

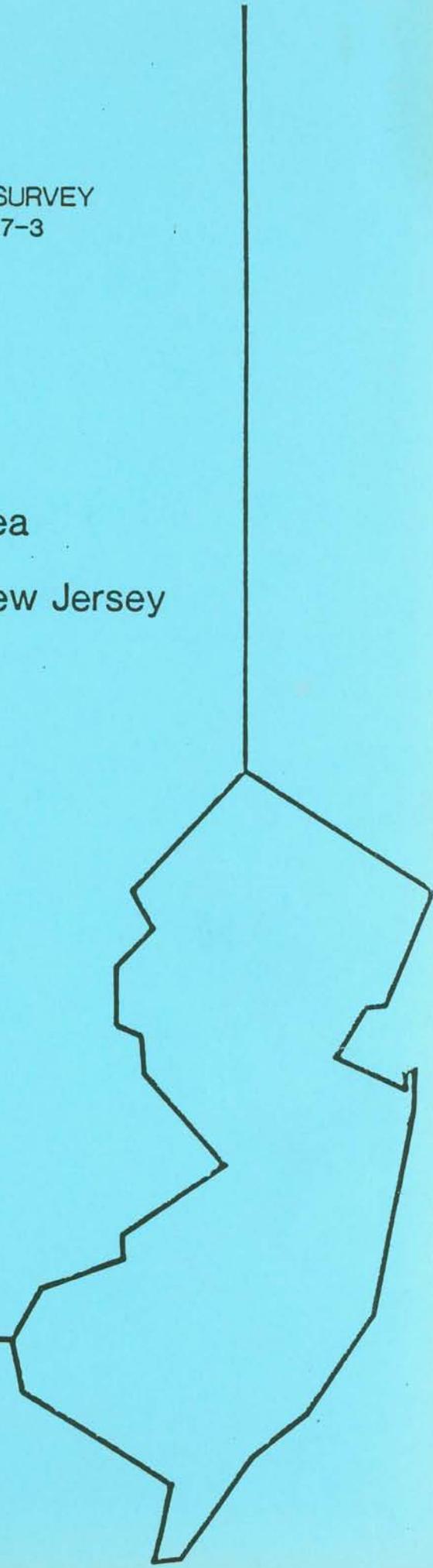


NEW JERSEY GEOLOGICAL SURVEY
TECHNICAL MEMORANDUM 87-3

Ground-Water Contamination
and the
Delineation of a Well Restriction Area
in
East Hanover Township, Morris County, New Jersey

Department of Environmental Protection
Division of Water Resources

1987



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New Jersey Geological Survey
Technical Memorandum 87-3

**GROUND-WATER CONTAMINATION AND
THE DELINEATION OF A
WELL-RESTRICTION AREA IN
EAST HANOVER TOWNSHIP, MORRIS COUNTY,
NEW JERSEY**

by

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Trenton, NJ 08625
1987

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**GROUND-WATER CONTAMINATION AND
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NEW JERSEY**

SUMMARY

1. The purpose of this Technical Memorandum is to evaluate the types, sources, distribution and movement of ground-water contamination in East Hanover Township. These data are the basis for the delineation of a Well-Restriction Area.
2. The New Jersey Department of Environmental Protection (NJDEP) is investigating 38 ground-water pollution sites within East Hanover Township and its immediate vicinity. As of July 1987, monitor wells had been installed at 25 of these sites.
3. Ground-water contaminants within East Hanover include volatile organic, base neutral, acid extractable and petroleum hydrocarbon compounds. Contamination has been detected in over 70 domestic wells, 70 monitor wells and 3 municipal-supply wells. The contamination problem involves ground water in all sections of the Township and in neighboring communities.
4. A regional ground-water contamination problem exists in the aquifers of the East Hanover area. The problem is largely the result of the discharge of industrial chemicals through subsurface disposal systems.
5. A Well-Restriction Area is necessary in East Hanover Township to prevent the use of contaminated and threatened ground-water supplies by local consumers and to help control the spread of contamination within the aquifers. Approximately 800 residences in East Hanover are using private domestic wells as their source of potable water in July 1987.
6. The East Hanover Well-Restriction Area as delineated herein encompasses the entire Township.

BACKGROUND

East Hanover Township is located in eastern Morris County as shown in figure 1. East Hanover has a population of approximately 9,000 residents and an area of approximately 9 square miles. The Township is predominantly residential, but has concentrations of light industry on Deforest Avenue, Merry Lane and NJ Route 10. Industries include electronics, metal working and finishing, pharmaceuticals, specialty chemicals, and auto-repair facilities.

The Township water system includes four wells: well nos. 1 and 2 on Melanie Lane, no. 5 on Homestead Avenue and no. 6 on Valley Road (fig. 2). As of July 1987, the Township had not been granted a water-diversion permit from the New Jersey Department of Environmental Protection (NJDEP) for well no. 6. Municipal wells no. 3 and no. 4 are inactive due to low yields. East Hanover has water-line interconnections with the Florham Park Water Department and the Southeast Morris Municipal Utilities Authority (NJDEP, 1975). Second-tier interconnections exist with the Madison Water Department, the Chatham Water Department and the Commonwealth Water Company (which serves Millburn and Chatham Townships). Adjacent water systems are shown in figure 2. The water system in East Hanover serves approximately 8,000 people with about 1.5 million gallons per day (mgd). Approximately 800 residences in the Township continue to use domestic wells for their water supply. Most of these residences and numerous others within the Township continue to operate onsite septic systems for waste disposal.

As of July 1987, NJDEP is investigating 38 ground-water pollution sites in the East Hanover area (fig. 3). Due to the discovery of contamination in municipal well no. 2 in 1981, septic-tank and seepage-pit wastes were sampled as part of a Township-wide industrial survey. Numerous industrial disposal systems throughout the Township were determined to contain volatile organic compounds (VOCs). The owners were directed by NJDEP to install monitor wells for the purpose of delineating the extent of possible ground-water contamination. As of July 1987, monitor wells have been installed at 25 of these suspected pollution sites.

Ground-water samples have been obtained from approximately 100 monitor wells at the 25 sites with monitor wells. Additionally, ground-water samples have been obtained from approximately 100 domestic wells and East Hanover municipal well nos. 1, 2, 5 & 6. Appendix 1 shows the analyses of ground water from the municipal wells. Appendices 2-3 show the analyses of ground water from selected domestic and monitor wells. Figure 4 shows the distribution of volatile organic compounds in the ground water of the East Hanover area based on the analyses given in appendices 2-3. The concentrations of VOCs range from below minimum detection limit (BMDL) to 16,690 parts per billion (ppb). The highest concentrations of volatile organics in the unconsolidated deposits are near the intersection of Ridgedale and Deforest Avenues. As of July 1987, only five bedrock wells had been

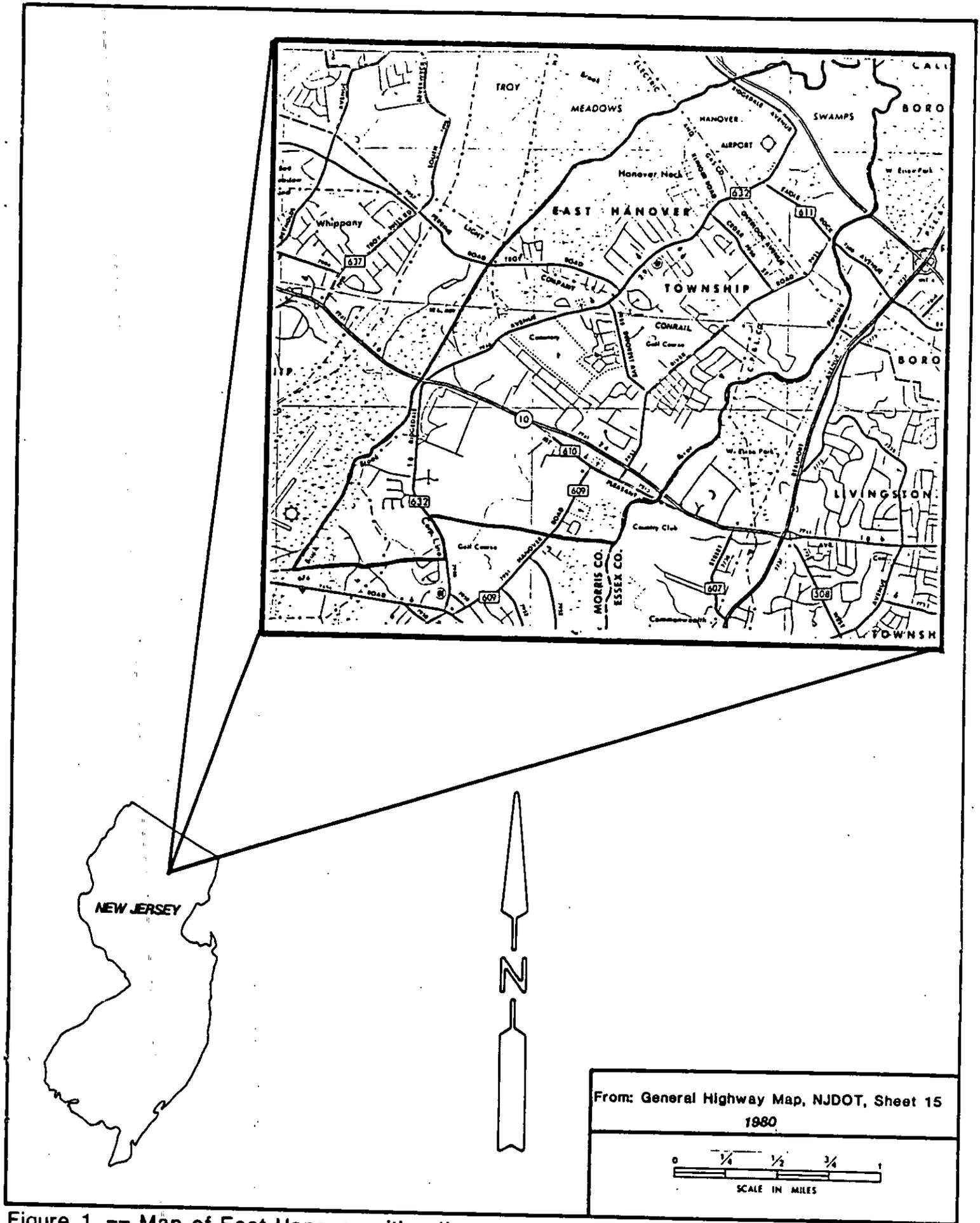


Figure 1. -- Map of East Hanover with adjacent townships

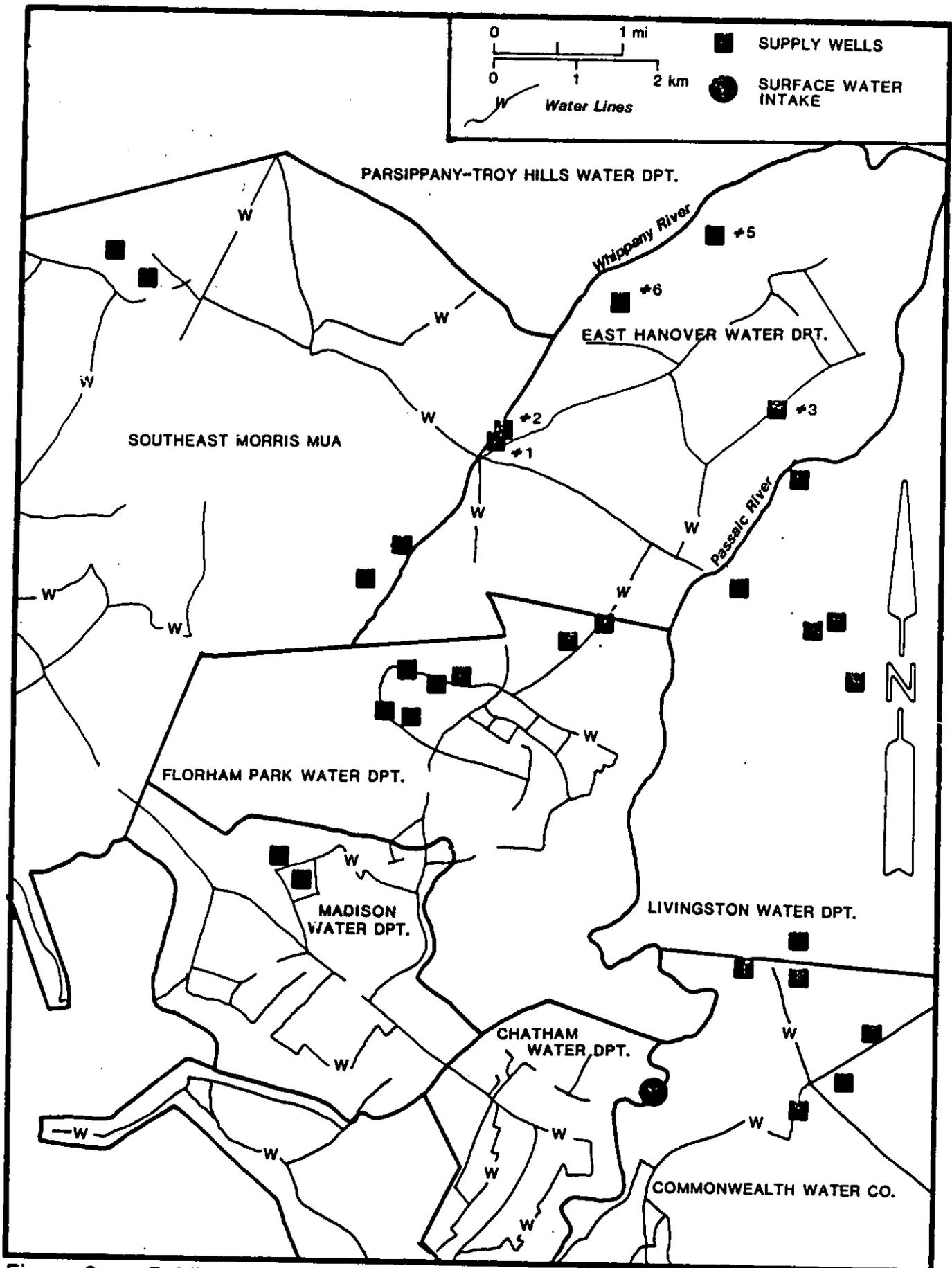


Figure 2. -- Public-water supplies in East Hanover and adjacent townships
 Source: NJDEP Water Supply Overlay No. 25, 1975

sampled. Water samples from these bedrock (Brunswick Supergroup) wells had concentrations ranging from 24.1 to 1,055 ppb total volatile organics (appendixes 2-3).

