Report No. 5040-01F
Revision No. 0

Remedial Action Plan
for Organic Compounds in Groundwater

General Electric Facility
Wilmington, North Carolina

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Submitted by

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1.0 Introduction

Research Triangle Institute (RTI) has prepared this Remedial Action Plan (RAP) for General Electric Company (GE) to address concentrations of certain organic compounds in excess of State groundwater standards at GE's Wilmington, North Carolina, facility. The corrective measures detailed herein are designed to reduce or eliminate the potential threat to human health, contain groundwater contamination within site boundaries, and reduce the total amount of organic compounds in the groundwater to applicable State standards to a degree that is economically and technologically feasible. For the reader's convenience, a brief history of the groundwater conditions which are the subject of this RAP is provided below.

GE discovered small quantities of trichloroethylene (TCE) in its water supply in June 1991. RTI sampled the water-supply wells at the site, some of which indicated the presence of organic compounds. Additional testing and sampling of wells, determination of potential offsite groundwater users, and installation of perimeter monitoring wells were also performed by RTI. A historical review of work addressing the organics in groundwater situation to date is presented in Figure 1. A Notice of Violation (NOV) was issued to GE by the N.C. Department of Environmental Management (DEM) in October 1991. The assessment of the TCE contamination at the site is described in the "Summary Report of Organic Compounds in Groundwater at the General Electric Facility, Wilmington, N.C." (RTI Report No. 5040-01F dated September 22, 1992) and more recently in the fourth quarter sampling report (RTI Report No. 5040-01F dated November 23, 1992). Additional sampling, assessment, and preliminary remedial activities are currently being implemented.

The NOV also addressed the presence of BTEX compounds and naphthalene in some of the wells in the principal aquifer. Some of the wells in the principal aquifer (i.e., OB-2 and WW-1A) are downgradient of the former underground storage tank area. The underground storage tanks in this area were removed by GE. A groundwater remediation system was installed in the surficial aquifer at this former source area and includes a soil vapor extraction system and a groundwater pump and treatment system under permit No. WQ-0005524. The occurrence of BTEX compounds and naphthalene in other wells (i.e., WW-10A and FX-3) appears to

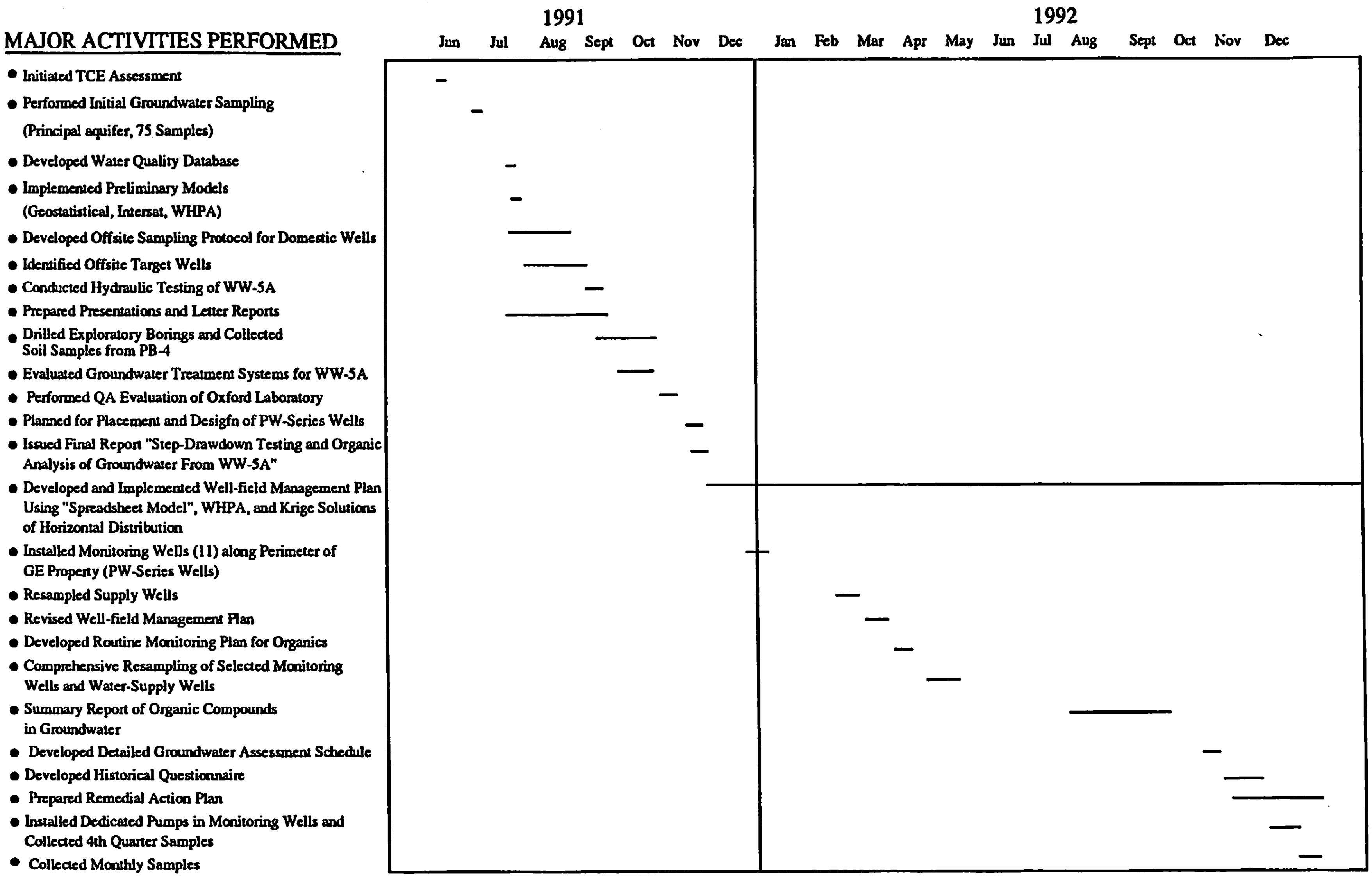


Figure 1 - Historical Review of Organics in Groundwater Activities

be localized and will be assessed later in 1993. Therefore, the focus of this RAP is on the TCE contamination present at the site.

In October 1992, the DEM indicated that GE would be required to perform additional assessment of the TCE contamination at the site, implement a RAP, and provide a schedule for these activities. This RAP is intended to address the criteria for Corrective Action Plans based on 40 CFR 280.66 and NCAC T15A:2L.0106. Section 2 of this document contains pertinent information on the hydrogeologic characteristics of the region and site. Section 3 addresses the identity and characteristics of the contaminants and potential exposure pathways, including the estimated contaminant behavior with little or no remedial action. The current understanding of the horizontal and vertical extent of contamination is described in Section 4. Section 5 outlines additional assessment activities proposed for the site. Existing and potential remedial alternatives are set forth in Section 6.

The remedial measures proposed herein are based on existing data concerning the horizontal and vertical extent of the organic contaminants detected in the groundwater at the Wilmington facility. GE will consider additional or alternative remedial actions in light of new data generated during the proposed additional assessment activities, as described in Section 5. GE will provide to DEM written modifications to the RAP as conditions warrant.

2.0 Hydrogeologic Framework

2.1 Regional Hydrogeology

The GE plant site is located in the northwest portion of New Hanover County, North Carolina (Figure 2). Elevations in this region of the Atlantic Coastal Plain generally range between 0 and 50 ft above sea level. The Northeast Cape Fear River represents a major hydrogeologic feature in the site area. A regional hydrogeologic cross-section is provided in Figure 3.

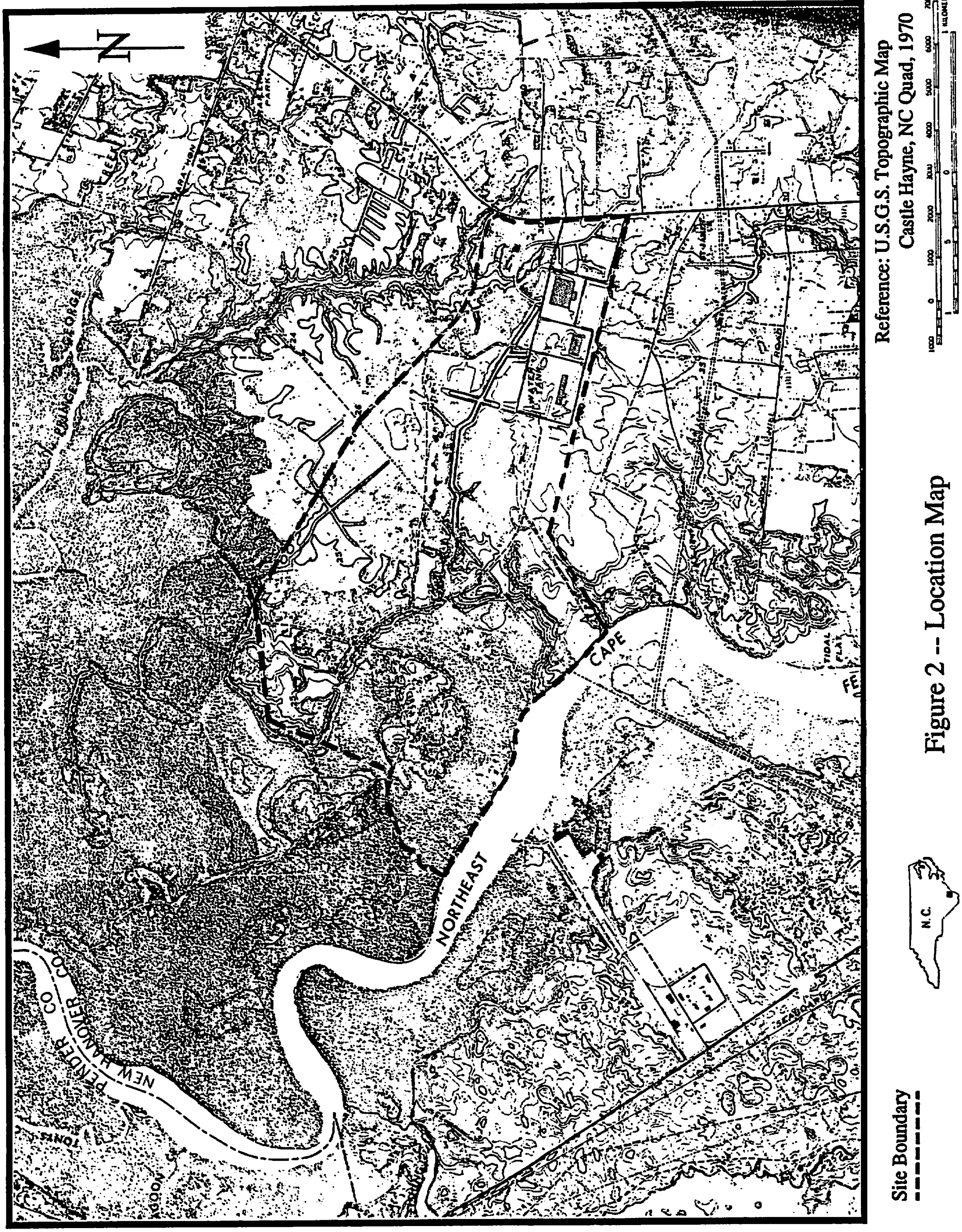
2.1.1 Surficial Deposits

The upland portions of the region, generally between 20 and 40 ft, m.s.l., are underlain by highly stratified, undifferentiated deposits of late Tertiary/Quaternary age. These surficial deposits primarily include terraced and barrier beach deposits, fossil sand dunes, and stream channel deposits. The surficial deposits in the region typically include medium to fine-grained sands, clayey sands, silts, and clays. Peat is also present in these deposits, and coarse-grained sands are found in some areas where channels of the Cape Fear once flowed.

