	NAv	5	NAv
Total Petroleum Hydrocarbons (ug/l)							
TPH-GRO (ug/l)	<100	<100	<100	<100	NAv	NAv	NAv
TPH-DRO (ug/l)	<100	<100	<100	<100	NAv	NAv	NAv

Bold values represent detected compounds.
Shaded values represent concentrations that are equal to or exceed the MCL and/or the KAL.

The piezometers were installed and developed in January 1995. Therefore, no samples were collected for the October 1993, July 1994 and October 1994 sampling events.

Wells R-2 and R-3 were not sampled in October 1993 due to regional flooding.
The July 1994 samples were collected on 6, 7 and 8 July 1994; volatiles analyses is based on samples recollected on 23 and 24 August 1994.
The identification in the QCSR for all VOC resamples (July/August 1994) is the well identification followed by "-1R".
Irrigation well I-1 was included in the periodic groundwater monitoring activities for the first time in October 1994.
For the January 1995 samples, wells F-1, F-2, R-1 and R-2 had been shut down for the winter. Therefore, no samples were collected from these wells.

B Analyte detected in the associated method blank; result has not been blank corrected.
\+ Kansas Department of Health and the Environment, Bureau of Environmental Remediation, Groundwater Contamination Cleanup Target Concentrations, November 1988.
++ U.S. EPA, Office of Water, Drinking Water Regulations and Health Advisories, May 1995.

(a) Although a KAL, KNL and MCL for 1,2-DCE (mixed) is not available, concentrations reported as 1,2-DCE (mixed) will be compared to the more conservative KAL, KNL and MCL for 1,2- DCE isomers.
(b) Although no standards or guidelines are available for m- &/or p-Xylenes, concentrations reported as m- &/or p-Xylenes will be compared to the standards and guidelines for Xylenes (mixed).
(c) R-1R-1 is a duplicate of R-1R.
(d) R-5-02 is a duplicate of R-1-02
(e) R-4-3 is a duplicate of R-3-3

NA Not Analyzed
NAv Not Available
< Below Practical Quantitation Limit

For complete list of analytes determined, see QCSR Site Investigations of High Priority Sites, 17 December 1993; QCSR Periodic Groundwater Monitoring Samples, 11 November 1994; QCSR Periodic Groundwater Monitoring Samples, 8 December 1994; QCSR Periodic Groundwater Sampling, March 1995.

Table 4
CHLORINATED VOC GROUNDWATER DATA
COMPARISON OF SAMPLING EVENTS

SAMPLE LOCATION	OCT 1993 (1)	JUL 1994 (2)	OCT 1994 (3)	JAN 1995 (4)
1,2-DCE RESULTS (µg/L)				
FP-93-02	76	29	21	5.5
FP-93-04	4100	820	710	3.3
FP-93-05	<0.5	<0.5	0.8	0.8
R-1	98	96	290	NS
R-2	NS	88	110	NS
M-1	2.2	<0.5	0.9	0.5
FP-94-09	NS	NS	NS	94
FP-94-11	NS	NS	NS	51
PCE RESULTS (µg/L)				
FP-93-02	210	140	100	16
FP-93-04	<55	<55	<11	<1.1
FP-93-05	1.2	3.5	1.7	<1.1
R-1	160	170	380	NS
R-2	NS	140	130	NS
TCE RESULTS (µg/L)				
FP-93-02	21	56	43	4.4
FP-93-04	<30	<30	<6.0	1.9
FP-93-05	1.2	2.4	1.7	<0.6
R-1	33	31	78	NS
R-2	NS	56	49	NS
FP-94-09	NS	NS	NS	1.9
FP-94-11	NS	NS	NS	1

(1) 7 on-post wells and 8 residential wells sampled
(2) 7 on-post wells and 8 residential wells sampled
(3) 7 on-post wells and 9 residential wells sampled
(4) 7 on-post wells, 5 off-post wells and 5 residential wells sampled

NS - Not Sampled.

Standard Operating Procedures for Installation of Piezometers Using Geoprobe Equipment

PIEZOMETER

Piezometer wells are a cost effective installation for acquiring hydrostatic pressure, groundwater levels, flow, and water samples. Strategic installations of permanent monitoring wells without appropriate data can result in major miscalculations.

PSA's piezometer installation method and materials offers the client maximum reliable data at the minimum time and cost.

PSA INSTALLATION METHOD
(See Diagram)

PSA uses PVC or teflon casings flush threaded schedule 40 1" ID x 3' and 1" x 3' mill slotted (0.010) screen sections.

The screen section and casings are sleeved outside of our 7/8" OD rod sections and hydraulically advanced to suspected groundwater depth. An electric water level locator is lowered down the probe rod I-D to confirm groundwater. If not encountered the rod and casings is again advanced until water is detected.