NATURE OF THE PROBLEM

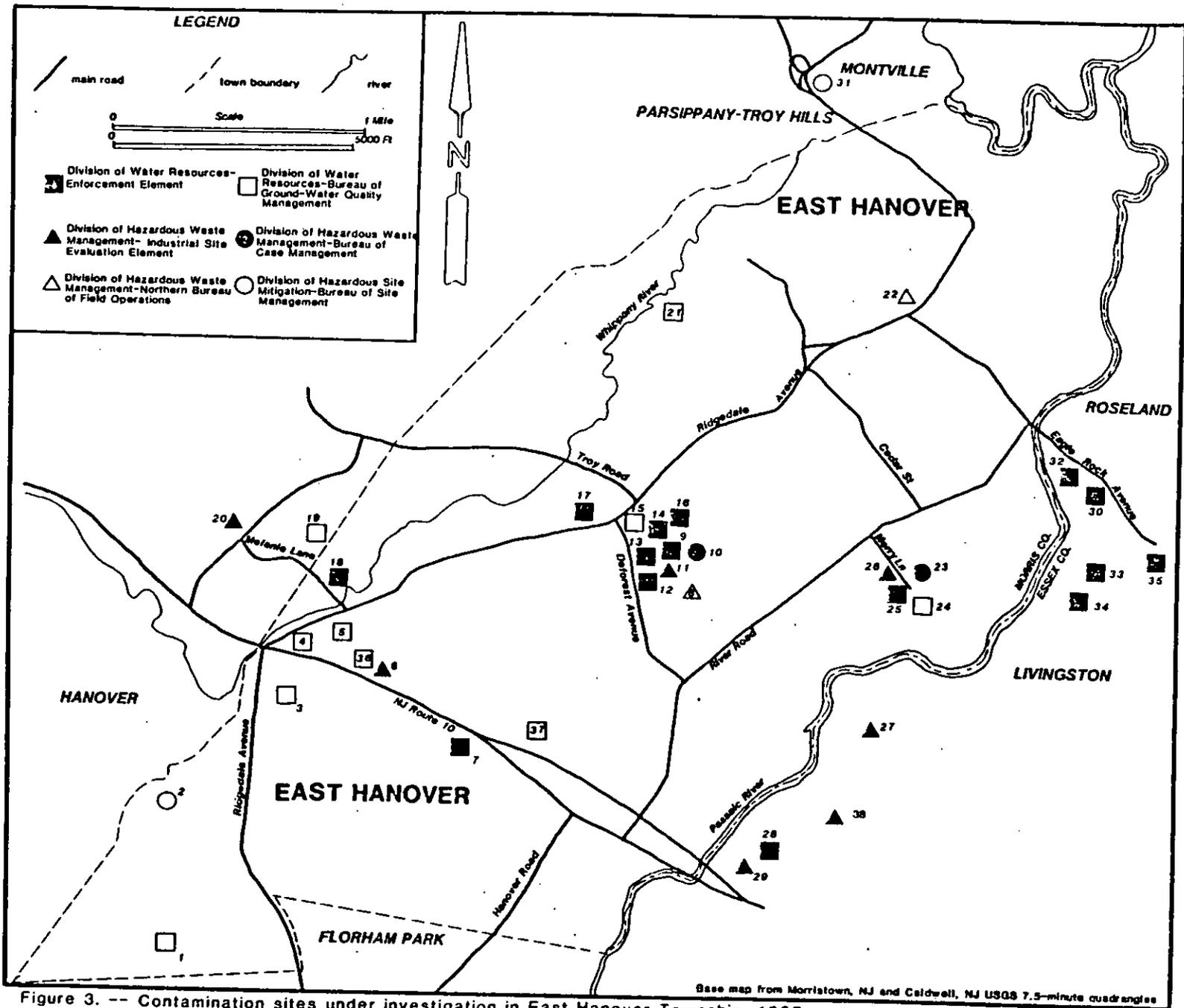
Many industries in East Hanover Township manufacture, store and handle hazardous substances. These industries made use of lagoons, seepage pits and dry wells for waste disposal until public sewerage became available in 1984. Municipal-sewage wastes were subsequently directed to the Parsippany-Troy Hills Treatment Plant which is outside the boundaries of the Township. Wastes, which include volatile organics, have infiltrated from the pre-sewerage disposal systems to the underlying soil and ground water. The pumping of domestic and municipal-supply wells has probably enhanced the spread of contaminants.

Underground storage tanks have also contributed to ground-water contamination in East Hanover. Most underground tanks installed during the past 40 years have been constructed of bare steel, were largely unprotected from corrosion, and lacked any monitoring system or

Table 1. -- Mobility and partition coefficients for selected ground-water contaminants. From Verschueren (1983).

Compound	Partition ¹ Coefficient (K_p)	Mobility
Volatile Organic Compounds:		
Trichloroethylene	10 ^{2.29}	High
Tetrachloroethylene	10 ^{2.60}	High
1,1,1-Trichloroethane	10 ^{2.17}	High
Benzene	10 ^{2.13}	High
Base Neutral Compounds:		
Bis (2-Ethylhexyl) phthalate	10 ^{8.73}	Low
Di-N-Butyl phthalate	10 ^{9.20}	Low
Butyl Benzyl Phthalate	10 ^{4.78}	Low

1 The partition coefficient for a given compound is the concentration of the compound sorbed (partitioned) onto the soil [s] divided by the concentration of the compound [c] in solution ($K_p = [s]/[c]$). Therefore, compounds with high partition coefficients will be sorbed onto soil particles, thus restricting their mobility. Mobility is proportional to the solubility and vapor pressure of the compound and inversely proportional to the partition coefficient of the compound. Base neutral and acid extractable compounds have high K_p values, are readily partitioned in soil and will be relatively immobile (USEPA, 1985).



- 1, Precision Rolled Products
- 2, Horstmann's Landfill
- 3, Sandoz Pharmaceutical
- 4, Hanco Wood Products
- 5, G & F Industrial Park
- 6, Nards
- 7, Gogol Tire Exchange
- 8, Nabisco
- 9, Prime Fabricators
- 10, Foster Wheeler
- 11, Eli-Bee Chemical
- 12, Siskak Laboratories
- 13, Deforest Investment Park
- 14, Chemical Components
- 15, DEH Realty
- 16, Triangle Industrial Park
- 17, Bronner Manufacturing & Tool
- 18, Peter Cova
- 19, Memo Landfill
- 20, Rowe International
- 21, Deskovik Landfill
- 22, Sunoco Oil
- 23, Royal Lubricants
- 24, Fritzsche, Dodge & O'cott
- 25, Welles-Aug 26, Durine Industrial Park
- 27, Paper Mart
- 28, Berlese Berings
- 29, Standard Optical
- 30, Allied Amphenol
- 31, Sharkey Farms Landfill
- 32, Intedge
- 33, Public Service Electric & Gas
- 34, Tricounty Asphalt
- 35, Ketchum & McDougall
- 36, Thermocision
- 37, US Army NIKE Base
- 38, Warren Communications

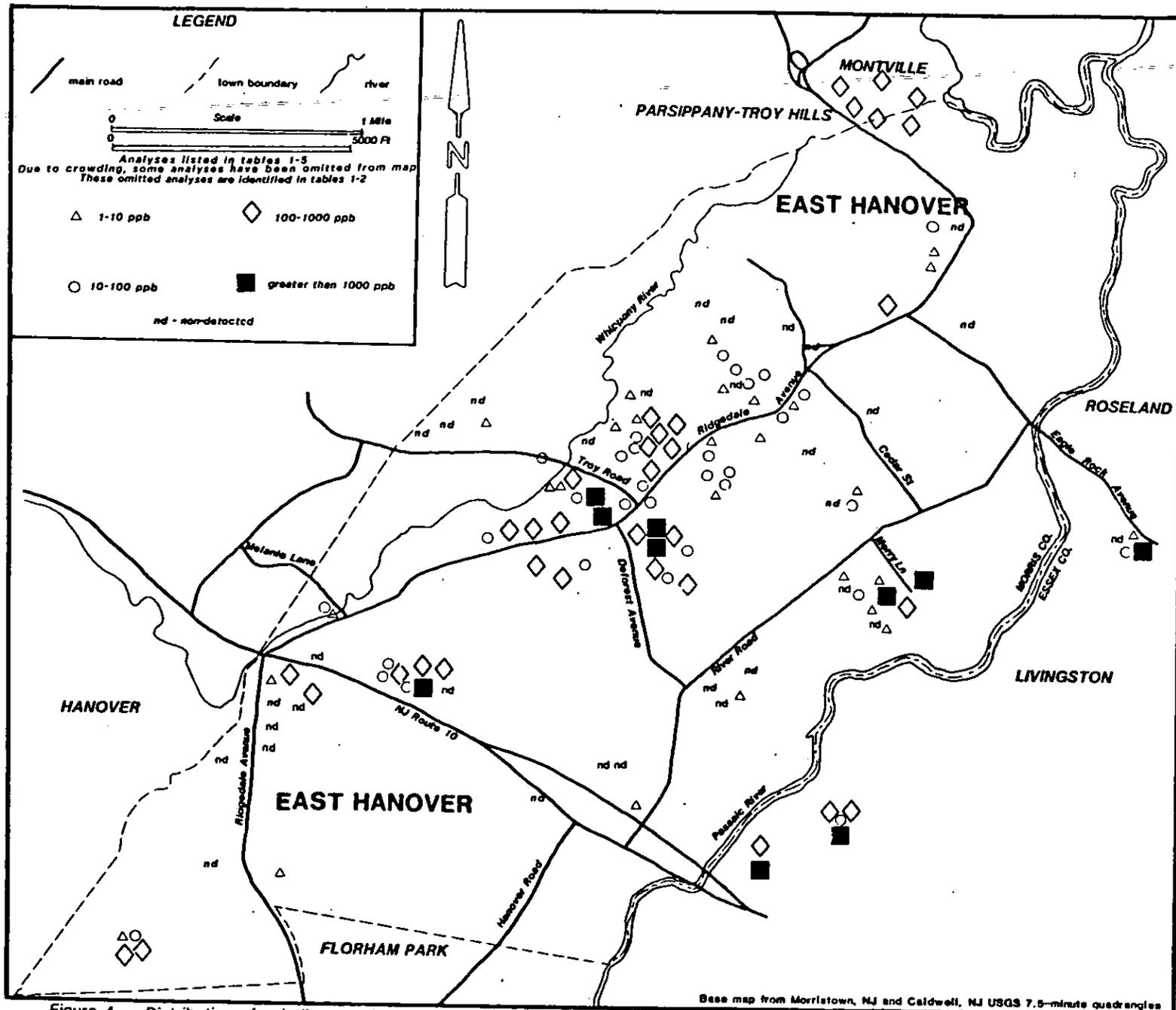


Figure 4.-- Distribution of volatile organic compounds (ppb) in ground water of East Hanover Township, 1983-87

cathodic protection. Due to age and corrosion, many underground tanks have leaked, allowing contaminants to migrate to the ground water. The contents of underground tanks in East Hanover have included gasoline and diesel fuel, fuel oils and industrial solvents. In addition, the improper handling of hazardous wastes, the burial of hazardous-waste drums and possible "midnight dumping" of wastes have also added contaminants to ground water in East Hanover.

Industrial wastes, including solvents and degreasers, have infiltrated through subsurface disposal systems into the unconsolidated deposits and subsequently to the underlying ground water. Due to low partition coefficients (K_D), the mobility of volatile organic compounds in ground water is high. The partition coefficients for some of the contaminants found in East Hanover are given in table 1.

Due to the high mobility of volatile organic compounds and the large number of contaminant sources, ground water in all sections of East Hanover is contaminated or vulnerable to contamination. Numerous plumes of volatile organics exist within the unconsolidated aquifers. As a result of their high mobility, these compounds are more likely to be induced toward a pumping well than are other compounds such as base neutrals or acid extractables. Contamination in East Hanover has affected municipal-supply wells, domestic wells and industrial-production wells. Many of the compounds detected in East Hanover's ground water are considered carcinogenic (Merck & Co., 1983).

HYDROGEOLOGY

SURFICIAL DEPOSITS

East Hanover is located within the Piedmont Physiographic Province. The surficial deposits in the Township occupy two buried valleys (Nichols, 1968) known as the East Hanover and the North Millburn Buried Valleys (figs. 5a and 5b). These valleys are the result of pre-Pleistocene bedrock incision. The valley fill is the result of the advance and retreat of two sublobes of the Wisconsin ice sheet which covered a major part of North America. The valleys generally trend north-south, but join in the northern part of the Township. The East Hanover Valley extends north into Parsippany-Troy Hills and Montville. It also extends south into Florham Park and then trends eastward into Madison and Chatham. The North Millburn Valley extends north into Parsippany-Troy Hills with its southern part extending into Livingston and Florham Park (where it is known as the South Millburn Valley). The thickest parts of the valley fill are as much as 200 feet thick with thinner deposits found along the valley walls. The buried valley aquifers in the East Hanover area have been designated a Sole Source Aquifer by the USEPA.

The surficial deposits within the valleys are of late Wisconsin age. They consist largely of stratified drift, but include substantial

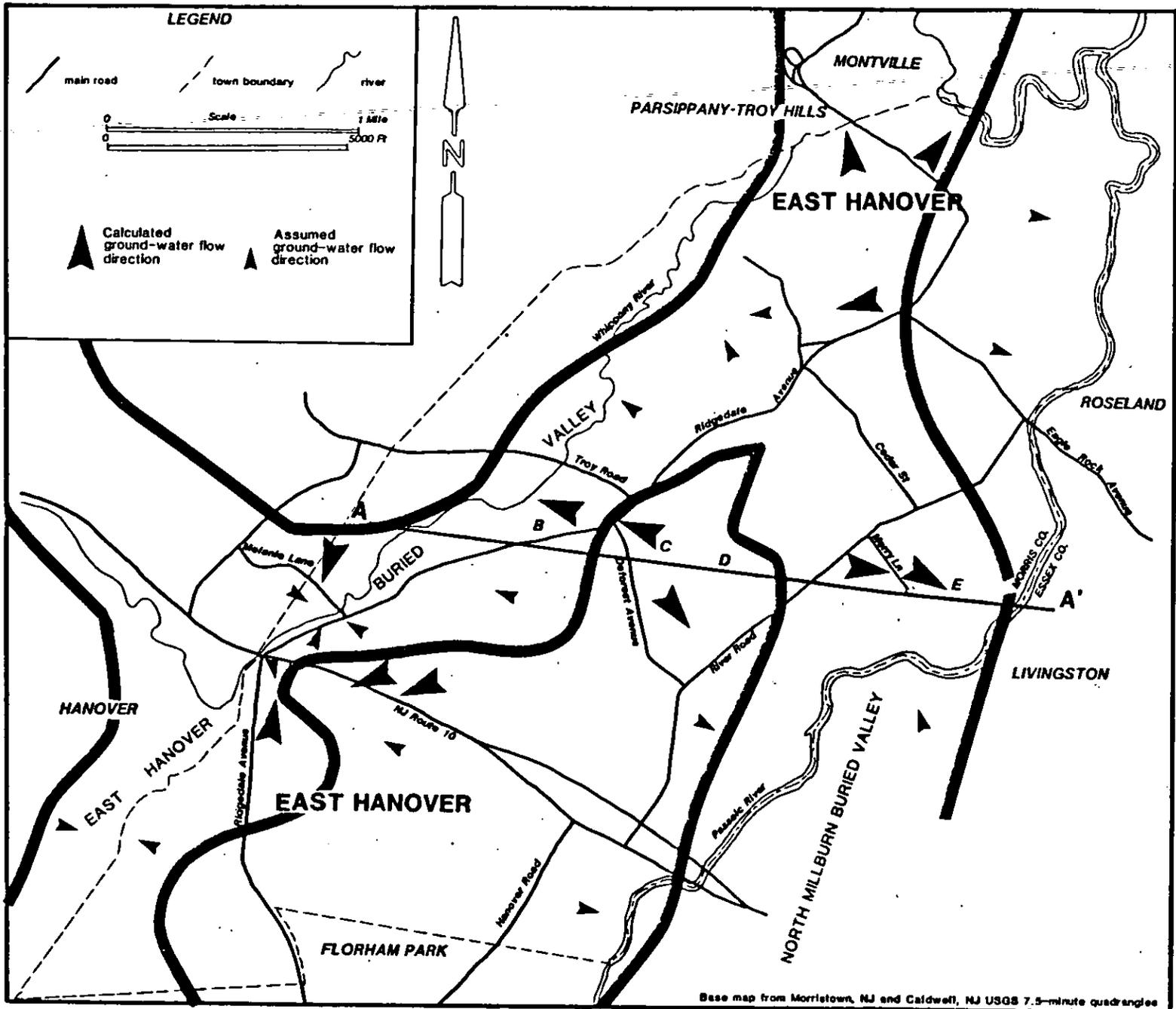


Figure 5a. -- Delineation of buried valley aquifer showing ground-water flow directions, East Hanover Township area, Morris County, New Jersey. Sources: Meister (1975), Ghatge and Hall (1987). Line A-A' indicates cross-section shown in figure 5b.