The more permeable surficial deposits in the region form a shallow aquifer. The shallow aquifer is recharged directly by rainfall and the water table is near the land surface. Discharge of the aquifer is into streams and drainage canals and, in some areas, into underlying aquifers (Le Grand, 1960).

2.1.2 Castle Hayne Formation

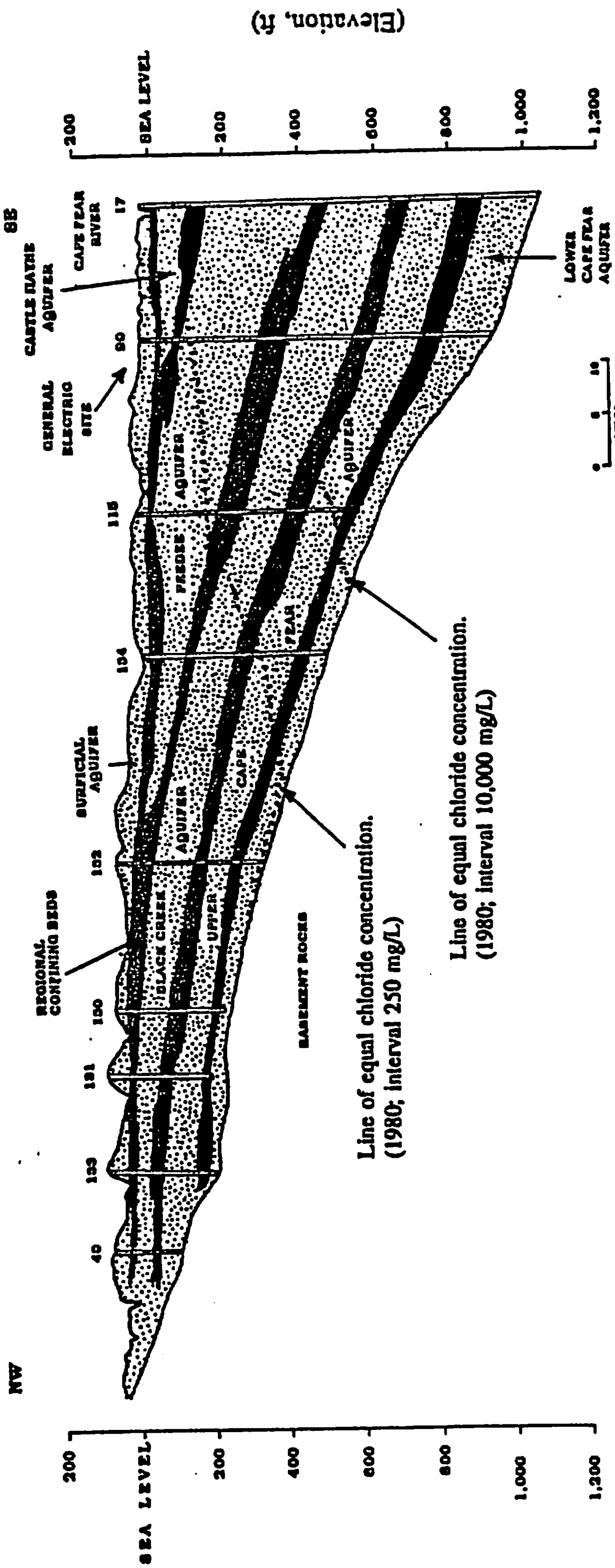
The surficial deposits are underlain by the Castle Hayne Formation of the Eocene age in the eastern part of New Hanover County. The Castle Hayne Formation consists primarily of shell, marl, sand, and limestone. The distribution and thickness of the formation is irregular, resulting from its deposition on the eroded surface of the Peedee Formation. The formation does not appear to be present beneath the General Electric property on the basis of lithologic observations from site borings and on the basis of recently mapped stratigraphy of the region by Zarra (1991).



Reference: U.S.G.S. Topographic Map
Castle Hayne, NC Quad, 1970

Site Boundary

Figure 2 -- Location Map



Source: Winner, M.D., Jr., and R.W. Coble, 1989. *Hydrogeologic Framework of the North Carolina Coastal Plain Aquifer System*. U.S. Geological Survey, Open-File Report 87-690. (Modified from Plate 5.)

Figure 3 -- Regional Hydrogeologic Cross-Section

2.1.3 Peedee Formation

The Peedee Formation of Upper Cretaceous age typically consists of unconsolidated greenish-gray to dark-gray silt, olive-green to gray sand, and massive black clay interbedded with consolidated calcareous sandstone and limestone. The upper portion of the formation has more sand and lime content than the base of the formation (Bain, 1970). The sand within the formation is fine to very fine-grained subangular quartz with trace quantities of glauconite and other minerals. The Rocky Point Member of the Peedee Formation contains sandy, moldic limestone and very calcareous sandstone (Zarra, 1991). The top of the formation dips to the east-southeast in New Hanover County.

2.1.4 Principal Aquifer

The Castle Hayne and Peedee Formations usually are not differentiated from a hydrologic standpoint because of similarities in lithologies and evidence that these formations form essentially one hydrologic unit. The fresh water portion of this unit (chloride concentrations less than 250 mg/L) is referred to as the Castle Hayne aquifer by the U.S. Geological Survey (Winner and Coble, 1989). The unit is referred to as the principal aquifer at the site because it is the sole source of the plant's process and potable water.

Where present in the region, the silty and clayey deposits that underlie the shallow aquifer form a confining bed to the principal aquifer. The Castle Hayne aquifer is considered semiconfined in parts of the region where the confining bed is thin or absent. Groundwater levels in the Castle Hayne aquifer indicate that recharge principally occurs in an upland area around Murraysville (Bain, 1970), about 6 miles southeast of the site. Groundwater flow in the region is from the recharge area to the north and west toward the northeast Cape Fear River, which serves as a discharge zone. Fresh groundwater is generally encountered within the upper portion of the Castle Hayne aquifer in the region. Chloride concentrations increase near the discharge areas and increase with depth within the aquifer. The most productive wells within the Castle Hayne aquifer are within the consolidated limestones and sandstones of the formations. Although deeper aquifers exist beneath the Castle Hayne aquifer, they are known to contain an increasing concentration of chloride with depth (Winner and Coble, 1989) and do not appear to be used for a source of drinking water in the immediate vicinity of the site.

2.2 Site Hydrogeology

The site hydrogeologic framework is similar to that of the region, consisting of a surficial sandy aquifer unit underlain by a clay confining layer. Discontinuous clay layers are also present in the surficial aquifer. Beneath these units is the principal aquifer unit, in which TCE compounds have been detected. Cross-sections bisecting what are currently considered to be the two TCE source areas on the site are presented in Figures 4 and 5. The confining unit varies in thickness, and in some areas of the site may not be present at all. Contacts between the layers are typically gradational. However, the lithology of each stratum is distinctive. A summary of available permeability data for hydrogeologic units at the site is presented in Figure 6.

The current estimation of the potentiometric surface of the principal aquifer at the site is presented on Figure 7. This figure is based on water level measurements obtained at the site in April of 1992. Based on this figure, the inferred groundwater flow direction is to the north-northwest towards the Cape Fear River. Information on water levels in the western area of the site is limited. However, based on the location and estimated hydrologic effect of the Northeast Cape Fear River, the groundwater flow direction in this area of the site is inferred to be to the west-southwest. Figure 7 also indicates the presence of an elongated cone-of-depression in the area of the northern well field due to sustained pumping of these wells. Potentiometric information is provided only for the principal aquifer, in which TCE concentrations have been detected. TCE has not been detected in the surficial aquifer to date.