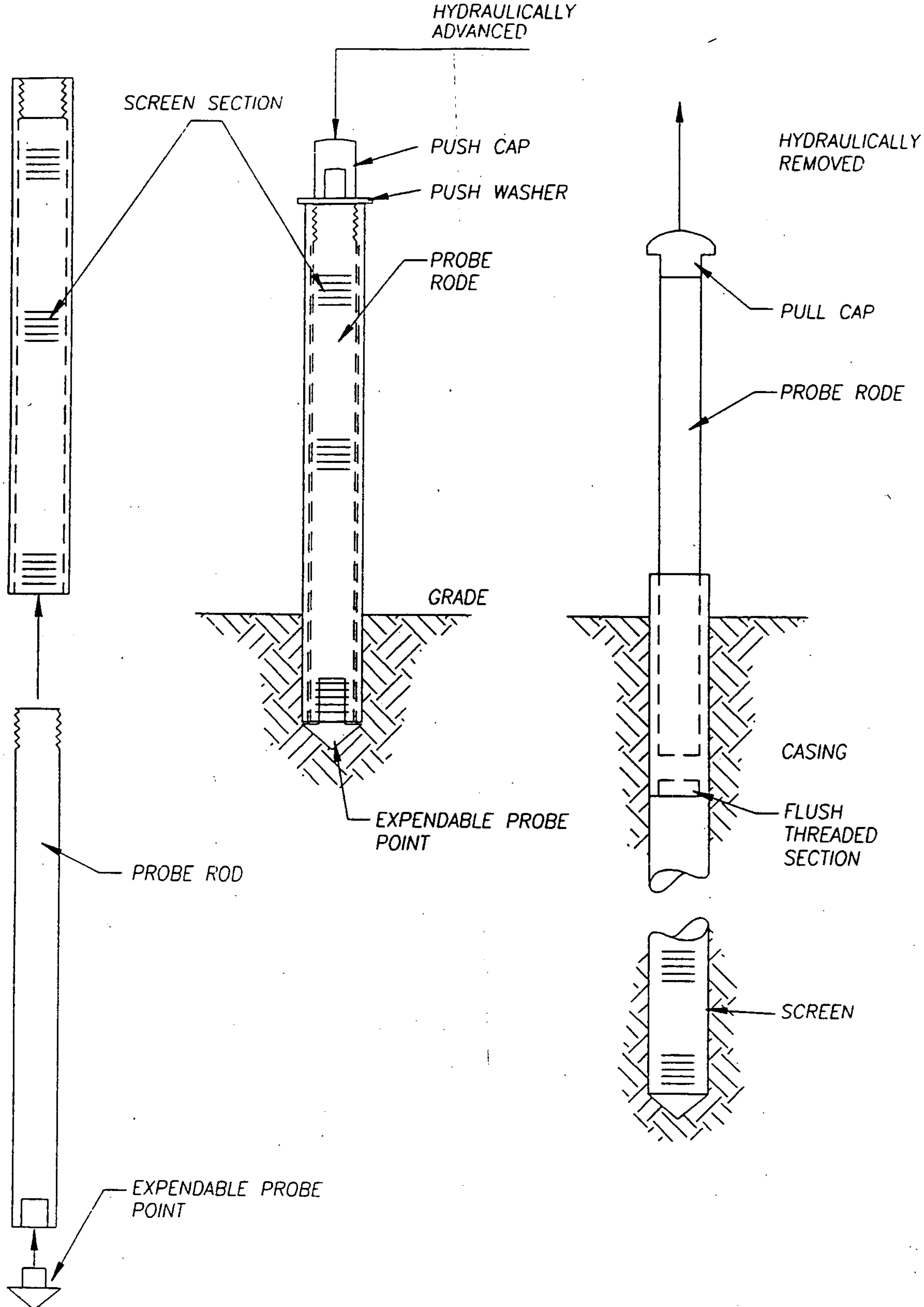
When water is encountered proper depth the drive rods are withdrawn leaving the piezometer in place.

Subsurface pressure on the casings allows the rods to be withdrawn freely. The same pressure on the casings exterior seals the casing train from vertical filtration of perched or surface water.

Depending on subsurface composition and depth to groundwater each complete installation takes from 30 min. to 45 minutes.

Sampling of groundwater can be achieved in either of three ways: A) 40 ml SS bailer B) 3/8" Teflon line with a SS foot valve or C) 3/8" Teflon line and a peristaltic pump.

The piezometer can be used and reused indefinitely. When of no use the top section can be unthreaded and the entire length bentonited and cemented at the surface.



Not to Scale

INSTALLATION OF PIEZOMETERS USING GEOPROBE EQUIPMENT