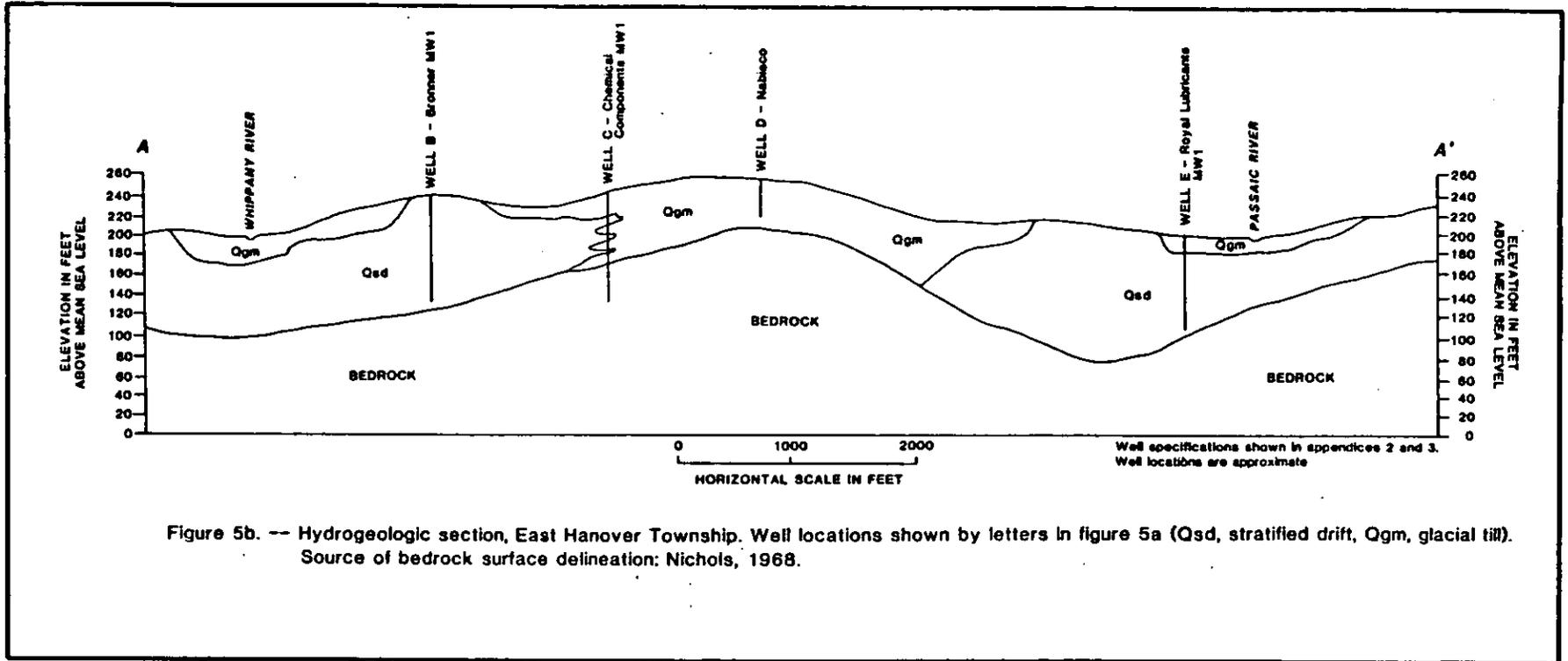


Figure 5b. -- Hydrogeologic section, East Hanover Township. Well locations shown by letters in figure 5a (Qsd, stratified drift, Qgm, glacial till). Source of bedrock surface delineation: Nichols, 1968.

volumes of till. The stratified drift is comprised of glaciolacustrine sand and gravel interbedded with glaciolacustrine clay layers or lenses. The clay was deposited in Glacial Lake Passaic which covered the area during the retreat of the last glacier. A clay layer, ranging from 15 to 50 feet in thickness, extends beneath the Sharkey's Landfill site in the northern part of the Township (fig. 3). The clay acts as a confining layer. Laboratory tests on Shelby tube samples of the clay disclosed a hydraulic conductivity of 1.3×10^{-7} cm/s (R. E. Wright Associates, 1986). The clay layer is not laterally continuous, but occurs intermittently throughout the Township. Glacial till may occur above and below the stratified drift in both of the valleys shown in Figure 5b and it may act as a confining or semiconfining layer. Ablation till which accumulated within or upon the shrinking glacier consists of poorly sorted silt, sand, clay and cobbles. Lodgement till was deposited beneath the glacier directly above bedrock. Due to crushing and abrasion when deposited, lodgement till is compact and may acquire a fissile structure (Flint, 1971). Therefore, it may act as a confining or semiconfining layer for the underlying bedrock aquifer. Sublacustrine fan deposits exist outside and between the two buried valleys. These deposits consist of interbedded stratified drift and till which were deposited beneath the lake surface. These deposits may be hydraulically continuous with sands and gravels within the buried valley.

Yields of individual wells in the thickest sections of stratified drift are as high as 1,400 gpm (or nearly 2 mgd). Based on a computer model (Meisler, 1976), the highest sustainable yield for the entire East Hanover Buried Valley Aquifer is 13 mgd. The present (1987) NJDEP water allocation is 10.65 mgd. At the Sharkey Farms Landfill site, hydraulic conductivities were found to range from 2.6 to 32.5 feet/day in the stratified drift aquifer (R. E. Wright Associates, 1986). Aquifer pumping tests performed on municipal well no. 6 have shown a range of transmissivity of 15,000 - 20,000 ft²/day. Storativity values ranged from 0.0008 to 0.06 (Geraghty & Miller, 1985). Storativity values between 0.01 and 0.3 denote water-table or unconfined conditions, and values less than 0.01 denote confined or semiconfined conditions (Freeze & Cherry, 1983). Using the following equation, the ground-water flow velocity can be determined,

$$v = \frac{K}{n_e} \frac{dh}{dl}$$

where v = the ground-water flow velocity (ft/day), K = hydraulic conductivity (ft/day), dh/dl = the hydraulic gradient and n_e = the effective porosity of the material (Fetter, 1980). Based on data obtained from numerous pollution sites, the ground-water flow velocity in the stratified drift aquifers ranges from 0.3 to 13 feet/day. Based on water-level data gathered from monitor wells throughout the Township, ground-water flow directions have been calculated and compiled in figure 5a. Additionally, assumed ground-water flow directions, based on the effects of large pumping centers and regional

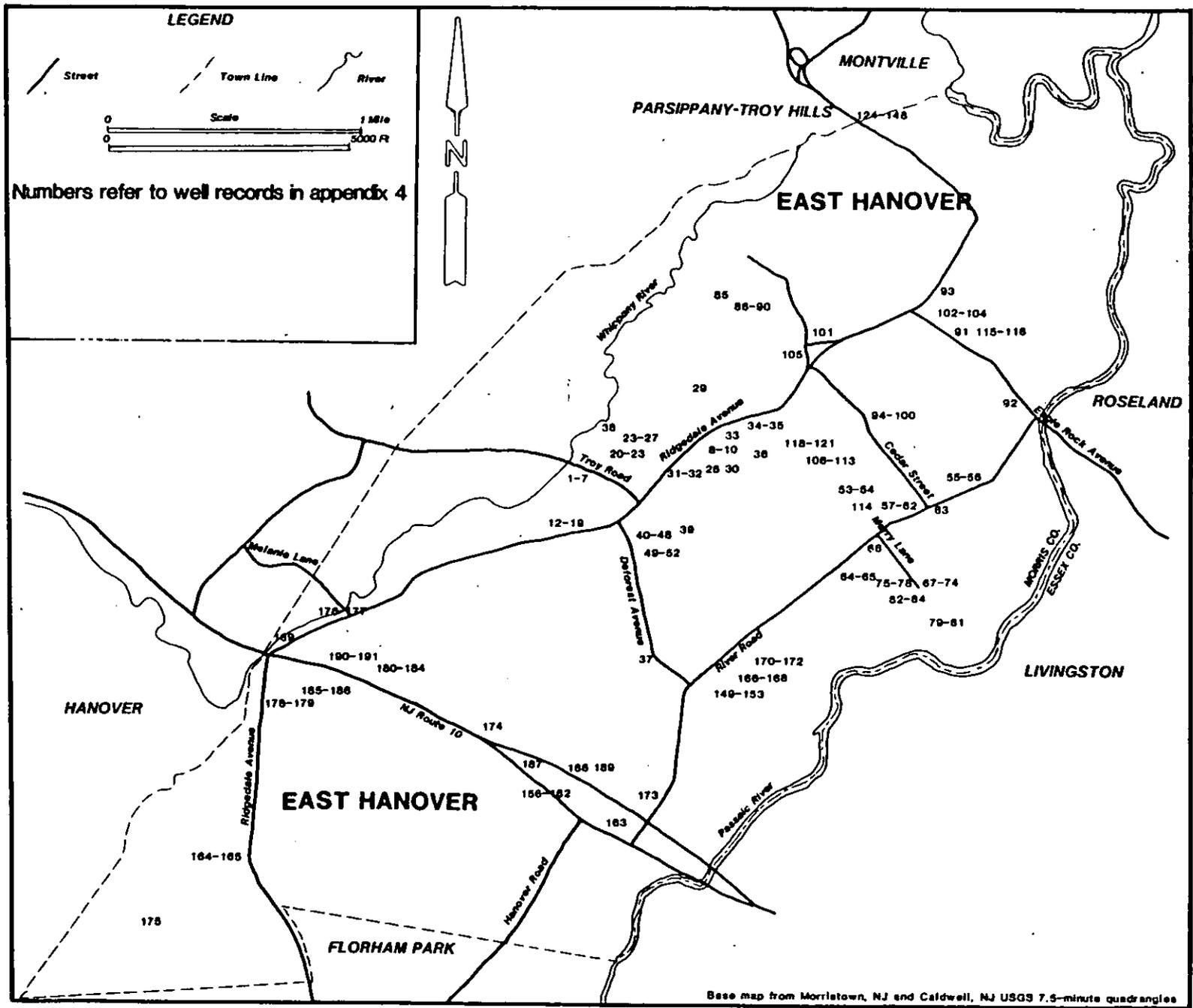


Figure 6 Well Location Map, East Hanover

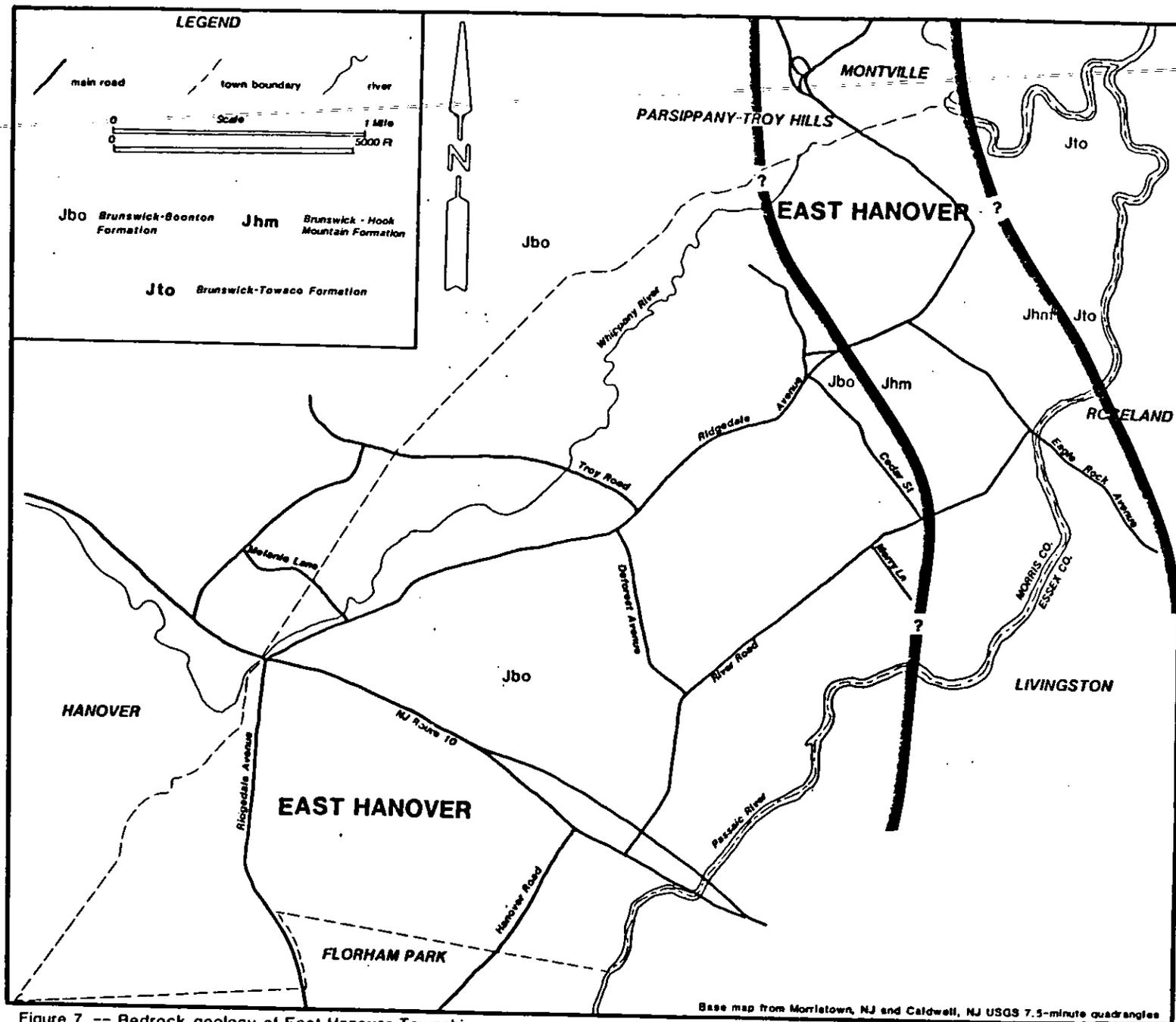


Figure 7. -- Bedrock geology of East Hanover Township area

hydrogeology, are included in figure 5a. Well records including depths, screened intervals, depth to bedrock and aquifer-pumping-test data are summarized in appendix 4. Locations of these wells are shown in figure 6.