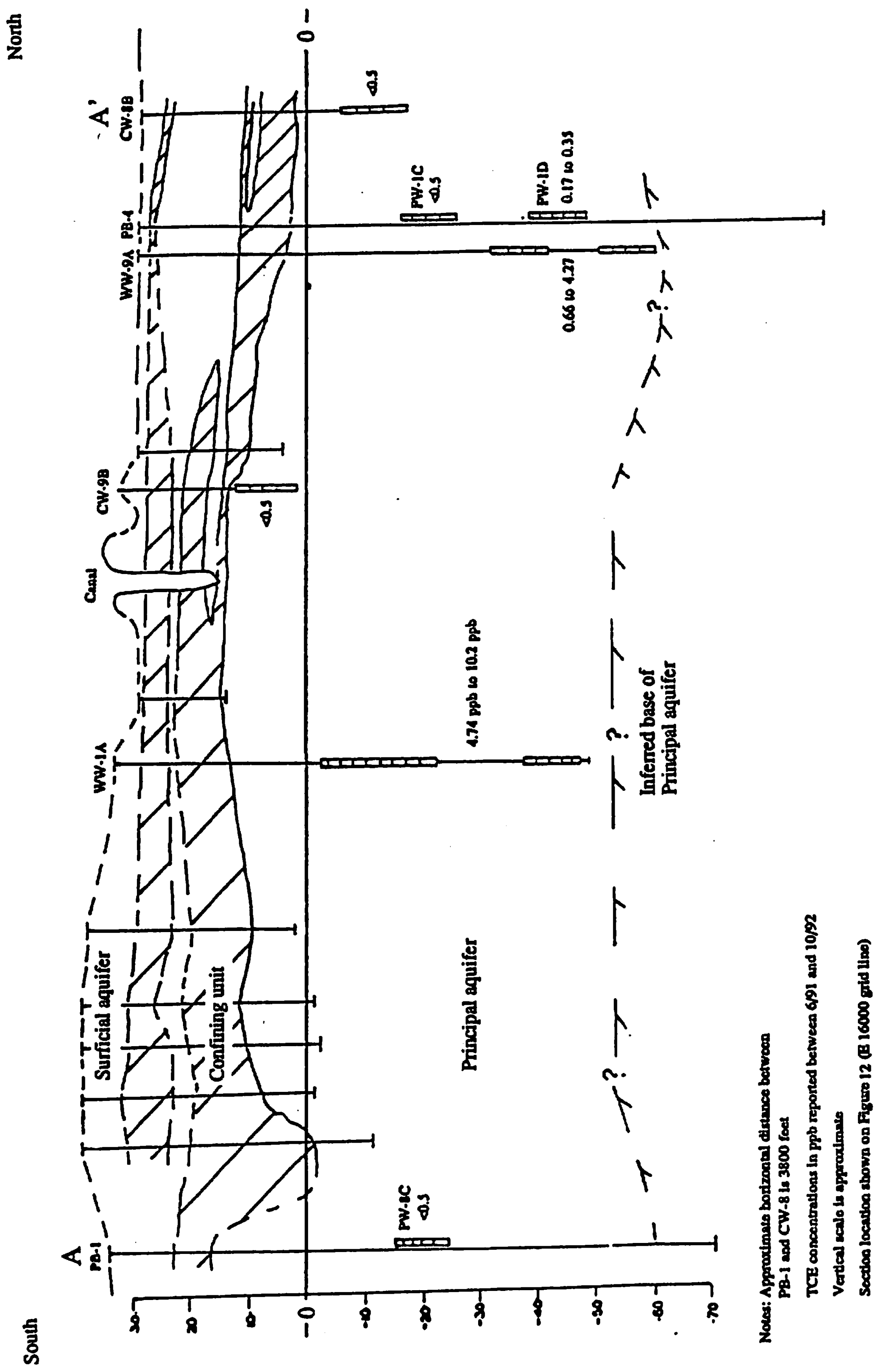
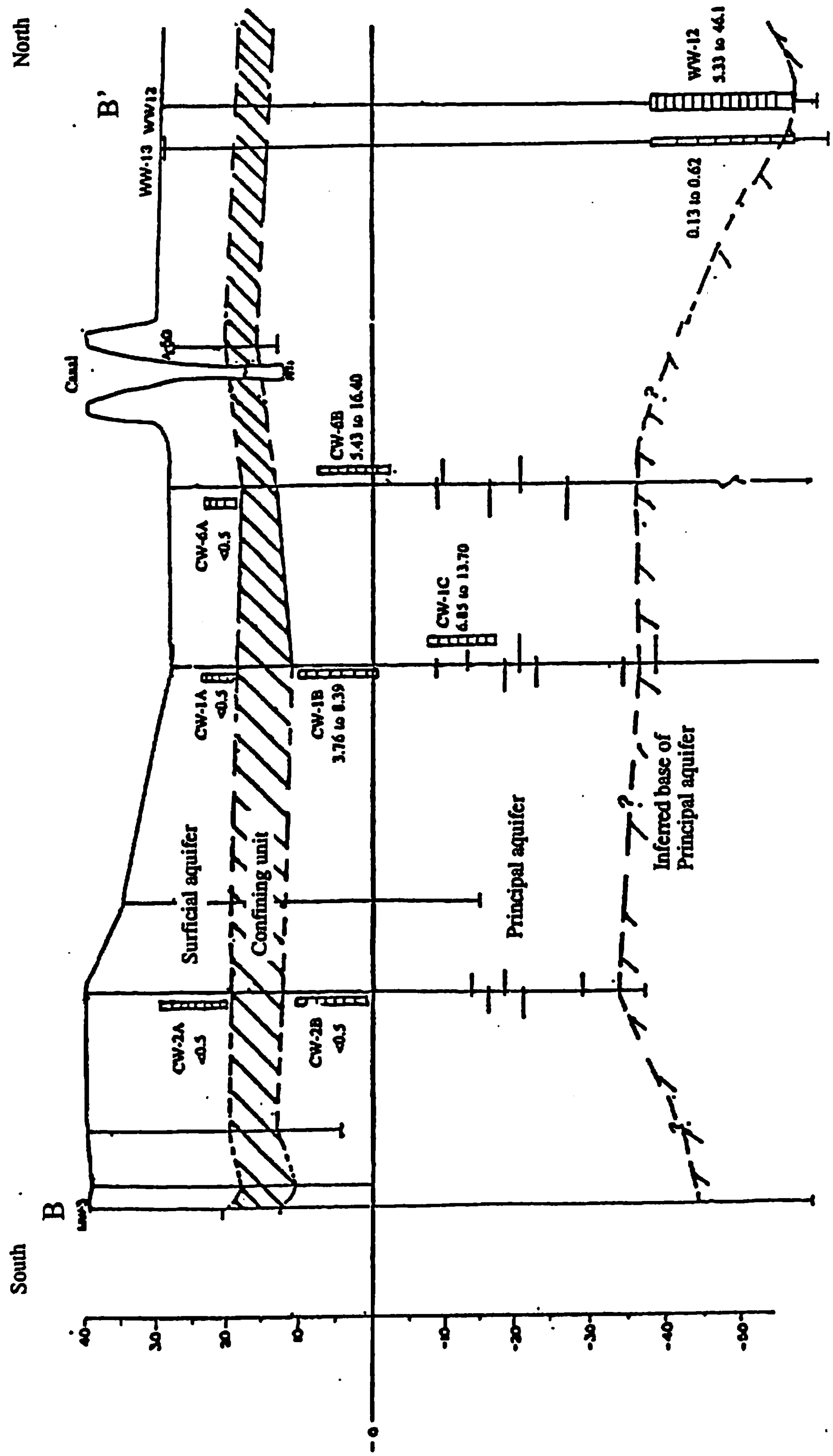


Figure 4 -- Geologic Cross-Section A-A' Near Eastern Source Area



Notes: Approximate horizontal distance between MW-3 and WW-12 is 3100 feet

TCE concentrations in ppb reported between 6/91 and 10/92

Vertical scale is approximate

Section location shown on Figure 12 (E 14000 grid line)

Figure 5 -- Geologic Cross-Section B-B' Near Western Source Area

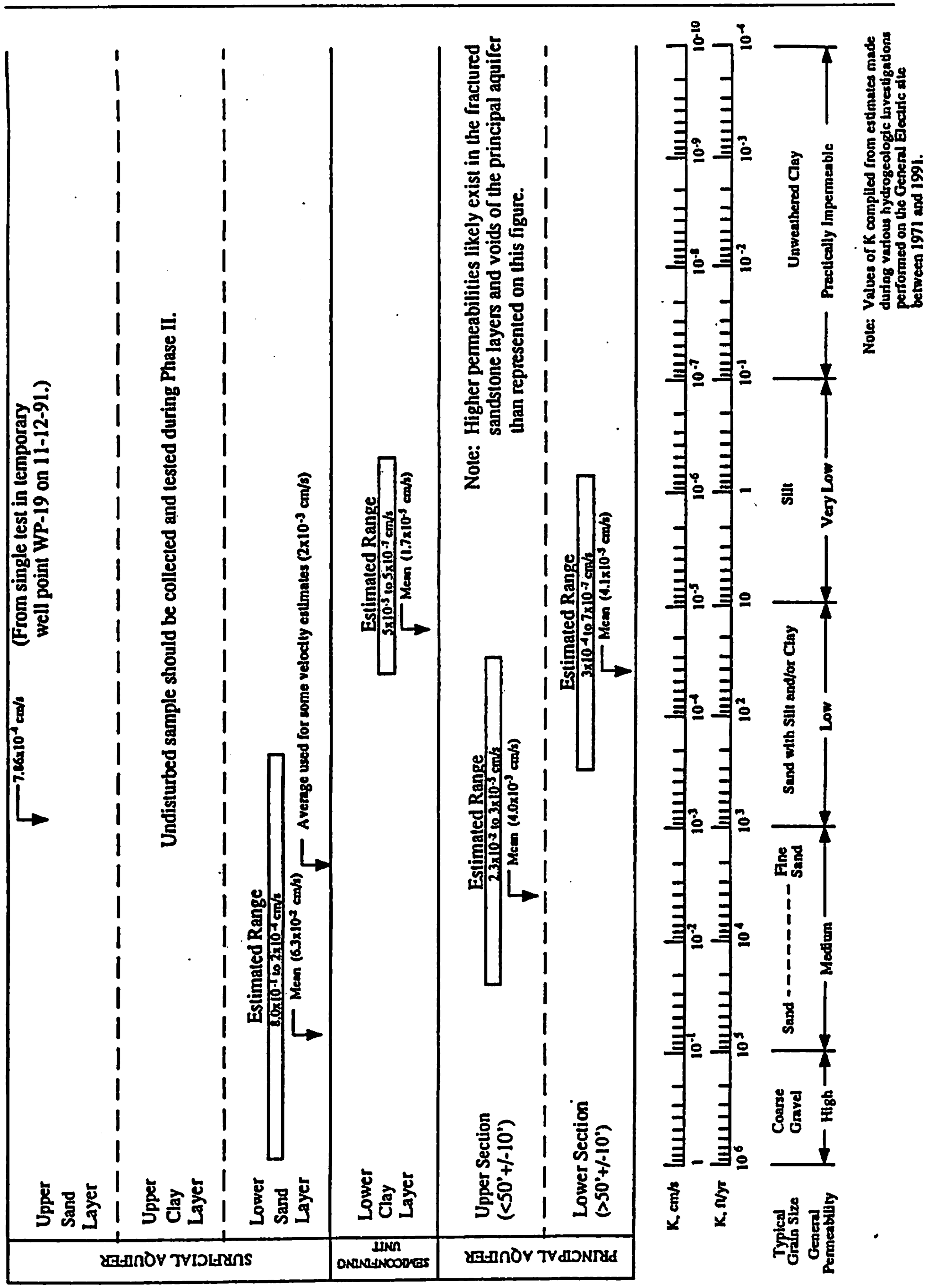


Figure 6 -- Summary of Available Permeability Data

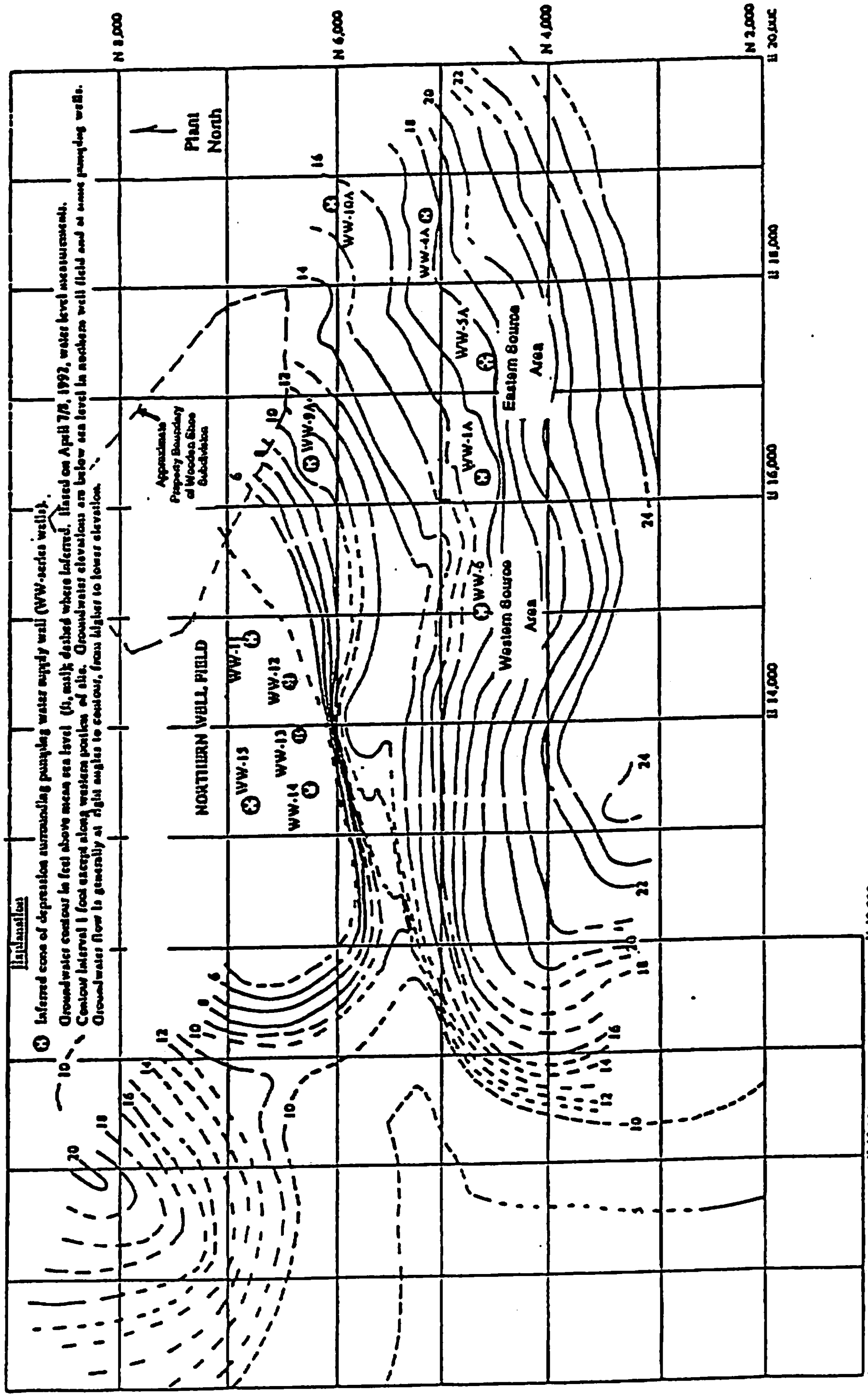


Figure 7 -- Generalized Potentiometric Surface of Principal Aquifer at Plant Site (April 1992)

3.0 Contamination Assessment

3.1 Contaminants Detected

General Electric discovered TCE in the plant potable water supply in early 1991 during testing of drinking water for volatile organic compounds (VOCs). TCE was used at the site for metal degreasing in the past. General Electric has not used or stored significant quantities of TCE onsite since the mid-1970s. There are no drums or tanks containing TCE at the site according to GE. Sampling of water-supply and monitoring wells on the site confirmed the presence of TCE and its degradation products[1]. A complete summary of water-supply and monitoring well sampling analysis results is presented in Appendix A, along with the results of field blank analyses.

TCE is a colorless, liquid solvent. It is a dense, nonaqueous phase liquid (DNAPL), and as a result moves downward through the vadose and saturated zones under the influence of gravity. The combination of its high density and low viscosity (of the nonaqueous phase) results in relatively high mobility in the subsurface. Therefore, dissolved constituents may migrate relatively large distances from the source, depending upon the following factors (EPA, 1992A):

- the volume of DNAPL released;
- the area of infiltration at the DNAPL entry point to the subsurface;
- the duration of release;
- properties of the DNAPL, such as density, viscosity, and interfacial tension;
- properties of the soil/aquifer media, such as pore size and permeability;
- general stratigraphy, such as location of and topography of low-permeability units;

[1] cis-1,2 - Dichloroethylene
trans-1,2 - Dichloroethylene
1,1 - Dichloroethylene
Vinyl Chloride

- micro-stratigraphic features, such as root holes, small fractures, etc., in soil layers.

A summary of pertinent physico-chemical properties of TCE is presented in Table 1.

3.2 Human Exposure Potential

Since TCE has been detected in the plant's water supply wells, which provide potable and process water to the site, the potential for human exposure to TCE exists at the site. Personnel may be exposed to TCE by ingestion of drinking water or by aspiration during showering or other spraying of TCE-containing water. The maximum contaminant level (MCL) for TCE in drinking water (for communities or for water supplies to over 25 people) is 5.0 ppb based on Federal and State drinking water standards. The groundwater standard for TCE established by the State of North Carolina is 2.8 ppb (NCAC T15A:2L .0202). Raw water from General Electric's supply wells passes through an aerator, reducing the inlet concentration of TCE from about 5 ppb to less than about 2.5 ppb in the outlet (Figure 8). The aerator has effectively maintained a TCE reduction efficiency in the range of about 50 to 60 percent (Figure 9). The drinking water at the plant is tested for TCE on a weekly basis. There have been no indications that TCE concentrations in the potable water supply have exceeded State or Federal drinking water standards since testing of the plant's drinking water for VOCs began in 1991 (Figure 10).

The locations of domestic wells in a 1500 ft radius of the site are presented in Figure 11. Domestic water wells in a residential development located north of the site would most likely be impacted under no-action (nonpumping) circumstances. These wells appear to tap the same section of the principal aquifer as General Electric's supply wells, with average well depths of approximately 70 ft. Sampling of monitoring wells along the northern site boundary (PW-1, 2, 3, and CW-8) has not indicated reportable[2] quantities of TCE. Sustained, relatively high-volume

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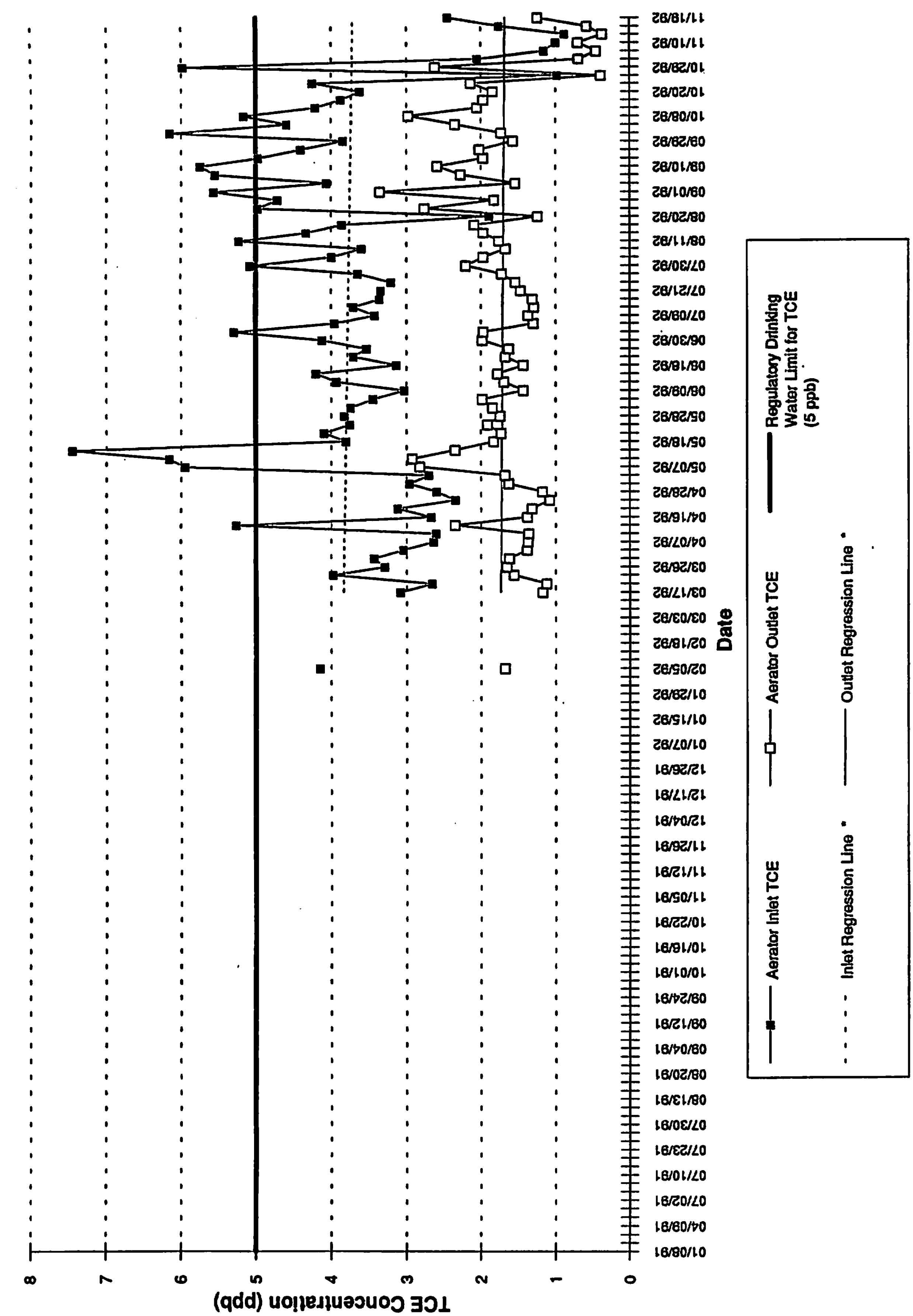
[2]The reporting limit for all compounds measured by the 6230D analysis method performed by Oxford Laboratories, Inc., is 0.5 ppb. This level is set by the EPA or State agencies in specifying the method for drinking water analyses. Reporting limits for such analyses are generally set at ten times the minimum detection limit or on the basis of the performance of laboratories routinely performing the analysis in question. Reporting limits represent concentration levels at which laboratories can routinely achieve precision and accuracy acceptance limits that are adequate for regulatory purposes. In general, concentrations reported below reporting limits should be viewed with care with respect to their accuracy and precision.