Ground-water levels in the East Hanover area have declined in the past 20 to 30 years. In the past, artesian conditions prevailed within parts of the buried valley covered by till. Municipal well no. 5 exhibited flowing-artesian conditions prior to pumping in 1972. As of 1987, the piezometric surface in the vicinity of well no. 5 had been drawn below the confining layer, preventing artesian conditions. East Hanover Township directs its municipal waste water to the Parsippany-Troy Hills Treatment Plant. The treated waste water is subsequently discharged to the Rockaway and Whippany Rivers. As a result, approximately 6 to 8 mgd is transferred outside the Township and, therefore, does not recharge the aquifer. The removal of this potential recharge combined with ground-water pumping in excess of natural recharge has led to a ground-water level decline of approximately 20 feet during the past 30 (1957-1987) years throughout much of East Hanover.

BEDROCK FORMATIONS

The surficial deposits overlie three bedrock formations of the Brunswick Supergroup of Jurassic age (145-190 million years before present): the Towaco Formation, the Hook Mountain Basalt and the Boonton Formation. The Towaco Formation occurs in the extreme northeastern portion of the Township (fig. 7). It consists of black to gray, calcareous siltstone with interbedded gray sandstone and clastic volcanics. The Hook Mountain Basalt, otherwise known as the Third Watchung Basalt Flow, trends approximately north-south through the eastern portion of the Township. The Hook Mountain is a fine to moderately coarse-grained, abundantly vesicular basalt composed of at least two distinct flow units (Puffer, 1984). In the East Hanover area, the Hook Mountain has a thickness of 200-250 feet (Darton, 1890). West of the basalt flow is the Boonton Formation, which is a highly-fractured red siltstone with interbedded layers of red, dense argillite. The dominant joint direction throughout the Brunswick Supergroup formations of this area is approximately north-south. These near-vertical planar fractures may facilitate the flow of ground water (and contaminants) in these directions within the bedrock. Large-diameter municipal and production wells drilled into the sedimentary formations of the Brunswick Supergroup have an average yield of 142 gpm, and range in yield from 4 to 650 gpm (Gill, 1965). Water-level data collected from monitor wells at the Chemical Components site (fig. 3) in April 1987 indicated that the vertical hydraulic gradient was downward from the unconsolidated deposits into the bedrock at this site. Therefore, ground water will migrate downward into the bedrock aquifer at this location. A stratigraphic column for East Hanover is given in table 2.

Table 2. -- Stratigraphic column for East Hanover area, Morris County, New Jersey

Period	Stage	Formation or unit	Maximum thickness (feet)	Description	Hydrogeologic characteristics
Quaternary	Wisconsinan	Glacial till	70	Heterogeneous, unsorted deposits composed of light-gray to dark-gray sand, silt, clay and cobbles. Forms discontinuous blanket over stratified drift	Normally, a semiconfining layer with low transmissivity and low hydraulic conductivity
		Stratified drift	200	Valley-fill deposits composed of glacially-derived medium to coarse-grained sand, gravel and cobbles with occasional clay layer or lense	A major aquifer in East Hanover. Very high transmissivity and hydraulic conductivity.
Jurassic	Brunswick	Boonton Formation	1,000	Highly fractured, fine-grained, red siltstone with interbedded red, dense argillite	Minor aquifer in East Hanover
		Hook Mtn. Basalt	200-250	Fine to moderately coarse-grained, abundantly vesicular basalt composed of at least three distinguishable flow units	Minor aquifer in East Hanover
		Super-group Towaco Formation	1,000	Black to gray, calcareous siltstone with interbedded gray sandstone and clastic volcanics	Minor aquifer in East Hanover

INDUSTRIAL SITE CONTAMINATION

For the purposes of describing the ground-water contamination in East Hanover, the Township has been divided into four geographic sections: Northern, Eastern, Southern, and Western as shown in figure 8. Ground-water contamination by volatile organic compounds has been detected at industrial sites throughout the Township. The sites are located in figure 3. Some of the major ground-water pollution sites are described below.

NORTHERN SECTION

Sharkey Farms Landfill - The 90-acre landfill bordering Parsippany-Troy Hills is located along the Rockaway, Whippany and Passaic Rivers. Leachate discovered at the landfill in 1977 was found to contain 15,000 ppb of volatile organics. Prior to its closure in 1972, Sharkey Farms accepted not only municipal wastes, but at least some industrial wastes as well. Information from Ciba-Geigy Corporation details the disposal of hazardous chemicals at Sharkey Farms Landfill from 1962 through 1969. These chemicals included toluene (560,000 lbs.), benzene (130,000 lbs.), chloroform (40,000 lbs.), methylene chloride (20,000 lbs.), ethylene dichloride (3,000 lbs.) and 100 lbs. of selenium oxide (R. E. Wright Associates, 1986). Twenty-six monitor wells were installed as part of a Superfund investigation. Analyses of ground-water samples disclosed measureable concentrations of benzene and trichloroethylene. The highest concentration of volatile organics detected in the monitor wells was 421 ppb. Based on water-level measurements taken at onsite monitor wells, the ground-water flow direction is toward the Whippany, Rockaway and Passaic Rivers.

Sunoco Service Station - A gasoline spill occurred due to a leaking underground storage tank at the Sunoco Service Station on Ridgedale Avenue in 1986. Product thicknesses of as much as 1.5 feet have been detected in 11 onsite monitor wells. The ground-water flow direction is southwesterly. A sample from an adjacent homeowner's well disclosed a total volatile organic concentration of 890 ppb. A possible plume of dissolved gasoline constituents may be migrating southwestward to municipal well no. 5, which has yielded water samples with benzene at concentrations of 5-10 ppb. Remediation in 1987 includes a floating-product recovery system.

EASTERN SECTION

Royal Lubricants, Inc. - Septic-tank samples from the Royal Lubricants facility on Merry Lane disclosed high concentrations of volatile organics including toluene (1,965 ppb), various benzene compounds (1,780 ppb) and methylene chloride (230 ppb). Samples from an onsite waste-water lagoon disclosed 38,000 ppb of dibromochloromethane and 1,100 ppb of chloroform. Ground-water samples from monitor wells onsite have shown volatile organic concentrations as high as 1,067 ppb.

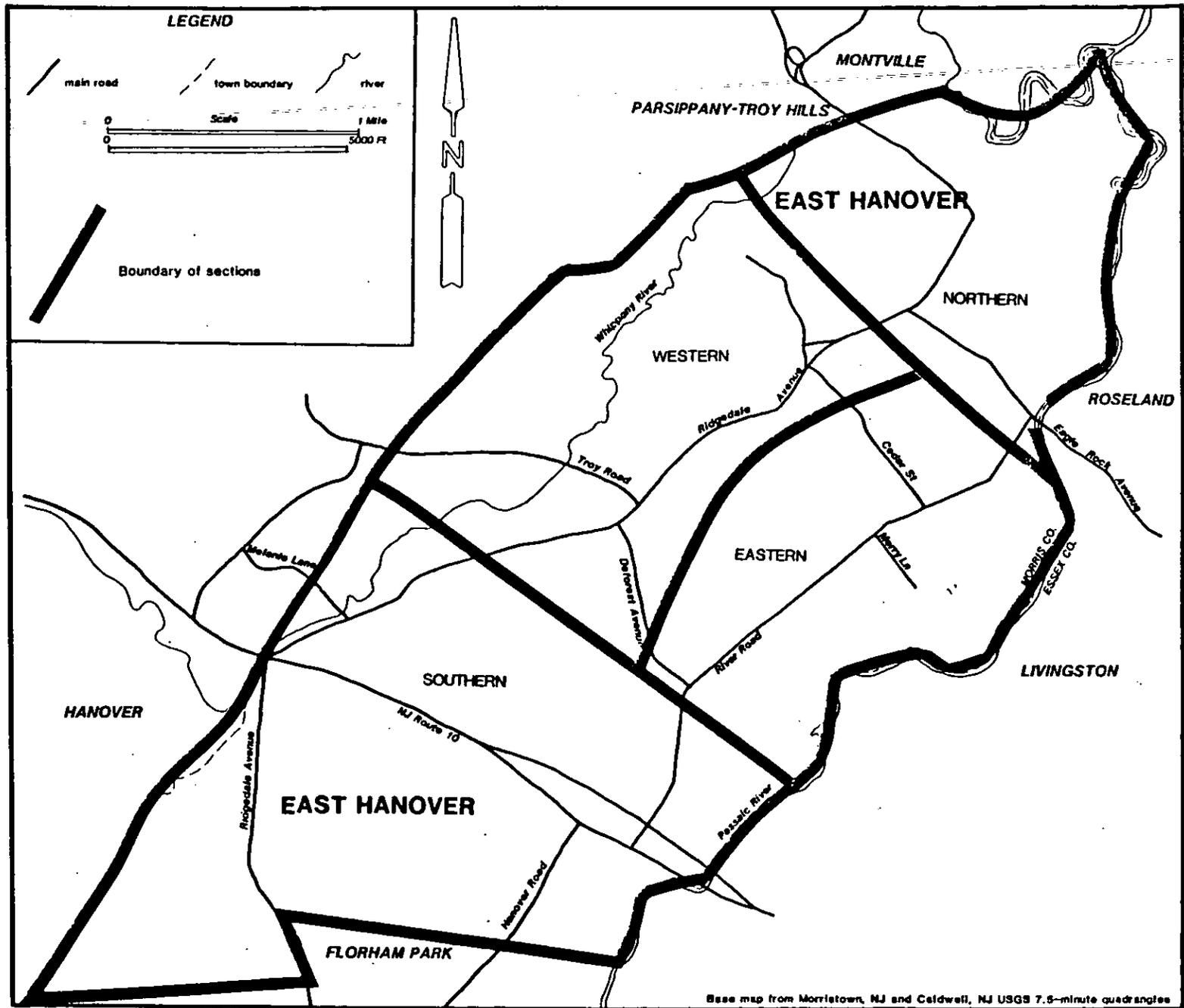


Figure 8. — Geographic sections of East Hanover

Base map from Morristown, NJ and Caldwell, NJ USGS 7.5-minute quadrangles

predominantly 1,1,1-trichloroethane and chloroform. Domestic wells along nearby Lincoln Street have also shown contamination by 1,1,1-trichloroethane. It appears that a plume of volatile organics is emanating from the Royal Lubricants area and extends southeast toward the Passaic River.

Chemservices, Inc - Sludge samples from a septic tank at Chemservices, a tenant of Dorine Industrial Park, located on Merry Lane, were analyzed and disclosed high concentrations of chloroform (48,000 ppb) and 1,1,1-trichloroethane (2,700 ppb). Four monitor wells were installed within the industrial park. Samples analyzed from wells hydraulically downgradient of Chemservices disclosed concentrations of volatile organics as high as 1,332 ppb. The ground-water flow direction was found to be easterly toward the Passaic River.

Nabisco, Inc. - A spill of 3,500 gallons of no. 2 fuel oil occurred from a leaking underground storage tank at the Nabisco facility on River Road in 1985. Analysis of ground-water samples from 11 monitor wells on site has disclosed as much as 10 ppm of petroleum hydrocarbons in ground water. Remediation of floating product is under way in July 1987. Based on water-level measurements taken at onsite monitor wells, the ground-water flow direction prior to remediation was easterly.

SOUTHERN SECTION

Hanco Wood Products - A liquid sample from a dry well at the Hanco facility on NJ Route 10 was analyzed and found to contain 2.9 percent methylene chloride. A sludge sample contained more than 400,000 ppb of volatile organics. The Hanco facility is within 1,500 feet of contaminated municipal well no. 2. As of July 1987, monitor wells have not been installed.

Norda, Inc. - More than 4,500 55-gallon waste drums were excavated from a depth of 10 feet below the ground surface at the Norda facility on NJ Route 10. The drums were buried behind the facility around 1970. Analyzed samples from five monitor wells at the site disclosed as much as 5,000 ppb of volatile organics including 1,1-oxy bismethane, 2-propanone, trichloroethylene, toluene and methylene chloride. Norda is within 1,800 feet of contaminated municipal well no. 2. The ground-water flow direction is southwest.

WESTERN SECTION

Chemical Components/Triangle Industrial Park - Samples from seven monitor wells installed into the unconsolidated deposits at the Chemical Components, Inc. (CCI) facility on Deforest Avenue have shown contamination by volatile organic, base neutral and acid extractable compounds with total concentrations as high as 17,000 ppb. Volatile organic compounds included trichloroethylene, 1,1,1-trichloroethane and tetrachloroethylene. Base neutral and acid extractable compounds

included bis (2-ethylhexyl) phthalate, dimethyl dioxane, and phenols. Three bedrock monitor wells were installed at CCI in January 1987. Ground-water samples obtained from these wells disclosed volatile organic concentrations ranging from 693 to 1,055 ppb. CCI formerly maintained three seepage pits and a waste-water lagoon. In addition, approximately 30 hazardous-waste drums were excavated from beneath the site in 1984. Domestic wells in the vicinity of Chemical Components have also shown high concentrations of VOC contamination. Sampling of domestic wells in the area for base neutral and acid extractable compounds has been recommended by the Bureau of Ground-Water Pollution Analysis. The septic system at the adjacent Triangle Industrial Park (TIP) was found to contain 4,646 ppb of 1,1,1-trichloroethane. Two onsite monitor wells were sampled and disclosed concentrations of trichloroethylene ranging from 340 to 620 ppb. Monitor well no. 1, which is adjacent to the contaminated septic tank, disclosed the highest concentration of total VOCs at 665 ppb. It appears that a plume of volatile organics is emanating from the CCI/TIP area and is travelling northwest into the residential areas of Ridgedale Avenue and Troy Road. Analyses of ground water from monitor wells are shown in appendix 2.