Table 1. Trichloroethylene Data Sheet

Chemical Formula - C_2HCl_3
Molecular Weight - 131.4

Property	Value	Units	Remarks
Density	1.4620	g/cc	Density greater than water results in vertical movement through unsaturated and saturated zones.
Solubility	1000	mg/L	Prefers to partition to another phase (volatilization), less subject to biological action.
Henry's Law Constant	8.92 E-03	atm-m^3/mol	Efficient transfer of TCE from water to atmosphere.
K_{oc}	2.42	---	Reduced retardation (sorption to soil particles), favorable to pump and treat remedial action.
Dynamic Viscosity	0.5700	centipoise	When combined with high density, easy movement through porous media.

(EPA, 1992B)



* Note: Linear regression analysis performed using Least Squares Method.

Figure 8. TCE Concentrations Measured Before and After Raw Water Aeration

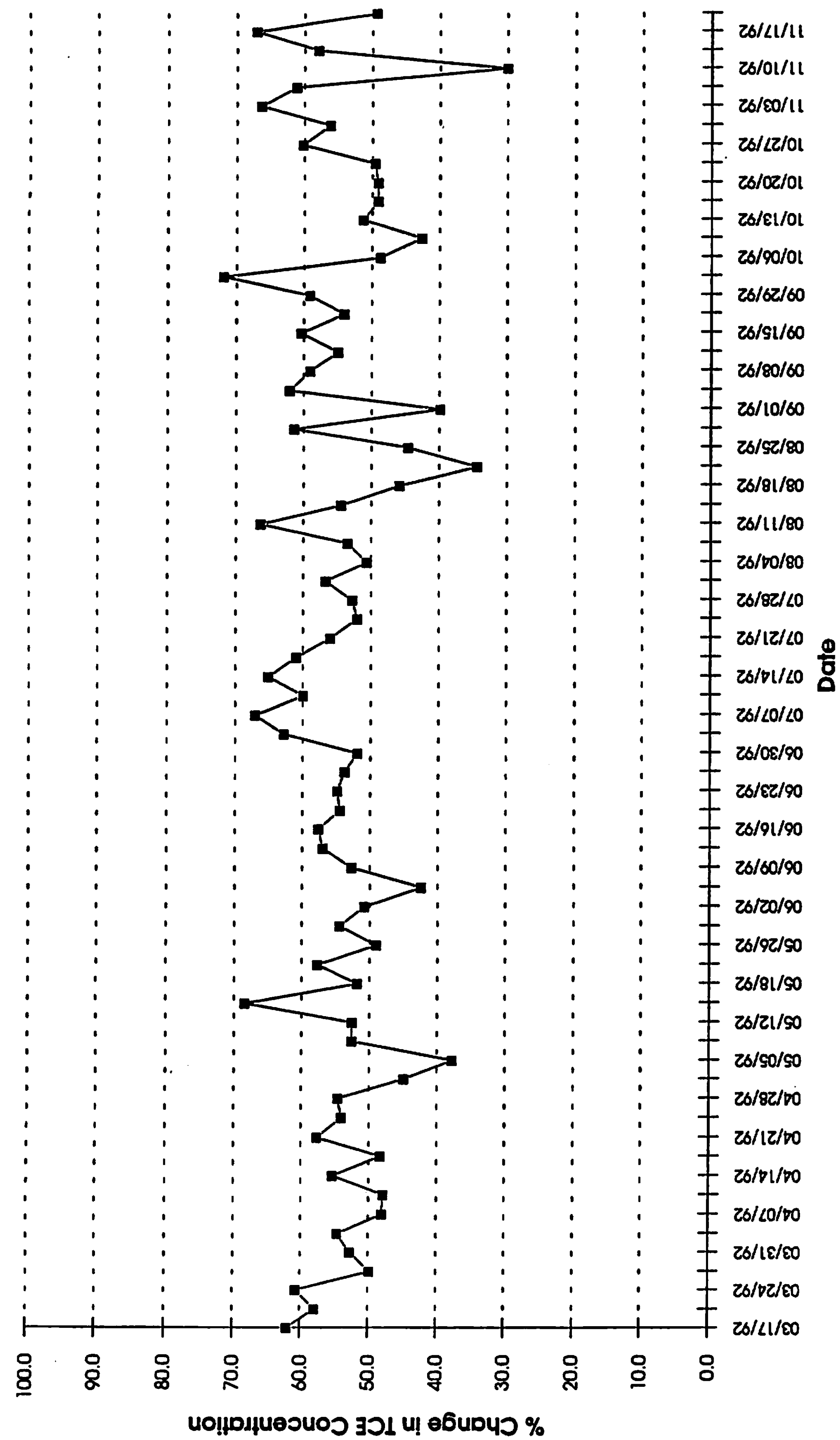
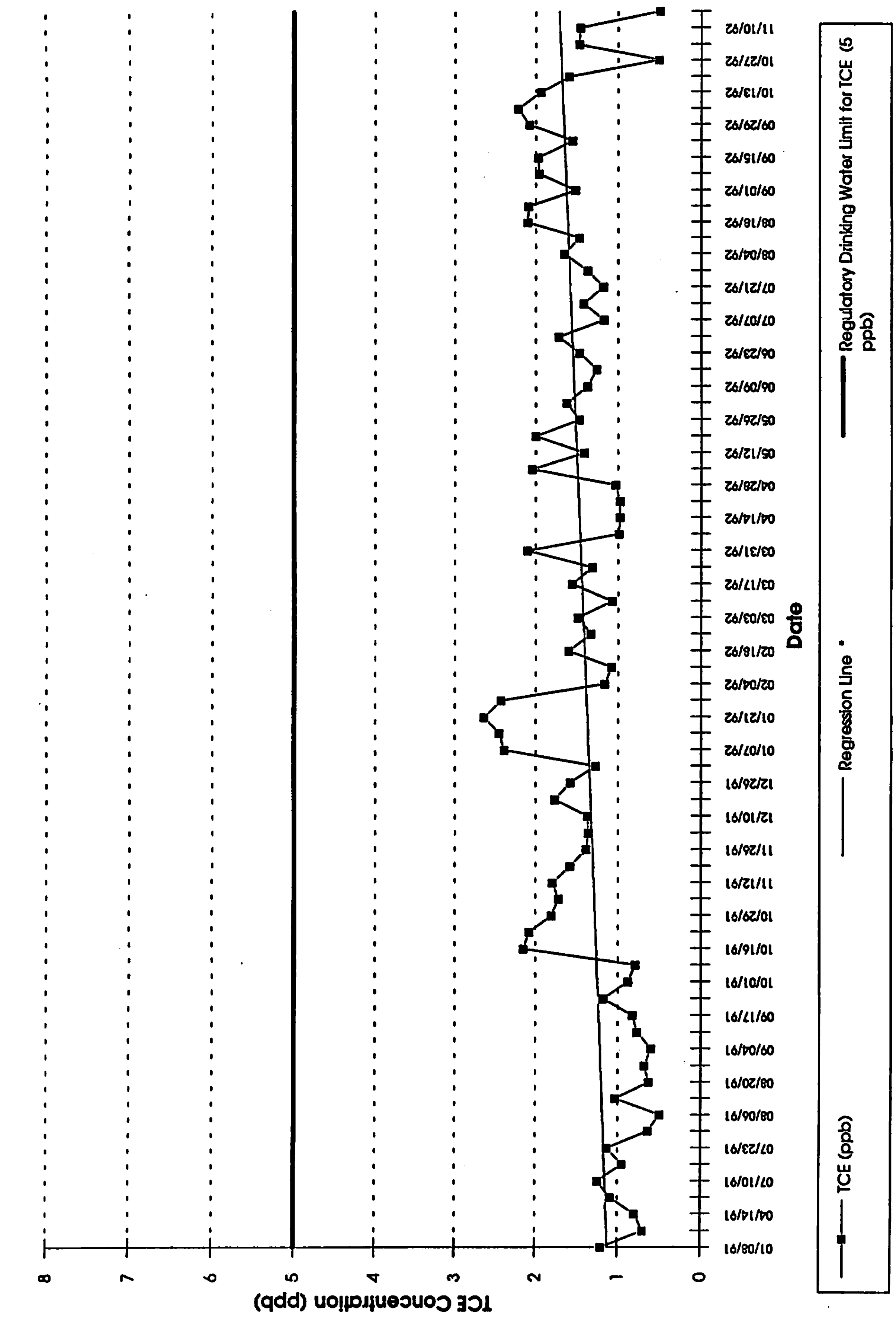


Figure 9. Percent Change in Before/After Aerator TCE Concentrations



* Note: Linear regression analysis performed using Least Squares Method.

Figure 10. Potable Water Supply (Utility Sink, Bldg. J) -- TCE Concentrations

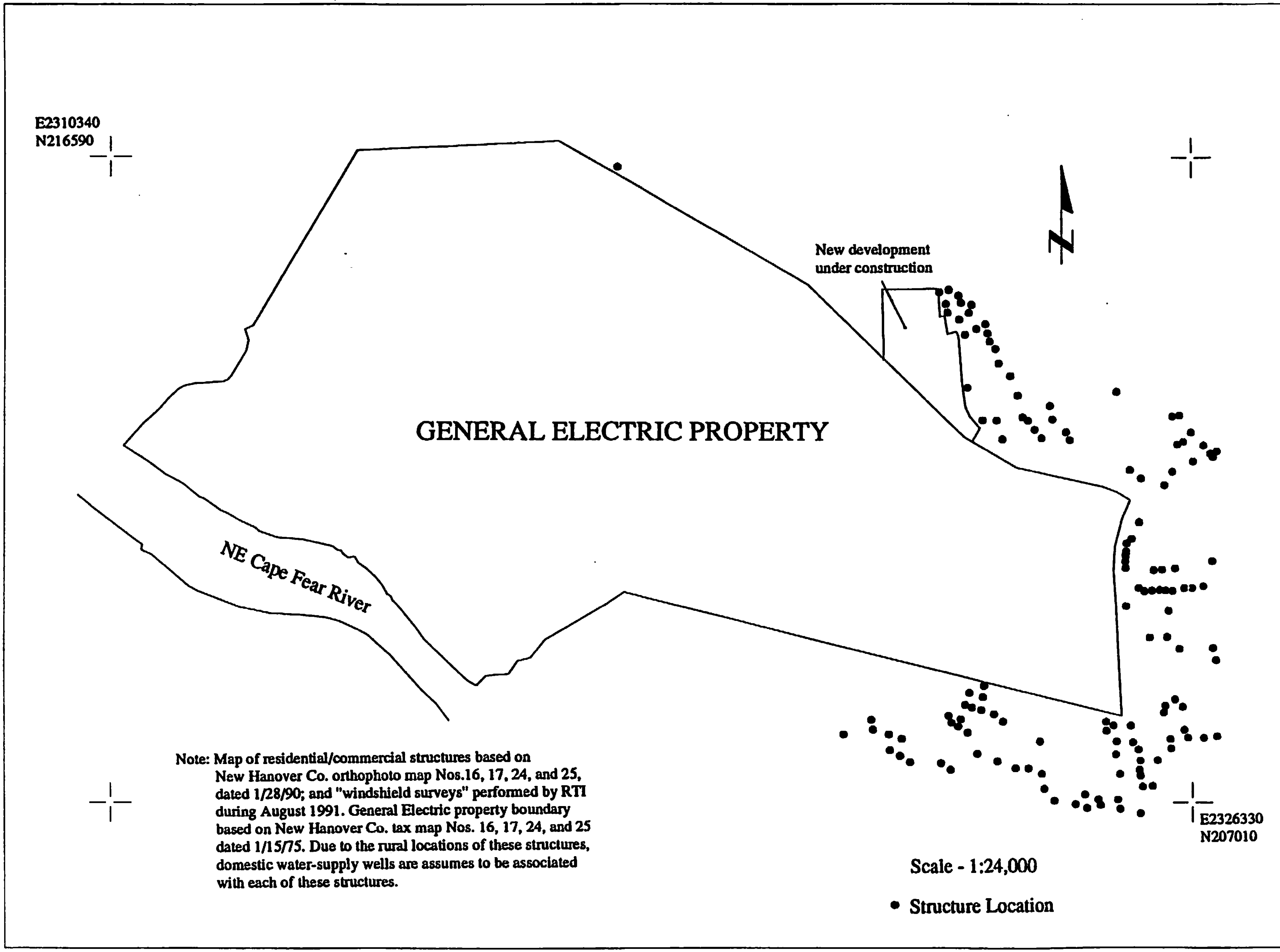


Figure 11 - Locations of Residential/Commercial Structures Within 1500 ft. of General Electric Property