Bronner Manufacturing & Tool Company - Bronner is located on Ridgedale Avenue. In 1983, the Township Health Officer discovered that waste waters were being discharged through a garden hose to an area behind the plant. Analyses of the waste water disclosed 1,1,1-trichloroethane (8,930 ppb), trichloroethylene (6,070 ppb), 1,1,2-trichloroethane (6,170 ppb), methylene chloride (5,540 ppb) and petroleum hydrocarbons (2,585,000 ppb). Samples from onsite septic tanks disclosed high concentrations of the same compounds. Five monitor wells were installed in 1986. Analyses of ground-water samples from the monitor wells and from an onsite production well disclosed more than 300 ppb of volatile organics. These organic compounds were the same as those detected in the waste-water discharge. The direction of ground-water flow is westward toward the Whippany River.

Sidmak Laboratory - Analysis of water and sludge samples obtained from the Sidmak septic system on West Street in 1983 disclosed extremely high concentrations of volatile organics including 1,1-dichloroethane (18,400 ppb), 1,1-dichloroethylene (5,100 ppb), methylene chloride (172,000 ppb) and 1,1,1-trichloroethane (21,000 ppb). As of July 1987, monitor wells had not been installed at the site.

SPILL FUND STATUS

Under the Spill Compensation and Control Act (Spill Act), the effective date for pre-Act versus post-Act determinations is April 1977. Discharges of hazardous substances, covered by the Spill Act, prior to April 1977 are considered pre-Spill Act. Discharges after April 1977 are considered post-Spill Act. The actual date(s) of discharge and the pre- or post-Spill Act determination affects the eligibility of Spill Fund monies available for remedial investigations and remedial actions.

In East Hanover, contamination of the aquifers is ongoing as a result of direct discharges of hazardous substances to the ground water. Most of these discharges continued until the municipal sewer system became available in 1984. Residual contaminants in landfills, lagoons, seepage pits and adjacent soils continue to leach to the ground water. Although many discharges occurred prior to April 1977, the vast majority continued to occur after April 1977. Therefore, most contaminant discharges discussed in this Technical Memorandum should be considered post-Spill Act.

A determination as to the percentage of pre-Spill Act versus post-Spill Act discharges which have occurred in East Hanover is not possible as of July 1987. Detailed information concerning the quantity, concentration and the actual dates of discharge is required but may not even exist. Because of the number and variety of discharges and the difficulties of obtaining accurate discharge information from potential responsible parties, obtaining an accurate percentage of pre-Act versus post-Act discharges may in this case be impossible.

DOMESTIC-WELL CONTAMINATION

As of July 1987, approximately 800 residences in East Hanover are supplied by domestic wells. Well depths range from 50 to 150 feet below the land surface. Most are screened within the unconsolidated deposits. Contamination of domestic wells disclosed by water analysis has included trichloroethylene, tetrachloroethylene, 1,1,1-trichloroethane, benzene and trans-1,2-dichloroethylene. The highest contaminant concentrations were in samples collected near the intersection of Ridgedale and Deforest Avenues and in the residential areas near the intersection of Deforest Avenue, Troy Road and Ridgedale Avenue (fig. 4). Levels of volatile organic compounds have ranged from BMDL to 2,091 ppb (appendices 2-3). A plume of these contaminants may be emanating from the Chemical Components and Triangle Industrial Park vicinity.

Ground-water contamination has also been detected in domestic wells in the Merry Lane and Lincoln Street area (appendix 2). A plume of volatile organics is probably emanating from some or all of the following industries in this area: Royal Lubricants, Inc., Weiss-Aug, Inc., Dorine Industrial Park, Fritzsche, Dodge & Olcott, Inc., and Chemservices, Inc. Based on water-level measurements and the analyses of ground water from monitor wells at these sites, a plume of volatile organic compounds is probably migrating eastward to the Passaic River.

An additional plume of dissolved gasoline constituents is probably emanating from the Sunoco Service Station near the intersection of Ridgedale and Eagle Rock Avenues (fig. 3). Based on analyses of raw-water samples from municipal well no. 5, it is presumed that the plume is travelling southwest toward the municipal well and possibly contaminating domestic wells along its migration route.

Ground-water contamination has been detected at low concentrations (<50 ppb) in most of the remaining parts of the Township. One factor controlling the degree of contamination detected in the domestic wells is the depth at which the well is screened. Due to the relatively high density of many of the compounds and heavy pumpage in the Buried Valley Aquifer system, the compounds are likely to descend through the aquifer to deeper unconsolidated deposits or into the bedrock. The densities of selected volatile organic compounds are shown in table 3.

Table 3. -- Density of selected ground-water contaminants. From Merck & Co. (1983). Mass per unit volume, M/L³, where M is mass and L is length. Densities given are for 20°C.

Compound	Density gm/cm ³ at 20°C
Carbon Tetrachloride	1.5890
Tetrachloroethylene	1.5018
Trichloroethylene	1.4904
Trans-1,2-Dichloroethylene	1.4435
Methylene Chloride	1.3617
1,1,1-Trichloroethane	1.3492
Phenol	1.0700
Water	1.0000
Benzene	0.8787
Toluene	0.8660

MUNICIPAL-WELL CONTAMINATION

East Hanover operates the three municipal-supply wells identified in figure 2 and table 4. All three wells have been found to contain volatile organic compounds including trichloroethylene, trans-1,2-dichloroethylene, 1,1,1-trichloroethane and benzene as shown in appendix I. Concentrations of volatile organic compounds in the wells ranged from BMDL to 77.9 ppb.

Treatment by air stripping was provided for well no. 2 in 1984. Well no. 1 is scheduled to be connected to this treatment system in 1987. Due to a nearby contaminant plume, well no. 6 was not granted a diversion permit by NJDEP.

Aerial photographs disclose that the site of well no. 2 was beneath the Whippany River in 1957. Between 1957 and 1967, the present location of the well was used as a landfill for waste construction materials. Possible additional sources for the VOCs include the G & F Industrial

Park on Littel Road, Hanco Wood Products on Route 10, Norda, Inc. on Route 10 and the P. Cuva Site (an industrial park) on Melanie Road. At each of these sites, volatile organic compounds have been discharged into onsite subsurface disposal systems.

Table 4. -- Specifications of East Hanover municipal wells

Well no.	Well permit number	Date of construction (mo/yr)	Screen depth* (feet)	Depth* of well (feet)	Pump capacity (gpm)**	Status in 1987
1	25-13672	5/66	100-110	130	500	In use
2	25-14205	3/67	85-115	115	1,000	In use
5	25-18268	8/72	65-85	120	900	In use
6	25-25792	3/85	75-100	110	1,000	Not in Use

* Feet below land surface; ** gpm, gallons per minute

REGIONAL GROUND-WATER CONTAMINATION

Ground-water contamination is widespread within the East Hanover area. Communities adjacent to East Hanover Township have similar water-quality problems with volatile organic compounds. Affected water supplies in nearby communities are listed below.

LIVINGSTON WATER DEPARTMENT, ESSEX CO.

Volatile organics including trichloroethylene, 1,1,1-trichloroethane and tetrachloroethylene have been detected in municipal well nos. 5, 9 and 11 ranging from 2.0 to 13.0 ppb. A source of contamination had not been identified as of July 1987, however, four ground-water contamination cases are located directly across the Passaic River in East Hanover.

ESSEX FELS WATER COMPANY, ROSELAND, ESSEX CO.

Five municipal wells (nos. 7, 8, 10, 11 and 12) were contaminated with volatile organics including trichloroethylene, tetrachloroethylene and 1,1,2,2-tetrachloroethylene ranging from 1.0 to 347.0 ppb. The wells were removed from service in 1983. Numerous potential responsible parties (PRPs) have been identified and investigations are under way in 1987.

FAIRFIELD REGIONAL CONTAMINATION, ESSEX CO.

Contamination has been detected in numerous domestic wells and in Fairfield municipal well nos. 2 and 7. Contaminants include trichloroethylene and carbon tetrachloride ranging in concentration from BMDL to greater than 10,000 ppb. Numerous PRPs have been determined, including Caldwell Trucking, Inc., presently a Superfund site.

MADISON WATER DEPARTMENT, MORRIS CO.

Five municipal-supply wells within Madison Borough are contaminated with trichloroethylene, tetrachloroethylene, toluene and carbon tetrachloride ranging from 1.0 to 18.0 ppb. These compounds have also been detected in numerous domestic wells. As of July 1987, no PRPs have been identified.

FLORHAM PARK WATER DEPARTMENT, MORRIS CO.

Water samples taken from within the distribution system of the Florham Park Water System, which draws water from the East Hanover Buried Valley, disclosed 2.0 ppb of carbon tetrachloride. These results have not been confirmed. As of July 1987, samples had not been taken from any of the four individual municipal wells in Florham Park.

SOUTHEAST MORRIS MUNICIPAL UTILITIES AUTHORITY, MORRIS CO.

Analyses of water samples taken from the authority's distribution system in 1986 indicated contamination by volatile organics including trans-1,2-dichloroethylene (4.0 ppb), 1,1-dichloroethane (1.5 ppb) and chloroform (5.0 ppb). Southeast Morris operates two supply wells, Black Brook nos. 1 and 2, which are located within 200 feet of the East Hanover town line. Contamination of a well supplying potable water at the adjacent Precision Rolled Products facility on Columbia Road is indicated by analyses (in 1986) showing levels of 150 ppb of VOCs (appendix 3).

CONCLUSIONS

1. Numerous ground-water pollution sources exist within and in the vicinity of East Hanover Township. The documented contaminants include volatile organic, base neutral, acid extractable and petroleum hydrocarbon compounds.
2. Contamination has been detected in the surficial aquifer(s) throughout much of the Township. Contamination has been detected in domestic, municipal, industrial-production and monitor wells.

3. As of July 1987, samples from five bedrock wells have disclosed high concentrations of volatile organics. Due to a downward hydraulic gradient in at least parts of the Township and the presence of relatively high density compounds, the bedrock aquifer is threatened.
4. Ground water beneath East Hanover Township currently (July 1987) contains and/or is likely to contain, in the near future, contaminant concentrations above NJDEP standards and/or guidelines for potable water.
5. A Well-Restriction Area is necessary in East Hanover Township to prevent the use of contaminated and threatened ground-water supplies by local consumers and to help control the spread of contaminants within the aquifers.
6. Ground-water contaminants will continue to migrate and spread in East Hanover until remediation of the contaminant sources and the affected ground water is initiated.

WELL-RESTRICTION AREA DELINEATION

A Well-Restriction Area is an area which contains and/or is likely to contain, in the near future, contaminant concentrations above NJDEP standards and/or guidelines for potable water. For this Township, separate 5- and 10-year Well-Restriction Areas, as required by current (July 1987) NJDEP policy, are not appropriate because the Well-Restriction Area includes the entire Township of East Hanover. The Well-Restriction Area includes both the unconsolidated and bedrock aquifers. Approximately 800 residences are using private domestic wells as their source of potable water within the Well-Restriction Area. The well-restriction delineation is based on all the information contained in this Technical Memorandum and on the following conclusions and assumptions (see figs. 3, 4 and 8):

NORTHERN SECTION

Concentrations of VOCs in ground water within the northern section range from BMDL to 890 ppb. Based on water-level measurements taken at the Sunoco and Sharkey Farms sites, the ground-water flow direction is toward either the Whippany and Passaic Rivers or municipal well no. 5. Based on these flow directions, domestic wells in the northern section are threatened with contamination. Therefore, the entire northern section currently contains and/or is likely to contain contaminant concentrations above NJDEP standards and/or guidelines for potable water.

EASTERN SECTION

Concentrations of VOCs in ground water within the eastern section range

from BMDL to 1,332 ppb. Based on water-level measurements taken at the Nabisco, Royal Lubricants, Weiss-Aug and Dorine Industrial Park sites, the predominant ground-water flow direction is eastward toward the Passaic River. Most of the domestic wells in the eastern section are hydraulically downgradient of known pollution sources or other contaminated wells. Therefore, the entire eastern section currently contains and/or is likely to contain contaminant concentrations above NJDEP standards and/or guidelines for potable water. The Passaic River is believed to act as a hydraulic boundary for shallow ground-water flow, except near large pumping centers. Therefore, the northern and eastern boundary of the recommended Well-Restriction Area is drawn at the Passaic River.

SOUTHERN SECTION

Concentrations of VOCs in ground water within the southern section range from BMDL to 4,953 ppb. Based on water-level measurements taken at the Norda, Thermocision and Sandoz sites, the ground-water flow direction is toward either the Sandoz production wells or East Hanover well nos. 1 and 2. In the eastern part of the southern section, ground-water flow is likely to be eastward to the Passaic River. Contamination by volatile organics has been detected in wells throughout the southern section (where wells are present). Ground-water contamination has been detected inside the southern section and in Florham Park to the south. Therefore, the entire southern section currently contains and/or is likely to contain contaminant concentrations above NJDEP standards and/or guidelines for potable water. As a result, the southern boundary of the recommended Well-Restriction Area is drawn at the East Hanover Township boundary. Ground-water quality data for the Florham Park area are needed to determine if an additional well-restriction area is necessary south of East Hanover.

WESTERN SECTION

Concentrations of VOCs in ground water within the western section range from BMDL to 16,691 ppb. Based on water-level measurements taken at the Chemical Components, Bronner and Ell-Bee Chemical sites, the predominant ground-water flow direction, east of the Whippany River, is westward toward the Whippany River. These pollution sites are hydraulically upgradient from most domestic wells in the western section. Analyses of ground-water samples from these domestic wells have disclosed high concentrations of volatile organics. Low but measurable concentrations of volatile organic compounds have also been detected west of the Whippany River. The Whippany River, in the western section, is assumed not to act as a hydraulic barrier. Based on soil boring logs obtained during the installation of municipal well no. 6, the Whippany River is likely underlain by an extensive layer of clay; therefore, ground water is believed to migrate underneath the river.

Thus, the entire western section currently contains and/or is likely to contain contaminant concentrations above NJDEP standards and/or guidelines for potable water. As a result, the western boundary of the recommended Well-Restriction Area extends across the Whippany River to the East Hanover Township boundary. Due to a lack of water-quality data, however, the Well-Restriction Area does not extend westward into Hanover Township. Ground-water quality data for the Hanover Township area are needed to determine if an additional well-restriction area is necessary west of East Hanover.

The need for additional Well-Restriction Areas cannot be determined until ground-water quality and flow data have been obtained from East Hanover's neighboring communities. Adjacent communities suspected in July 1987 of having ground-water contamination problems include Florham Park, Whippany, Livingston and Hanover.