pumping from the water-supply wells in the northern areas of the site has likely aided against migration of the contaminant plume offsite.

3.3 Other Potential Receptors

Other than the aforementioned potential receptors (plant employees and downgradient domestic wells in nearby residential areas), there are few other receptors likely to be impacted with little or no remedial action. With no remedial action, it is likely that low-levels of the dissolved-phase contaminant would migrate (and likely discharge) to the Northeast Cape Fear River. Based on a mean estimated groundwater velocity of 150 ft/yr and a distance of approximately 2,500 ft from the western 2.8 ppb isocon to the northeast Cape Fear River, it is estimated that migration of the plume this distance would take approximately 17 years if not intercepted by pumping wells.

4.0 Known Extent of Contamination

4.1 Horizontal Extent of Contamination

Figure 12 shows the total number of wells located on the subject site. Eight of fifteen water-supply wells tested have shown reportable concentrations of TCE compounds. In addition, a total of 50 monitoring wells have been sampled for organic compounds. Of these, 7 have indicated reportable concentrations of TCE compounds.

The present interpretation of the horizontal extent of TCE contamination is shown on Figure 13. The area of the plume above the State groundwater standard of 2.8 ppb is estimated to be approximately 0.4 square miles. The highest concentrations of TCE compounds have been detected in the vicinities of WW-5, WW-12, and WW-6, suggesting two potential source areas (Figure 13). However, visible indications (tanks, drums, etc.) of the exact locations of these source areas are not currently evident. Monitoring wells located along the northern site boundary do not show reportable concentrations of TCE compounds. Figure 13 represents inferred TCE concentrations based on Kriging interpolation methods.

4.2 Vertical Extent of Contamination

TCE has not been detected in wells terminating in the surficial aquifer. It is assumed that much of the free-phase TCE, if present, may have migrated downward into the principal aquifer. Each of the water-supply wells are screened in the principal aquifer. The base of the principal aquifer is not well-known (gradational with increasing silt content with depth) and is only inferred in the site cross-sections (Figures 4 and 5). The deepest water-supply well indicating the presence of TCE is WW-6 at approximately 95 feet below mean sea level.

Monitoring wells on the site terminate at various depths. Typically, monitoring wells are designated by a number followed by a letter A (surficial aquifer), or B, C, or D (progressively greater depths into the principal aquifer). The maximum depth at which TCE compounds were detected above reporting limits in a monitoring well was approximately 18 feet below mean sea level in CW-1C.

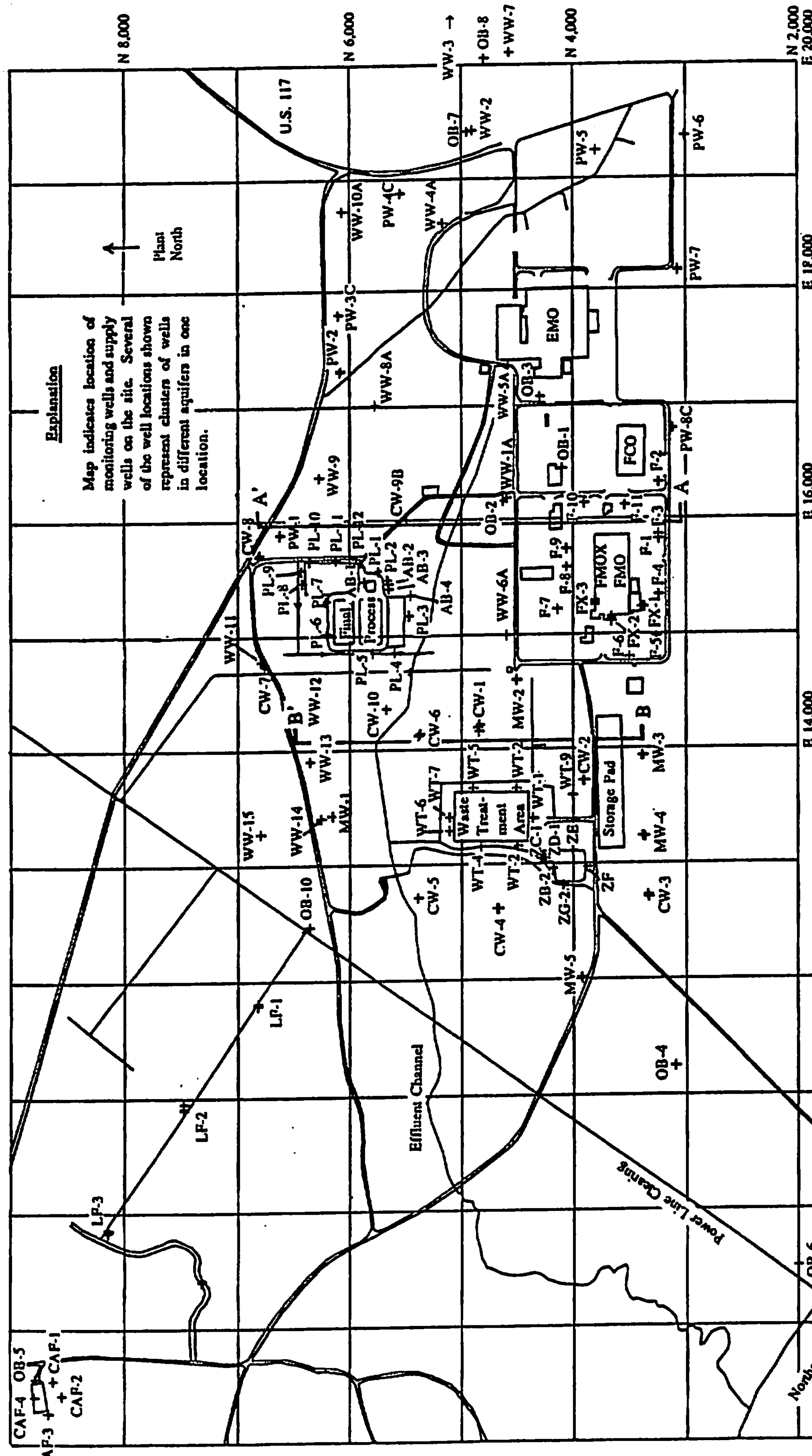
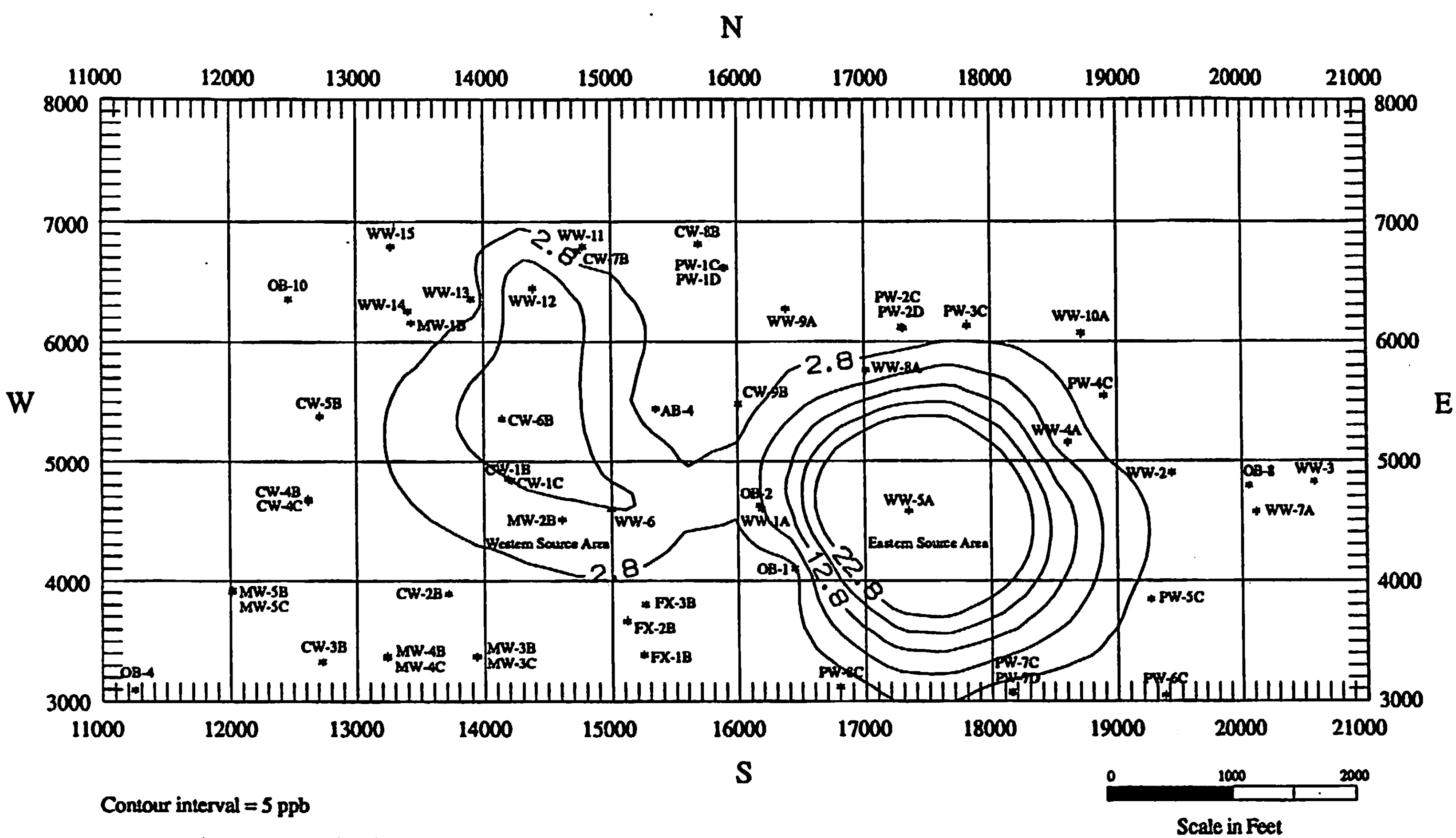


Figure 12 -- Location of Monitoring and Supply Wells at Plant Site



Contour interval = 5 ppb

* = Approximate location of boring.