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APPENDIXES

Appendix 1. -- Analyses of untreated water for volatile organic compounds (ppb) from municipal-supply wells, East Hanover Township, Morris County*
 BMDL, below minimum detection level; ppb, parts per billion

Well	-----SELECTED VOLATILE ORGANIC COMPOUNDS-----					Total** VOC (ppb)	Date of Collection
	Methylene Chloride	Trans-1,2- Dichloro- ethylene	Tri- chloro- ethylene	Tetra- chloro- ethylene	1,1,1- Trichloro- ethane		
No. 1	BMDL	7/5/84
No. 1	1.7	7/21/86AM
No. 1	4.0	7/21/86PM
No. 1	36.7	7/29/86
No. 1	23.7	7/31/86
No. 2	..	6.2	31.0	..	..	37.2	3/24/83
No. 2	..	5.5	43.6	..	..	51.2	5/30/84
No. 2	58.2	..	..	58.2	6/26/84
No. 2	70.2	..	..	70.2	7/11/84
No. 2	74.7	..	1.7	76.4	7/17/84
No. 2	..	10.6	58.2	..	2.1	70.9	7/25/84
No. 2	..	6.6	41.7	..	..	50.0	8/1/84
No. 2	..	4.3	71.7	..	1.9	77.9	8/7/84

* All wells tap unconsolidated deposits. All ground-water samples were obtained by representatives of NJDEP and/or the East Hanover Health Department. Analyses were performed by various NJ-certified laboratories. Analyses have been performed by different laboratories using different instrumentation and different analytical methods, but overall results are believed to accurately delineate ground-water quality in the aquifers of East Hanover.

** Total may be larger than sum of first five columns because VOCs with relatively low concentrations are not included.

Appendix 1 (cont.)

Well	-----SELECTED VOLATILE ORGANIC COMPOUNDS-----					Total VOC (ppb)	Date of Collection
	Methylene Chloride	Trans-1,2- Dichloro- ethylene	Tri- chloro- ethylene	Tetra- chloro- ethylene	1,1,1- Trichloro- ethane		
No. 2	..	5.2	43.8	..	..	49.0	8/31/84
No. 2	..	7.0	65.4	..	..	72.4	8/16/84
No. 2	48.0	..	..	48.0	9/5/84
No. 2	37.4	..	..	37.4	9/11/84
No. 2	28.7	..	..	28.7	3/4/86
No. 2	..	3.8	38.2	..	2.7	47.2	4/1/86
No. 2	..	15.0	49.5	..	..	78.2	10/7/86
No. 2	4.6	..	..	11.2	11/5/86
No. 2	..	3.1	25.5	..	..	31.6	12/2/86
No. 2	..	20.4	48.2	..	..	71.5	2/4/87
<hr/>							
No. 5	2.0	3/24/83
No. 5	BMDL	10/7/83
No. 5	2.4	5/30/84
No. 5	BMDL	12/12/84
No. 5	BMDL	5/29/85
No. 5	1.2	7.8	7/15/86
No. 5	BMDL	8/26/86
No. 5	BMDL	12/2/86
No. 5	BMDL	12/3/86
<hr/>							
No. 6	BMDL	3/11/85

APPENDIX 2. - Analyses of water for volatile organic compounds from domestic wells, all results in parts per billion (ppb), East Hanover, Morris County*
 2, not shown on figure 4; #, well penetrates bedrock aquifer; BMDL, below minimum detection level

Well Location	-----SELECTED VOLATILE ORGANIC COMPOUNDS-----					Total** VOC (ppb)	Date of Collection
	Methylene Chloride	Trans-1,2- Dichloro- ethylene	Tri- chloro- ethylene	Tetra- chloro- ethylene	1,1,1- Trichloro- ethane		
WESTERN SECTION:							
54 Troy Road	BMDL	4/18/84z
56 Troy Road	BMDL	5/22/84z
61 Troy Road	..	18.0	270.0	..	95.0	383.0	5/30/84
103 Troy Road	2.5	11.4	2/19/86
14 West Ridgedale Ave	BMDL	4/11/86
65 Ridgedale Avenue	BMDL	11/2/83z
124 Ridgedale Avenue	BMDL	12/18/84z
214 Ridgedale Avenue	2.7	..	..	2.7	1/9/86z
222 Ridgedale Avenue	14.1	..	3.0	17.1	5/30/84
225 Ridgedale Avenue Gate of Heaven Cemetary	66.4	..	69.2	133.6	9/4/86
225 Ridgedale Avenue Gate of Heaven, Monte Bldg.	..	1.9	24.6	..	4.0	30.5	3/30/84
268 Ridgedale Avenue Heavenly Rest Cem.	45.0	..	52.1	107.8	5/16/84
272 Ridgedale Avenue	..	17.2	206.0	..	3.9	227.1	5/22/84
278 Ridgedale Avenue Calculagraph	20.0	326.0	13.0	359.0	9/11/85

* All wells tap unconsolidated deposits unless otherwise indicated. All ground-water samples were obtained by representatives of NJDEP and/or the East Hanover Health Department. Analyses were performed by various NJ certified laboratories. Analyses have been performed by different laboratories using different instrumentation and different analytical methods, but overall results are believed to accurately delineate ground-water quality conditions in the aquifers of East Hanover.

** Total may be larger than sum of first five columns because VOCs with relatively low concentrations are not included.

Appendix 2 (cont.)

Well Location	-----SELECTED VOLATILE ORGANIC COMPOUNDS-----					Total VOC (ppb)	Date of Collection
	Methylene Chloride	Trans-1,2- Dichloro- ethylene	Tri- chloro- ethylene	Tetra- chloro- ethylene	1,1,1- Trichloro- ethane		
298 Ridgedale Avenue	..	21.3	167.0	..	..	188.3	12/2/83
304 Ridgedale Avenue	12.3	2.2	16.8	35.3	10/7/83z
304 Ridgedale Avenue	5.6	..	2.9	26.1	5/30/84
307 Ridgedale Avenue	..	11.2	25.4	2.0	6.0	48.6	10/7/83
336 Ridgedale Avenue	..	2.6	22.0	..	..	29.1	4/16/84z
342 Ridgedale Avenue	..	6.7	566.0	29.3	12.8	655.0	10/7/83
364 Ridgedale Avenue	BMDL	4/2/86z
376 Ridgedale Avenue	BMDL	11/27/85z
379 Ridgedale Avenue	..	14.0	259.0	..	18.5	294.0	4/18/84z
379 Ridgedale Avenue	322.0	..	..	322.0	2/6/86
Rose of Lima School Ridgedale Avenue	..	204.0	1727.0	37.4	99.0	2091.0	9/26/83
30 Fransen Drive	..	7.9	54.1	..	5.1	67.1	5/16/84
22 Florence Drive	..	580.0	466.0	..	47.0	1093.0	5/16/84
13 Florence Avenue	..	1.3	10.5	..	80.7	103.6	2/6/86z
28 Florence Avenue	..	4.7	35.7	..	19.1	59.5	10/7/83z
64 Walter Avenue	36.9	..	..	36.9	11/2/83
60 Walter Avenue	2.1	3.5	5/16/84
56 Walter Avenue	3.8	3.8	5/31/84
27 Ward Place	..	2.8	..	..	7.9	14.5	2/19/86
29 Ward Place	10.0	10.0	2/6/86
49 Ward Place	..	4.5	82.8	..	4.3	94.5	4/18/84
9 Weaver Place	..	12.3	100.0	..	14.9	127.2	10/31/84

Appendix 2 (cont.)

Well Location	-----SELECTED VOLATILE ORGANIC COMPOUNDS-----					Total VOC (ppb)	Date of Collection
	Methylene Chloride	Trans-1,2- Dichloro- ethylene	Tri- chloro- ethylene	Tetra- chloro- ethylene	1,1,1- Trichloro- ethane		
10 Weaver Place	..	16.9	160.0	..	12.7	193.4	4/18/84
17 Weaver Place	..	31.0	454.0	3.1	14.4	512.5	1/9/86
21 Weaver Place	58.0	58.0	1/29/86z
37 Weaver Place	3.1	4/18/84z
49 Weaver Place	BMDL	1/9/86z
30 Deforest Avenue	81.1	..	81.2	184.0	4/18/84
40 Deforest Avenue	28.7	..	..	..	112.0	191.7	3/21/84
30 Deforest Avenue Triangle Ind. Park	1.7	10/19/83
Prime Fabricators West Street	7.0	..	3.0	..	640.0	825.0	5/16/83#
35 McKinley Street	..	5.2	1.0	..	43.2	65.2	2/19/86
35 McKinley Avenue	7.7	7.7	5/16/84z
111 McKinley Drive	BMDL	5/22/84
123 McKinley Street	1.2	4/18/84
17 Grove Avenue	..	4.78	2.6	7.83	5.51	24.6	2/19/86
39 Grove Avenue	..	13.9	..	..	..	13.9	6/12/85
48 Grove Avenue	1.0	1.0	4/14/86
51 Grove Avenue	..	24.0	..	2.9	..	26.9	8/16/84
31 Ronald Drive	1.2	10/24/83
47 Ronald Drive	BMDL	4/8/86
20 School Avenue	6.9	..	..	8.3	10/25/84
32 Gail Drive	..	0.9	..	..	0.37	2.77	2/19/86

Appendix 2 (cont.)

Well Location	-----SELECTED VOLATILE ORGANIC COMPOUNDS-----					Total VOC (ppb)	Date of Collection
	Methylene Chloride	Trans-1,2- Dichloro- ethylene	Tri- chloro- ethylene	Tetra- chloro- ethylene	1,1,1- Trichloro- ethane		
61 Gail Drive	BMDL	4/8/86
12 Casey Drive	..	0.81	..	..	0.79	1.60	2/19/86
30 Casey Avenue	4.0	..	5.0	10.0	4/17/86
19 Wilson Street	37.0	..	..	37.0	10/19/84
24 Petry Drive	1.89	3.22	2/19/86
16 Cleveland Street	3.7	..	2.4	11.98	2/19/86
20 Norwood Road	BMDL	10/24/83
5 Groah Road	BMDL	4/22/86
24 Schoener Road	1.2	1.2	4/8/86
36 Kahl Road	BMDL	5/30/84
11 Eberhardt Street	18.8	..	..	18.8	10/15/86
54 Barnida Drive	13.0	..	..	..	..	13.0	12/7/83
61 Barnida Drive	BMDL	2/5/86
99 Klinger Road	BMDL	5/22/84
27 Peniston Street	7.17	..	..	..	..	7.17	10/31/86
<u>EASTERN SECTION:</u>							
90 Christine Drive	2.4	..	..	2.4	5/22/84
99 Christine Drive	10.4	..	..	..	..	10.4	10/31/86
33 Lincoln Street	6.6	..	..	6.6	10/31/84
48 Lincoln Street	BMDL	10/31/84
31 Lincoln Street	BMDL	10/31/84
48 Lincoln Street	30.6	30.6	9/22/83

Appendix 2 (cont.)

Well Location	-----SELECTED VOLATILE ORGANIC COMPOUNDS-----					Total VOC (ppb)	Date of Collection
	Methylen Chloride	Trans-1,2- Dichloro- ethylene	Tri- chloro- ethylene	Tetra- chloro- ethylene	1,1,1- Trichloro- ethane		
74 Lincoln Street	3.7	3.7	9/22/83
90 Lincoln Street	3.2	3.2	9/22/83
Nabisco River Road	20.4	24.1	7/26/84
269 River Road	8.36	..	..	..	..	8.36	10/31/86
30 Park Terrace	BMDL	5/16/84
<u>SOUTHERN SECTION:</u>							
30 Emmanuel Street	6.96	..	..	6.96	10/15/86
23 Emmanuel Street	BMDL	3/16/84
12 Fairview Drive	BMDL	11/1/83
47 Fairview Drive	BMDL	5/30/84
5 Colonia Way	BMDL	10/5/84
28 Tiffany Street	2.42	..	..	2.42	10/15/86
Hanco Furniture Rte. 10	BMDL	6/26/86
96 Mount Pleasant Avenue	BMDL	3/29/85
Sandoz Production Well 3	BMDL	11/5/86
Sandoz Production Well 4	BMDL	11/5/86
Sandoz Production Well 5	5.7	11/5/86
7 Great Meadow Lane	BMDL	1/4/84
US Army Housing, River Rd	2.40	..	..	2.40	2/6/86
PrecisionRollProd Pr Well	..	10.2	115.0	..	9.2	148.4	3/3/87
<u>NORTHERN SECTION:</u>							
34 Phylidan Court	4.12	10/14/86

Appendix 2 (cont.)

Well Location	-----SELECTED VOLATILE ORGANIC COMPOUNDS-----					Total VOC (ppb)	Date of Collection
	Methylene Chloride	Trans-1,2- Dichloro- ethylene	Tri- chloro- ethylene	Tetra- chloro- ethylene	1,1,1- Trichloro- ethane		
730 Ridgedale Avenue	..	..	..	..	..	BMDL	4/30/86
14 West Ridgedale Avenue	..	..	..	..	..	BMDL	4/11/86
7 Chicjon Terrace	4.88	..	..	..	..	4.88	10/31/86
East Hanover Airport	58.8	..	..	..	..	58.8	10/31/86
36 Dorianne Terrace	..	..	..	..	..	.890.0	7/86
41 Balsam Avenue	..	..	..	..	..	BMDL	12/20/83
7 Beach Street	..	..	..	..	..	BMDL	5/16/84
105 Overlook Avenue	..	..	..	..	..	BMDL	11/14/83

APPENDIX 3. - Analyses of water for volatile organic compounds from monitor wells, all results in parts per billion, East Hanover, Morris County*
 z, not shown in figure 4; #, penetrates bedrock aquifer; @, well is in Livingston Township; ~, well is in Roseland Township; h, well is in Hanover Township

Well Location	-----SELECTED VOLATILE ORGANIC COMPOUNDS-----					Total** VOC (ppb)	Date of Collection
	Methylene Chloride	Trans-1,2- Dichloro- ethylene	Tri- chloro- ethylene	Tetra- chloro- ethylene	1,1,1- Trichloro- ethane		
<u>EASTERN SECTION:</u>							
Royal Lubricants MW1	..	..	..	..	..	1.0	10/19/82z
Royal Lubricants MW2	..	..	..	..	..	9.0	10/19/82z
Royal Lubricants MW3	..	..	..	..	..	201.0	10/19/82z
Royal Lubricants MW4	..	..	..	6.0	..	80.0	10/19/82z
Royal Lubricants MW5	..	..	7.0	..	18.0	1067.0	10/19/82
Royal Lubricants MW6	..	..	..	59.0	3.0	180.0	10/19/82z
Royal Lubricants MW7	..	..	..	2.0	..	95.0	10/19/82z
Royal Lubricants MW8	..	..	..	..	322.0	388.0	10/19/82z
Dorine Ind. Park MW1	2.0	..	..	3.0	..	7.0	9/14/82z
Dorine Ind. Park MW2	2.0	..	..	1.0	15.0	30.0	9/14/82z
Dorine Ind. Park MW3	5.0	..	21.0	10.0	920.0	1332.0	9/14/82
Dorine Ind. Park MW4	2.0	..	2.0	2.0	230.0	252.0	9/14/82z
Weiss Aug WA1	..	..	..	..	210.0	560.0	10/19/82z
Weiss Aug WA2	..	..	..	..	150.0	630.0	10/19/82
Weiss Aug WA3	..	..	..	..	57.0	177.0	10/19/82z

* All wells tap unconsolidated deposits unless otherwise indicated. All ground-water samples were obtained by representatives of NJDEP, contractors for each specific pollution site and/or the East Hanover Health Department. Analyses were performed by various NJ certified laboratories. Analyses have been performed by different laboratories using different instrumentation and different analytical methods, but overall results are believed to accurately delineate ground-water quality conditions in the aquifers of East Hanover.

** Total may be larger than sum of first five columns because VOCs with relatively low concentrations are not included.

Appendix 3 (cont.)

Well Location	-----SELECTED VOLATILE ORGANIC COMPOUNDS-----					Total VOC (ppb)	Date of Collection
	Methylene Chloride	Trans-1,2- Dichloro- ethylene	Tri- chloro- ethylene	Tetra- chloro- ethylene	1,1,1- Trichloro- ethane		
SOUTHEAN SECTION:							
Norda MW1	137.0	1984
Norda MW2	115.0	..	..	115.0	1984
Norda MW3	ND	1984
Norda MW4	10.0	..	10.0	..	..	4953.0	11/7/84
Norda MW5	24.0	24.0	1984
Sandoz DEP-1	562.0	1/87
Sandoz DEP-2	ND	1/87
Sandoz DEP-3	165.0	1/87
Thermocision MW1	19.0	19.0	N/A
Thermocision MW2	17.0	17.0	N/A
Thermocision MW3	104.0	104.0	N/A
Precision Roll Prod. MW1	BMDL	3/3/87z
Precision Roll Prod. MW2	1.5	..	..	1.5	3/3/87
Precision Roll Prod. MW4	19.3	3/3/87
Precision Roll Prod. MW1	150.0	..	..	150.0	8/23/84
WESTERN SECTION:							
Ell-Bee EBC1	9.0	..	6.0	15.0	9/9/85z
Ell-Bee EBC2	10.0	..	44.0	67.0	9/9/85z
Ell-Bee EBC3	5.0	..	5.0	10.0	9/9/85z
Ell-Bee EBC4	90.0	9/9/85

Appendix 3 (cont.)

Well Location	-----SELECTED VOLATILE ORGANIC COMPOUNDS-----					Total VOC (ppb)	Date of Collection
	Methylene Chloride	Trans-1,2- Dichloro- ethylene	Tri- chloro- ethylene	Tetra- chloro- ethylene	1,1,1- Trichloro- ethane		
Chem Components MW1	..	46.0	2.0	..	10.0	118.4	7/86z
Chem Components MW2	..	6.0	110.0	1.4	24.0	191.0	7/86z
Chem Components MW3	2.7	..	..	4.4	7/86z
Chem Components MW4	1.8	1.8	1.6	1.0	..	413.4	7/86z
Chem Components MW5	..	1.0	1.8	..	..	93.4	7/86z
Chem Components MW6	..	1.0	4.3	1.0	..	13.8	7/86z
Chem Components MW7	2.0	31.0	14710.0	130.0	1700.0	16691.0	7/86
Chem Components MW8	2.1	230.0	660.0	36.0	36.0	1055.0	1/87#z
Chem Components MW9	..	140.0	520.0	21.0	32.0	759.0	1/87#z
Chem Components MW10	..	100.0	460.0	15.0	..	693.0	1/87#z
Bronner P-1	370.0	..	12.0	..	..	445.0	8/86
Bronner MW1	52.0	..	12.0	133.0	8/11/86z
Bronner MW2	35.0	..	16.0	126.0	8/11/86z
Bronner MW3	71.0	..	..	102.0	8/11/86z
Bronner MW4	34.0	..	14.0	48.0	12/8/86z
Bronner MW5	9.0	..	10.0	19.0	12/8/86z
Foster Wheeler MW1	5.0	..	27.0	37.0	9/86
<u>NORTHERN SECTION:</u>							
Sharkeys WS1	25.0	11/85z
Sharkeys WS2	14.0	11/85z
Sharkeys WS3	2.0	11/85
Sharkeys WS4	12.0	11/85z

Appendix 3 (cont.)

Well Location	-----SELECTED VOLATILE ORGANIC COMPOUNDS-----					Total VOC (ppb)	Date of Collection
	Methylene Chloride	Trans-1,2- Dichloro- ethylene	Tri- chloro- ethylene	Tetra- chloro- ethylene	1,1,1- Trichloro- ethane		
Sharkeys WS6	13.0	3.0	..	132.0	11/85
Sharkeys WS7	3.0	..	3.0	11/85z
Sharkeys WS8	2.0	..	..	3.0	..	5.0	11/85z
Sharkeys WS9	3.0	..	190.0	11/85
Sharkeys WS11	421.0	11/85
Sharkeys WS12	1.0	..	251.0	11/85
Sharkeys WS13	2.0	..	..	..	..	127.0	11/85z
Sharkeys WS14	16.0	11/85z
Sharkeys WS17	10.0	11/85z
OUTSIDE EAST HANOVER							
Standard Optical MW1	..	170.0	2600.0	..	37.0	2823.0	1986e
Standard Optical MW2	..	38.0	190.0	6.3	230.0	478.0	1986e
Warren Conn. MW1	..	18.0	100.0	840.0	21.0	879.0	9/17/86e
Warren Conn. MW4	..	17.0	110.0	850.0	23.0	1000.0	9/17/86e
Warren Conn. MW3	8.6	530.0	96.0	638.0	9/17/86e
Warren Conn. MW2	15.0	..	15.0	9/17/86e
Tricounty Asph. MW1	BMDL	11/25/86 ⁺
Tricounty Asph. MW2	5480.0	5993.0	11/25/86 ⁺
Tricounty Asph. MW3	..	4.6	1.3	..	62.0	194.1	11/25/86 ⁺
Rowe Int. W-4	..	250.0	..	..	..	276.0	12/8/86h
Rowe Int. A-5	2900.0	..	..	2900.0	1987h

APPENDIX 4. - Available Records of East Hanover Wells*
 Water-Yielding Material: Sd, stratified drift; Ba, basalt; Ss, sandstone; Sh, shale; Fi, fill
 Type of Well: Dom, domestic; Obs, observation; Prod, production; Mon, monitoring
 Others: msl, mean sea level; N/A, not available; (), exact address unknown

Well No.	Location	Owner or Tenant	Year completed	Altitude above msl (feet)	Depth below land (feet)	Diameter (inches)	Casing set from-to (feet)	Depth to bed-rock (feet)	Water-Yielding Material	Type of Well	Static Water Level (feet)	Date of Measurement	Duration of Test (hrs)	Draw-down (feet)
WESTERN SECTION:														
1	107 Troy	Wolff	1965	-	65	6	N/A	-	Sd	Dom	20	12/65	4	7
2	43 Troy	Edell	1965	-	116	6	N/A	100	Ss	Dom	32	11/65	4	3
3	() Troy	Varian	1957	287	51	6	N/A	-	Sd	Dom	15	10/57	2	30
4	() Troy	Cardarella	1960	264	62	6	N/A	-	Sd	Dom	39	8/60	6	55
5	98 Troy	Guilliano	1966	178	51	7	N/A	-	Sd	Dom	8	7/66	2.5	15
6	14 Troy	Bellush	1962	-	79	6	N/A	-	Sd	Dom	7	5/62	6	3
7	130 Troy	Gaudert	1964	-	130	6	N/A	130	Sd	Dom	10	10/64	4	80
8	21 Grant	Bauk	1964	240	193	6	N/A	132	Sh	Dom	99	4/64	4	160
9	19 Grant	Bauk	1962	204	80	6	N/A	-	Sd	Dom	37	1/62	2	65
10	41 Grant	Cerra	1958	-	90	6	N/A	-	Sd	Dom	65	8/58	4	10
11	307 Ridgedale	Hicks	1966	-	150	6	N/A	90	Ss	Dom	60	11/66	6	30
12	267 Ridgedale	Regn	1965	-	75	6	N/A	-	Sd	Dom	30	6/64	4	10
13	268 Ridgedale	Calcugraph	1959	-	106	8	0-96	106	Sd	Prod	21	8/59	8	53
14	286 Ridgedale	Bronner Tool	1961	200	109	6	N/A	-	Sd	Prod	50	5/61	5	5
15	268 Ridgedale	Bronner 1	1986	206	63	4	0-23	-	Sd	Mon	36	7/86	-	-
16	268 Ridgedale	Bronner 2	1986	196	62	4	0-12	-	Sd	Mon	31	7/86	-	-
17	268 Ridgedale	Bronner 3	1986	205	72	4	0-22	-	Sd	Mon	40.5	7/86	-	-
18	268 Ridgedale	Bronner 4	1986	201	65	4	0-20	-	Sd	Mon	36.5	7/86	-	-
19	268 Ridgedale	Bronner 5	1986	201	63	4	0-20	-	Sd	Mon	55	7/86	-	-

* Well records available at the Division of Water Resources, Bureau of Water Allocation and the New Jersey Geological Survey, Bureau of Ground Water Pollution Analysis, Trenton. Well locations shown on figure 6.

Appendix 4 (cont.)

Well No.	Location	Owner or Tenant	Year completed	Altitude above msl (feet)	Depth below land (feet)	Diameter (inches)	Casing set from-to (feet)	Depth to bed-rock (feet)	Water-Yielding Material	Type of Well	Static Water Level (feet)	Date of Measurement	Duration of Test (hrs)	Draw-down (feet)
20	42 Weaver	Palmarozza	1964	210	141	6	0-105	90	Sh	Don	39	10/64	4.5	80
21	40 Weaver	Palmarozza	1962	-	117	6	N/A	-	Sd	Don	10	7/62	4	5
22	47 Weaver	Prospero	1963	210	50	6	N/A	-	Sd	Don	10	6/63	3	0
23	Weaver	USGS	1966	-	125	6	0-94	120	Sd	Obs	8	12/66	48	11
24	41 Ward	Sylvester	1963	190	53	6	N/A	-	Sd	Don	27	11/63	4	1
25	() Ward	Woodward	1963	-	140	6	0-125	140	Sd	Don	17	9/63	4	6
26	31 Ward	Bystrak	1964	-	61	6	N/A	-	Sd	Don	30	11/64	4	10
27	27 Ward	Bystrak	1964	-	64	6	N/A	-	Sd	Don	40	10/64	4	-
28	23 Callahan	Sylvester	1965	176	97	6	N/A	-	Sd	Don	4	8/65	2	25
29	35 Grove	Allen	1966	-	125	6	N/A	-	Sd	Don	25	11/66	4	5
30	12 Casey	Farrell	1962	-	120	6	N/A	-	Sd	Don	20	11/63	4	15
31	137 McKinley	Schnauffel	1962	-	88	6	N/A	-	Sd	Don	55	12/62	4	-
32	176 McKinley	Rose	1960	264	51	6	N/A	-	Sd	Don	38	4/60	3	40
33	11 Garfield	Bauk	1966	190	157	6	0-102	103	Sh	Don	52	10/66	10	100
34	14 School	Ross	1959	-	230	6	0-150	150	Ss	Don	70	8/59	6	30
35	() School	Ojala	1960	-	115	6	N/A	-	Sd	Don	65	1/60	4	20
36	8 Hoover	McPhail	1959	-	73	6	0-53	80	Sd	Don	15	7/59	4	10
37	() Deforest	Little	1962	-	173	6	0-90	90	Ss	Don	64	12/62	4	1
38	Valley	EHanover Twp	1985	-	110	20	0-75	-	Sd	Mun	46.35	2/85	72	37
39	20 Deforest	F.Wheeler	1986	222	67	4	0-47	-	Sd	Mon	49	8/86	-	-
40	20 Deforest	ChemCom 1	1986	-	70	4	0-42	-	Sd	Mon	-	-	-	-
41	20 Deforest	ChemCom 2	1986	-	71	4	0-51	-	Sd	Mon	-	-	-	-

Appendix 4 (cont.)

Well No.	Location	Owner or Tenant	Year completed	Altitude above msl (feet)	Depth below land (feet)	Diameter (inches)	Casing set from-to (feet)	Depth to bed-rock (feet)	Water-Yielding Material	Type of Well	Static Water Level (feet)	Date of Measurement	Duration of Test (hrs)	Draw-down (feet)
42	20 Deforest	ChenCom 3	1986	-	55	4	0-35	-	Sd	Mon	-	-	-	-
43	20 Deforest	ChenCom 4	1986	-	60	4	0-40	-	Sd	Mon	-	-	-	-
44	20 Deforest	ChenCom 5	1986	-	60	4	0-40	-	Sd	Mon	-	-	-	-
45	20 Deforest	ChenCom 6	1986	-	60	4	0-40	-	Sd	Mon	-	-	-	-
46	20 Deforest	ChenCom 7	1986	-	60	4	0-40	-	Sd	Mon	-	-	-	-
46	20 Deforest	ChenCom 8	1986	-	126	6	0-95	91	Sh	Mon	-	-	-	-
47	20 Deforest	ChenCom 9	1986	-	113	6	0-87	77	Sh	Mon	-	-	-	-
48	20 Deforest	ChenCom 10	1986	-	125	6	0-97	91	Sh	Mon	-	-	-	-
49	35 West	EllBee 1	1985	-	92	4	0-72	92	Sd	Mon	66.5	8/85	-	-
50	35 West	EllBee 2	1985	-	85	4	0-65	-	Sd	Mon	66.2	8/85	-	-
51	35 West	EllBee 3	1985	-	75	4	0-55	75	Sd	Mon	60	8/85	-	-
52	35 West	EllBee 4	1985	-	76	4	0-56	75	Sd	Mon	62.7	8/85	-	-
EASTERN SECTION:														
53	7 Christine	LaPorta	1961	-	86	6	N/A	-	Sd	Dom	50	6/61	4	5
54	17 Christine	Bauk	1961	224	100	6	N/A	-	Sd	Dom	52	11/61	4	68
55	324 River	Dixon	1965	-	185	6	0-147	147	Ss	Dom	35	3/65	4	65
56	391 River	Petry	1962	-	178	6	0-135	135	Ss	Dom	39	11/62	4	3
57	124 River	Fiesser	1962	-	150	6	0-55	55	Ss	Dom	20	8/62	4	45
58	96 River	Matarazzo	1963	-	130	6	0-60	60	Ss	Dom	20	6/63	5	60
59	107 River	Monther	1966	-	135	6	0-73	65	Sh	Dom	25	8/66	4	5
60	188 River	Durham	1959	-	147	6	0-66	66	Ss	Dom	12	6/59	6	23
61	() River	Courter	1957	287	140	6	0-110	110	Sh	Dom	35	12/57	3	5

Appendix 4 (cont.)