Note: This map is based on the average concentration of TCE obtained from the analyses of routine groundwater sampling activities between 6/91 and 10/92. The contours shown are inferred based on Kriging interpolation methods using Surfer software. Alternate interpretations could be made from available data. Lowest contour interval shown is State Groundwater Standard for TCE (2.8 ppb).

Figure 13. Distribution of TCE in the Principal Aquifer at the Plant Site

Due to its physical properties, DNAPLs such as TCE migrate downward under the influence of gravity until low-permeability (i.e., clay) layers are encountered. Here they may pool and migrate over and around discontinuous clay layers. Based on a significant amount of site characterization, the subsurface lithology in the site vicinity is known to be quite variable. Even with this extensive amount of subsurface data, it is insufficient to fully delineate the vertical extent of contamination. Continued evaluation of the vertical extent of contamination is required. These additional assessment activities are described in Section 5.2.

5.0 Proposed Additional Assessment

A schedule of additional assessment activities is presented on Figure 14. These activities are intended to further delineate the source(s) and extent of contamination. Results of these activities will be periodically reported to the State by GE and used to modify any operative remedial activities. The scope of the additional assessment is addressed in the following sections.

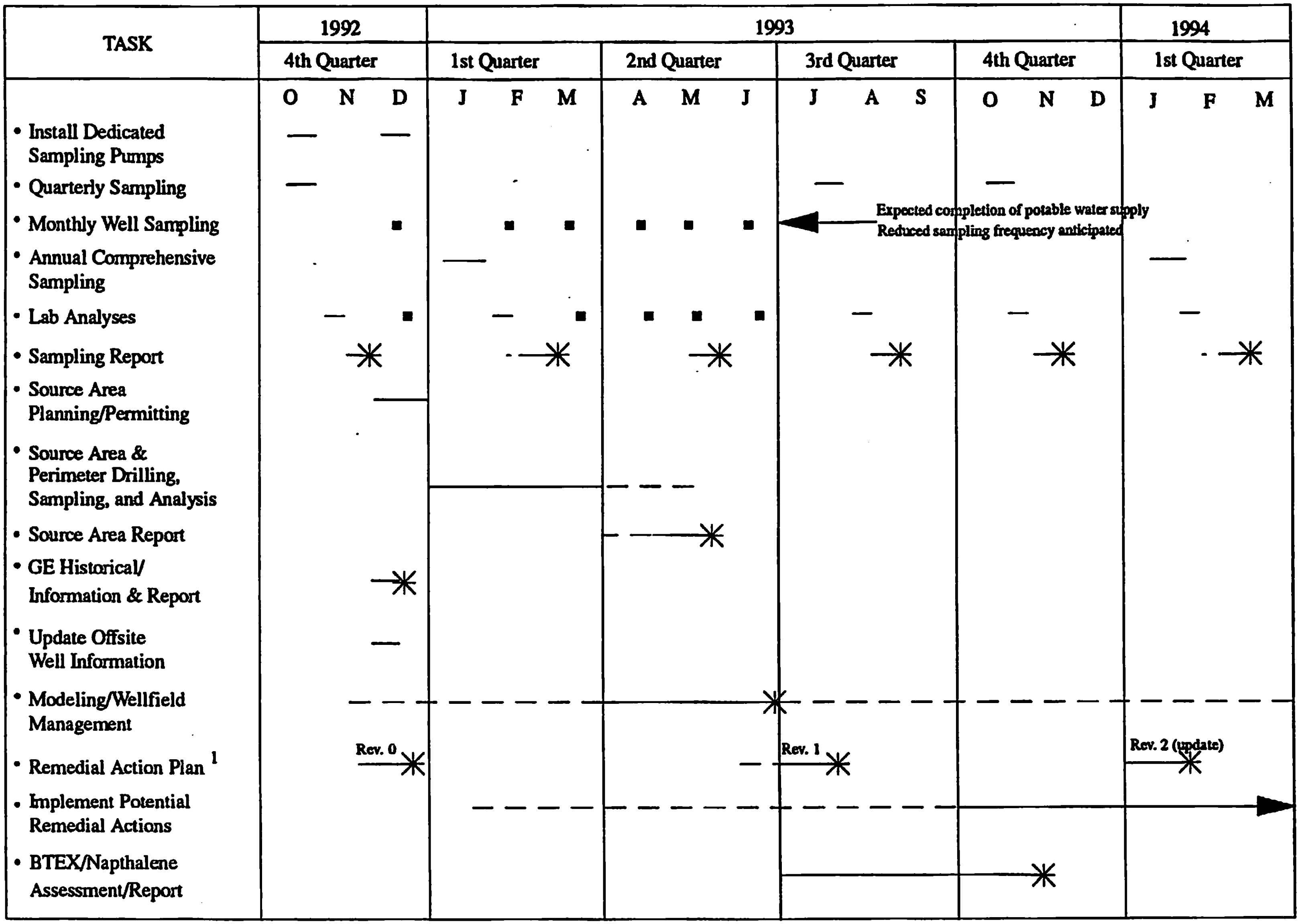
5.1 Horizontal/Perimeter Monitoring

Due to the natural northwestward flow of the principal aquifer, continued monthly sampling of the perimeter monitoring wells (including those along the northern site boundary) is proposed. As indicated by the DEM in a letter dated October 7, 1992, the horizontal extent of TCE contamination is well-defined on the site except in the area northwest of WW-12. Installation of an additional monitoring well is proposed in this area. Monitoring wells are also recommended for areas between the source areas and the northern site boundary, with the actual locations dependent upon the results of source area testing. Sampling of water-supply and perimeter monitoring wells will continue on a monthly basis until a separate potable water supply system is implemented (Section 6.2.1) after which sampling will return to a quarterly basis. A sampling schedule for water-supply and monitoring wells on the site is presented in Table 2.

5.2 Source Area Assessment

Additional assessment of the source areas is also proposed. These activities include, but are not limited to, the following methodologies:

1. Historical review;
2. Drilling of exploratory borings and screening of soils in the approximate source areas; and
3. Installation and sampling of monitoring wells in the source areas.



✳ = Deliverable

[1] Later revisions will be submitted based on findings of additional assessment/monitoring.

Figure 14. Tentative Schedule for Additional Assessment (4th Quarter 1992 through 1st Quarter 1994)

Table 2. Recommended Groundwater Sampling Schedule
RTI Project 5040

Well [1] ID	1992	1993											
		1st Quarter			2nd Quarter			3rd Quarter			4th Quarter		
	Dec	Jan	Feb	Mar	April	May [2]	June	July	Aug	Sept	Oct	Nov	Dec
Group 1	(Perimeter; Upgradient: No TCE Detections)												
MW-5B		x											
MW-5C		x											
CW-3B		x											
MW-4C		x											
MW-4B		x											
MW-3C		x											
PW-8C		x											
PW-7C	x	x	x	x	x	x		x			x		
PW-7D	x	x	x	x	x	x		x			x		
PW-6C [3]		x						x			x		
PW-5C	x	x	x	x	x	x		x			x		
Group 2	(Perimeter; Downgradient: No TCE Detections)												
CW-8B	x	x	x	x	x	x		x			x		
CW-7B	x	x	x	x	x	x		x			x		
PW-2C	x	x	x	x	x	x		x			x		
PW-2D	x	x	x	x	x	x		x			x		
PW-3C	x	x	x	x	x	x		x			x		
PW-4C	x	x	x	x	x	x		x			x		
Group 3	(Perimeter; Downgradient: TCE Detection Below Reporting Limit)												
PW-1C	x	x	x	x	x	x		x			x		
PW-1D	x	x	x	x	x	x		x			x		
Group 4	(Water Supply Wells)												
WW-3	x	x	x	x	x	x		x			x		
WW-7A	x	x	x	x	x	x		x			x		
WW-2	x	x	x	x	x	x		x			x		
WW-15	x	x	x	x	x	x		x			x		
WW-14	x	x	x	x	x	x		x			x		
WW-11	x	x	x	x	x	x		x			x		
WW-10A	x	x	x	x	x	x		x			x		
WW-13	x	x	x	x	x	x		x			x		
WW-9A	x	x	x	x	x	x		x			x		
WW-6A	x	x	x	x	x	x		x			x		
WW-4A	x	x	x	x	x	x		x			x		
WW-8A	x	x	x	x	x	x		x			x		
WW-1A	x	x	x	x	x	x		x			x		
WW-12	x	x	x	x	x	x		x			x		
WW-5A	x	x	x	x	x	x		x			x		

Well ID[1]	Table 2. Recommended Groundwater Sampling Schedule RTI Project 5040												
	1992	1993											
		1st Quarter			2nd Quarter			3rd Quarter			4th Quarter		
	Dec	Jan	Feb	Mar	April	May[2]	June	July	Aug	Sept	Oct	Nov	Dec
Group 5	(Interior Monitoring Wells: No Previous Detections)												
CW-5B		x											
CW-4C		x											
CW-9B		x											
CW-2B		x											
Group 6	(Interior Monitoring Wells: Previous TCE Detections)												
AB-4		x											
OB-1		x											
OB-2		x											
MW-1B		x											
MW-2B		x											
CW-1B		x											
CW-1C		x											
CW-6B		x											
Group 7	(FMO/FMOX Wells in Principal Aquifer: Previous Detection of Organic Compounds)												
FX-1B		x											
FX-2B		x											
FX-3B		x											
Group 8	(Source Area Wells: Not Installed)												
Total No. of Samples	26	49	26	26	26	26		27			27		

[1] Wells listed in order of increasing potential of TCE contamination (known and suspected contamination).

[2] Continuance of monthly sampling frequency dependent upon completion of new potable water system.

[3] Monitoring well PW-6C will be included in the quarterly sampling schedule if a new water supply well is completed near the south entrance to the plant.

The historical review would tentatively consist of reviewing past aerial photographs and topographic maps of the area. A review of available company records and interviews with long-term and possibly retired personnel will be conducted in an attempt to discover information on the types and amounts of chemicals previously stored in specific areas of the site, as well as storage, handling, and disposal practices. Structured questionnaires are being developed for use in the near future. Findings from this review will be used to determine optimum locations for exploratory soil borings and/or monitoring wells.

Considering the complexity of the subsurface environment at the site and the properties of DNAPLs, efforts will be made to delineate to a reasonable limit the vertical extent of contamination. Screening of deep ($\geq$ 150 feet) soil borings in source areas is proposed in an effort to delineate source areas. Tentatively, soils from the borings will be screened in 2 or 5 feet intervals using an organic vapor analyzing instrument. In addition, a Hydropunch™ sampling instrument may also be used to sample formation pore waters.

Monitoring wells are also proposed in each source area. These wells will be of multi-cased construction in order to prevent increased downward contaminant migration. The wells will then be introduced into the existing periodic sampling program and may also be used to monitor the effects of potential remedial activities.

These activities are anticipated to better define the locations and extent of the source areas and the vertical extent of contamination in these areas.

5.3 Groundwater Modeling

Additional proposed assessment includes expansion of groundwater modeling for the site. A computer flow model is intended to provide information on changes in the flow regime of the principal aquifer, resulting from variable pumping scenarios. Previous modeling efforts have focused on capture zone analysis (E.P.A. WHPA) or for flow in limited areas of the site. The size of the model grid is being expanded and the U.S. Geological Survey's modular, finite-difference flow model (MODFLOW) is being used for this study. In addition, alternate modeling programs may be used to perform particle-tracking and/or capture zone analyses which would be useful when determining optimum pumping scenarios for remediation and wellhead protection.

6.0 Preliminary Evaluation of Remediation Alternatives

6.1 Current Management/Containment Activities

Currently, activities are underway that are intended to address the two highest priorities at the site, which are:

1. maintaining a safe drinking water supply for the plant; and
2. containing the contaminant plume within site boundaries.

Management activities being implemented are described in the following sections.

6.1.1 Periodic Sampling Activities

In order to assess drinking water quality and the TCE plume containment, an extensive sampling program has been implemented at the site.

Raw water from water supply wells is routed to an aeration unit for initial treatment. The water transported into and out of the aeration unit is sampled and analyzed twice a week by GE. The mean inlet TCE concentration for 1992 is 4.59 ppb. After aeration, the mean outlet TCE concentration is 2.12 ppb, indicating a mean stripping efficiency of 54 percent (Figure 9).

In addition to testing the potable water supply at the aerator outlet, the water is tested weekly for TCE at the utility sink in Building J, which is representative of the plant's potable water supply after resident time in the distribution system. The mean TCE concentration measured at this location was 1.62 ppb in 1992. The drop in TCE concentration from the aerator to the Building J utility sink is attributed to volatilization within the distribution system.

Current plans are to sample each water supply well for organics on a monthly basis until a separate potable water system is installed, and then revert back to quarterly monitoring. In addition, perimeter monitoring wells are to be tested for organics on a monthly basis to monitor for potential migration of the dissolved contaminant plume.

A comprehensive monitoring program is implemented annually. Approximately 50 monitoring and water supply wells on the site are sampled for organics during this program.

After completion of this sampling, a revised map showing the approximate extent and shape of the TCE plume is produced.

6.1.2 Wellfield Management

The yield and pumping duration of each water-supply well is reported to RTI by GE on a weekly basis. Using the calculated water contribution from each well and its corresponding TCE concentration, the influent TCE concentration can be approximated. Using this "spreadsheet model", the wellfield pumping scenario can be modified and its effect on the potable water supply can be estimated. This method will continue to be useful in regulating inlet TCE concentrations until the proposed separate water-supply system is operational (Section 6.2.1) and the groundwater flow model is fully functional (Section 5.3).

6.1.3 Current Recovery Pumping/Aeration Activities

The highest concentrations of TCE measured on site (up to 241 ppb) have been detected in samples collected from WW-5A during a special step-drawdown test (RTI Report No. 5040-01F, dated September 21, 1991). This area is presently considered to be (or proximal to) the eastern source area. Elevated TCE concentrations (up to 46.1 ppb) have recently been detected in samples from WW-12 (contributions thought to be from a western source area south of WW-12). Due to these elevated TCE concentrations, water from these two supply wells is no longer introduced into the process/potable water supply. Water from WW-5A has not been used for water supply for several years. Based on the potentiometric configuration and preliminary WHPA-generated particle tracking maps, pumping these and other wells aid in the restriction of movement of the TCE plume to the north and offsite. Therefore, instead of shutting these wells off, they are pumped near their maximum safe yields (70 gpm each) and the water is routed to process lagoons where it is aerated and discharged. This rerouting of water from WW-5A and WW-12 has been discussed with DEM and documented in memos referencing the existing NPDES permit. Due to the Henry's Law Constant of the TCE (Table 1), aeration is an efficient method of reduction of dissolved-phase TCE in groundwater.

These activities reduce the total TCE concentration in the potable water supply and provide a preliminary method of plume containment and reduction of total TCE in the principal aquifer.

6.2 Potential Management/Remedial Activities

6.2.1 Separate Potable Water Supply

The highest probability risk for human exposure at the GE facility is the presence of TCE in the drinking water. In order to eliminate this risk, GE has initiated plans to use water-supply wells 2, 3, and/or 7 solely for potable water (Figure 13). As a backup contingency, the drilling of a new potable well(s) in upgradient areas of the site is also being considered. Once the well site and the required flow rate(s) have been determined, the impacts of these wells on surrounding areas and the contaminant plume will be evaluated. This method is considered to be most reliable and effective in the elimination of human exposure potential to TCE at the plant.

6.2.2 Continued Pumping/Aeration of Selected Water Supply Wells

After an alternate potable water supply for the plant has been selected and implemented, the purpose of the existing water-supply wells will shift to:

1. providing an adequate supply of water for the industrial processes;
2. containing the contaminant plume within site boundaries; and
3. serving as recovery wells for remediation of dissolved-phase TCE in the principal aquifer.

Continued sampling of the water-supply and monitoring wells will provide valuable data on the contaminant plume orientation and source area remediation/recovery. Computer models may also be used to determine optimum pumping rates for these wells. This method is considered to be cost-effective because aeration is a very efficient method of TCE removal. In addition, many of these "recovery" wells are already in place at optimal locations, minimizing initial remediation costs.

6.2.3 Additional Recovery Wells

If additional information on the source areas or plume shape and extent is determined during additional assessment or periodic monitoring, additional recovery wells may be installed where they support additional significant TCE plume management or removal.

6.2.4 Offsite Sampling Contingency Plan

Accessible records for domestic wells in the vicinity of the site were reviewed to determine their depth and construction. The wells in the Wooden Shoe subdivision (north of the site) average approximately 70 feet in depth, which is similar to the depth of the water-supply wells on the site. Domestic wells south of the site (along Chair Road) are not as deep (average 54 feet). Some of these wells, however, range from 65 to 90 feet deep. Should sampling activities indicate that the contaminant plume has most likely migrated beyond the site boundaries despite containment efforts, a contingency plan for offsite sampling has been developed. Therefore, if required, sampling of selected, critically-located domestic wells can occur without major delay.

6.2.5 Other Remediation Alternatives

Other potential remediation alternatives may exist for this site. However, until additional assessment is performed, the applicability of these methods cannot be evaluated. A brief comparison of potential remedial alternatives and contamination problems to be treated is presented on Table 3. A review of Table 3 indicates that pump and treat technology appears to be the remediation method of choice for controlling the dissolved-phase plume onsite. If shallow or limited occurrences of soil and/or groundwater contamination are detected during the additional assessment phase, methods such as soil venting, containment walls, or closed-loop remediation may be considered in addition to the pump and treat technology.

Table 3. Potential Remedial Action Goals and Methods

Goal of Remediation / Remediation Scenario	No Action	New Potable Water Supply	Pump and Treat[1] Technology	Soil Venting	Closed-Loop[2] Remediation (w/Biological Treatment)	Containment[3] Walls
Soil remediation	N/A	N/A	N/A	Potential use if shallow soil contamination detected during additional assessment phase; not currently feasible.	Potential use if shallow soil contamination detected during additional assessment phase; not currently feasible.	N/A
Free-phase recovery	N/A	N/A	Free-phase TCE not detected to date. Would be viable method if detected during additional assessment phase.	N/A	N/A	May be used to contain limited area(s) of free-phase TCE if detected during additional assessment phase.
Groundwater Remediation	Dissolved-phase TCE may be naturally attenuated under no-action conditions.	N/A	Preliminary pump and treat activities currently implemented. Most likely to be continued as most efficient method of remediation.	N/A	Potential use especially if well-defined source area identified during additional assessment phase.	N/A
Vapor remediation	N/A	N/A	Vapor remediation unnecessary if emissions from air stripping techniques remain below 40 lb/day.	Potential use if shallow soil vapor presence detected during additional assessment phase.	N/A	N/A
Alternate water supply	N/A	Siting of potable water supply wells currently underway.	N/A	N/A	N/A	N/A
Offsite contaminant migration	Offsite migration eminent due to northward natural gradient.	N/A	Cone(s) of depression and/or gradient shift resulting from pumping inhibits plume migration.	N/A	N/A	Due to potential great depth of contamination, containment barriers not likely feasible.

[1] May consist of air stripping tower(s), shallow trays, or lagoon aeration.
[2] Consists of infiltration gallery and recovery well (treatment of discharge with nutrients to enhance biological activity).
[3] Slurry trench, vibrated beam, sheet piling, grout curtains.

7.0 Summary and Conclusions

GE discovered small quantities of trichloroethylene (TCE) in its water supply in June 1991. Assessment and remediation activities have been underway at the site in order to delineate the source(s) and extent of the contamination and eliminate or minimize the potential threat to human health or the environment. Due to the large size and hydrogeologic complexity of the site, adequate assessment of the extent of contamination is yet to be completed.

Additional assessment activities are proposed that will result in a better understanding of the horizontal and vertical extents of contamination, including installation of additional perimeter wells and source area testing. Groundwater models are also being used to better understand the hydrogeologic conditions at the site.

Current remedial activities (wellfield management, pumping and aeration of water-supply wells with elevated TCE concentrations, periodic sampling, and development of a separate potable water supply) are believed to be adequate in reducing human exposure potential, containment of the TCE plume within site boundaries, and reduction of total TCE concentrations in the principal aquifer.

The remedial measures proposed are based on existing data concerning the horizontal and vertical extent of the organic contaminants detected in the groundwater at the Wilmington facility. GE will consider additional or alternative remedial actions in light of new data generated during GE's proposed additional assessment activities. GE will provide to DEM written modifications to the RAP as conditions warrant.

8.0 References

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