Well Location No.	Owner or Tenant	Year completed	Altitude above msl (feet)	Depth below land (feet)	Diameter (inches)	Casing set from-to (feet)	Depth to bed-rock (feet)	Water-Yielding Material	Type of Well	Static Water Level (feet)	Date of Measurement	Duration of Test (hrs)	Draw-down (feet)	
62	() River	Vitale	1957	200	162	6	0-108	108	Ss	Dom	30	4/57	6	40
63	261 River	Ressdorf	1960	-	160	6	0-106	106	Ss	Dom	45	8/60	4	35
64	48 Lincoln	Dorne	1965	-	70	6	N/A	-	Sd	Dom	24	7/65	4	18
65	() Lincoln	Harding	1964	-	43	6	N/A	-	Sd	Dom	18	8/64	4	7
66	() Merry	Gaessle	1960	236	121	6	N/A	-	Sd	Dom	6	2/60	4	5
67	Merry Lane	RoyalLube1	1982	-	50	10	N/A	-	Sd	Mon	35	9/82	-	-
68	Merry Lane	RoyalLube2	1982	-	54	10	N/A	-	Sd	Mon	37	9/82	-	-
69	Merry Lane	RoyalLube3	1982	-	55	10	N/A	-	Sd	Mon	37	9/82	-	-
70	Merry Lane	RoyalLube4	1982	-	51	10	N/A	-	Sd	Mon	37	9/82	-	-
71	Merry Lane	RoyalLube5	1982	-	52	10	N/A	-	Sd	Mon	52	9/82	-	-
72	Merry Lane	RoyalLube6	1982	-	55	10	N/A	-	Sd	Mon	36	9/82	-	-
73	Merry Lane	RoyalLube7	1982	-	61	10	N/A	-	Sd	Mon	47	9/82	-	-
74	Merry Lane	RoyalLube8	1982	-	63	10	N/A	-	Sd	Mon	47	9/82	-	-
75	Merry Lane	Dorine 4	1982	-	32	12	0-26	-	Sd	Mon	32	8/82	-	-
76	Merry Lane	Dorine 2	1982	-	55	12	0-49	-	Sd	Mon	30	8/82	-	-
77	Merry Lane	Dorine 1	1982	-	55	12	0-49	-	Sd	Mon	30	8/82	-	-
78	Merry Lane	Dorine 3	1982	-	46	12	0-40	-	Sd	Mon	35	8/82	-	-
79	Merry Lane	Fritzsche DO	1975	-	610	8	0-140	134	Sh	Prod	30	5/75	8	215
80	Merry Lane	Fritzsche DO	1968	-	643	8	0-121	120	Sh	Prod	16	5/68	8	234
81	Merry Lane	Fritzsche DO	1969	300	533	8	0-136	133	Sh	Prod	27	4/69	24	105
82	Merry Lane	WeissAug 1	1982	-	52	4	0-32	-	Sd	Mon	45.5	10/82	-	-
83	Merry Lane	WeissAug 2	1982	-	57.5	4	0-37.5	-	Sd	Mon	45.3	10/82	-	-
84	Merry Lane	WeissAug 3	1982	-	58	4	0-38	-	Sd	Mon	45.2	10/82	-	-

Appendix 4 (cont.)

Well No.	Location	Owner or Tenant	Year completed	Altitude above msl (feet)	Depth below land (feet)	Diameter (inches)	Casing set from-to (feet)	Depth to bed-rock (feet)	Water-Yielding Material	Type of Well	Static Water Level (feet)	Date of Measurement	Duration of Test (hrs)	Draw-down (feet)
NORTHERN SECTION:														
85	48 Harvest	Barisciano	1967	-	94	6	N/A	-	Sd	Dom	1	6/67	4	11
86	41 Homestead	Schneider	1962	180	43	6	N/A	-	Sd	Dom	6	8/62	2	15
87	() Homestead	Czarnecki	1959	-	60	6	N/A	-	Sd	Dom	18	9/59	2	30
88	7 Homestead	Pentland	1966	-	62	6	N/A	-	Sd	Dom	30	8/66	4	10
89	Homestead	USGS	1967	-	125	6	0-62	118	Sd	Obs	1	1/67	48	22
90	6 Homestead	Rittweger	1962	-	119	6	N/A	-	Sd	Dom	16	12/62	4	6
91	13 Eagle Rock	Sherman	1961	220	59	6	N/A	-	Sd	Dom	18	9/61	3	50
92	68 Eagle Rock	Rello	1961	180	83	8	0-41	37	Ba	Dom	2.5	2/60	6	65
93	621 Ridgedale	Esposito	1963	-	70	6	N/A	-	Sd	Dom	16	10/62	6	6
94	50 Cedar	Minier	1961	-	68	6	N/A	-	Sd	Dom	40	8/61	4	13
95	() Cedar	Villone	1961	225	82	6	N/A	-	Sd	Dom	42	4/61	2	9
96	() Cedar	Swet	1958	264	85	6	N/A	-	Sd	Dom	41	10/58	3	5
97	() Cedar	Glutting	1959	264	110	6	N/A	-	Sd	Dom	65	10/59	2.5	80
99	120 Cedar	Milchus	1967	-	61	6	N/A	-	Sd	Dom	45	9/66	4	5
100	100 Cedar	Young	1968	-	78	6	N/A	-	Sd	Dom	45	6/68	4	15
101	12W. Ridgedale	Malakov	1965	180	55	6	N/A	-	Sd	Dom	17	12/65	3.5	25
102	8 Tuttle	Nelson	1963	-	68	6	0-50	-	Sd	Dom	12	10/63	4	25
103	13 Tuttle	Knapp	1963	-	65	6	0-50	-	Sd	Dom	28	9/63	6	1
104	9 Tuttle	Algeier	1958	-	130	6	0-52	52	Ba	Dom	25	5/58	4	75
105	8 Klinger	Peters	1965	-	85	6	N/A	-	Sd	Dom	20	3/65	4	27
106	147 Overlook	Quarte	1964	200	110	6	0-72	67	Ba	Dom	12	9/64	14	90

Appendix 4 (cont.)

Well No.	Location	Owner or Tenant	Year completed	Altitude above msl (feet)	Depth below land (feet)	Diameter (inches)	Casing set from-to (feet)	Depth to bed-rock (feet)	Water-Yielding Material	Type of Well	Static Water Level (feet)	Date of Measurement	Duration of Test (hrs)	Draw-down (feet)
107	() Overlook	Bertolo	1955	230	101	6	0-90	91	Sh	Dom	35	6/58	2	35
108	Overlook	USGS	1965	-	119	6	0-115	112	Sd	Dom	-	-	-	-
110	72 Overlook	Giarobbe	1965	-	52	6	N/A	-	Sd	Dom	20	5/65	4	10
111	91 Overlook	Yanuzzi	1965	-	157	6	0-113	113	Sh	Dom	15	4/63	6	25
112	22 Overlook	MacQuade	1961	-	107	6	N/A	-	Sd	Dom	24	8/61	4	10
113	5 Overlook	Bensen	1962	240	148	6	0-98	95	Sh	Dom	11	4/62	4	60
114	Overlook/Riv	Leonardo	1964	200	185	6	0-59	59	Ba	Dom	11	9/64	8	90
115	21 Brace	Froysland	1961	-	86	6	N/A	-	Sd	Dom	9	9/61	4	55
116	() Brace	Olander	1961	280	147	6	N/A	-	Sd	Dom	60	5/61	4	8
117	9 Robert	Zito	1965	178	105	6	0-71	66	Sd	Dom	27	10/65	12	38
118	8 Eberhardt	Cantalupo	1965	-	95	6	N/A	-	Sd	Dom	25	7/65	4	32
119	71 Eberhardt	Olsen	1961	204	77	6	N/A	-	Sd	Dom	47	3/61	4	55
120	28 Eberhardt	Johannessen	1961	224	135	6	N/A	-	Sd	Dom	49	5/61	5	60
121	31 Eberhardt	Olsen	1959	240	92	6	N/A	-	Sd	Dom	50	4/59	4	85
122	9 Highview	Accentura	1961	190	103	6	0-88	85	Sh	Dom	3	5/61	4	25
123	3 Highview	Accetturo	1955	-	110	6	0-80	80	Ss	Dom	1	5/58	6	24
124		Sharkeys WS1	1985	172	18	4	0-6	-	Sd	Mon	8	10/85	-	-
125		Sharkeys WD2	1985	172	73.5	4	0-55.5	103.4	Sd	Mon	8	10/85	-	-
126		Sharkeys WS2	1985	172.4	27	4	0-15	-	Sd	Mon	9	10/85	-	-
127		Sharkeys WS3	1985	171.5	15	4	0-5	-	Sd	Mon	11.5	10/85	-	-
128		Sharkeys WI3	1985	171.02	67	4	0-54	-	Sd	Mon	6	10/85	-	-

Appendix 4 (cont.)

Well Location No.	Owner or Tenant	Year completed	Altitude above msl (feet)	Depth below land (feet)	Diameter (inches)	Casing set from-to (feet)	Depth to bed-rock (feet)	Water-Yielding Material	Type of Well	Static Water Level (feet)	Date of Measurement	Duration of Test (hrs)	Draw-down (feet)	
129	Sharkeys	WD3 1985	171.42	98	4	0-84	96	Sd	Mon	9	10/85	-	-	
130	Sharkeys	WS4 1985	173.63	17	4	0-5	-	Sd	Mon	8.5	10/85	-	-	
131	Sharkeys	WI4 1985	173.83	62	4	0-50	-	Sd	Mon	7	10/85	-	-	
132	Sharkeys	WS5 1985	181.98	30	4	0-18	-	Sd	Mon	13.5	10/85	-	-	
133	Sharkeys	WI5 1985	181.77	104	4	0-88	-	Sd	Mon	15	10/85	-	-	
134	Sharkeys	WS6 1985	182.31	25	4	0-12	-	Sd	Mon	14	10/85	-	-	
135	Sharkeys	WI6 1985	182.24	76	4	0-64	-	Sd	Mon	15	10/85	-	-	
136	Sharkeys	WS7 1985	174.54	23	4	0-12	-	Sd	Mon	5	10/85	-	-	
137	Sharkeys	WI7 1985	174.65	74	4	0-59	-	Sd	Mon	9	10/85	-	-	
138	Sharkeys	WS8 1985	176.15	24	4	0-13	-	Sd	Mon	8.5	10/85	-	-	
139	Sharkeys	WI8 1985	175.62	80	4	0-65	-	Sd	Mon	8.5	10/85	-	-	
140	Sharkeys	WS9 1985	193.60	52	4	0-32	-	Sd	Mon	27	10/85	-	-	
141	Sharkeys	WI10 1985	177.81	76	4	0-64	-	Sd	Mon	11.5	10/85	-	-	
142	Sharkeys	WS11 1985	225.77	70	4	0-58	-	Fi	Mon	58	10/85	-	-	
143	Sharkeys	WS12 1985	197.03	46	4	0-33.4	-	Fi	Mon	33	10/85	-	-	
144	Sharkeys	WS13 1985	182.01	32	4	0-19.5	-	Sd	Mon	18	10/85	-	-	
145	Sharkeys	WS14 1985	172.64	18	4	0-7	-	Sd	Mon	8	10/85	-	-	
146	Sharkeys	WI15 1985	169.02	55	4	0-39	50	Sd	Mon	3	10/85	-	-	
147	Sharkeys	WI16 1985	169.33	76	4	0-59.5	-	Sd	Mon	3	10/85	-	-	
148	Sharkeys	WS17 1985	174.97	22	4	0-8.4	-	Sd	Mon	9	10/85	-	-	
SOUTHERN SECTION:														
149	13 Emanuel	Wood	1962	-	80	6	0-70	-	Sd	Don	18	10/62	3	30

Appendix 4 (cont.)

Well No.	Location	Owner or Tenant	Year completed	Altitude above msl (feet)	Depth below land (feet)	Diameter (inches)	Casing set from-to (feet)	Depth to bed-rock (feet)	Water-Yielding Material	Type of Well	Static Water Level (feet)	Date of Measurement	Duration of Test (hrs)	Draw-down (feet)
150	() Emmanuel	Morgan	1960	-	60	6	N/A	-	Sd	Dom	12	7/60	3	30
151	26 Emmanuel	Welch	1963	-	100	6	0-50	50	Sh	Dom	16	7/63	3	60
152	() Emmanuel	Hunkele	1962	-	93	6	0-63	93	Sd	Dom	9	6/62	3	90
153	Emmanuel	Calontuoni	1963	-	88	6	0-70	70	Sh	Dom	18	11/63	4	60
154	11 Fairview	Domorski	1960	-	175	6	N/A	88	Sh	Dom	55	6/60	4	35
155	2 Gr. Meadow	Captrim	1969	-	42	6	N/A	-	Sd	Dom	10	8/69	4	12
156	33 MtPleasant	Davy	1962	-	118	6	0-65	-	Sd	Dom	29	11/62	4	21
157	157MtPleasant	Piccola	1965	-	150	6	0-65	65	Ss	Dom	25	10/65	4	10
158	208MtPleasant	MacDonald	1964	-	100	6	0-45	40	Ss	Dom	5	5/63	4	10
159	156MtPleasant	Elsesser	1963	-	142	6	0-63	63	Sh	Dom	15	4/63	4	10
160	()MtPleasant	Sorg	1958	-	130	6	0-67	67	Ss	Dom	20	12/58	4	15
161	()MtPleasant	Wild	1960	-	170	6	0-96	96	Ss	Dom	52	1/60	4	6
162	()MtPleasant	Stoll	1961	-	167	6	0-84	84	Ss	Dom	20	10/61	4	25
163	OldMtPleasant	Whaites	1959	-	159	6	0-75	75	Ss	Dom	35	2/59	4	14
164	8 Colonia	Leon	1963	196	148	6	0-108	80	Sh	Dom	40	6/63	3	5
165	7 Colonia	Wuetrich	1963	196	141	6	0-95	80	Sh	Dom	38	6/63	4	20
166	6 Parkside	Wuetrich	1963	190	168	6	0-111	-	Sh	Dom	41	6/63	2	17
167	5 Parkside	Boetsen	1963	196	87	6	N/A	-	Sd	Dom	42	5/63	2	5
168	4 Parkside	Wuetrich	1963	196	143	6	0-97	46	Ss	Dom	40	6/63	5	13
169	10 Ridgedale	World Homes	1963	190	56	6	N/A	-	Sd	Dom	8	10/63	3	25
170	30 Park	Jocher	1964	-	170	6	0-123	123	Ss	Dom	50	4/63	4	50
171	27 Park	Roskosz	1963	-	175	6	0-126	126	Ss	Dom	50	8/63	4	55

Appendix 4 (cont.)

Well No.	Location	Owner or Tenant	Year completed	Altitude above msl (feet)	Depth below land (feet)	Diameter (inches)	Casing set from-to (feet)	Depth to bed-rock (feet)	Water-Yielding Material	Type of Well	Static Water Level (feet)	Date of Measurement	Duration of Test (hrs)	Draw-down (feet)
172	() Park	Greenhalgh	1963	-	190	6	0-127	127	Sb	Dom	53	10/63	4	52
173	360 River	Shiells	1963	-	235	6	0-205	205	Ss	Dom	90	7/63	4	75
174	232 Rte 10	Atwell	1963	-	135	6	0-90	90	Ss	Dom	35	9/63	4	20
175	306 Columbia	Amex Metals	1984	-	35	4	0-20	-	Sd	Prod	20	8/84	-	-
176	Melanie	Twp EHanover	1966	-	130	8	0-110	-	Sd	Mun	10	5/66	6	53
177	Melanie	Twp EHanover	1967	-	115	12	0-85	125	Sd	Mun	12	3/67	48	33
178	Rte. 10	Sandoz	1966	-	101	6	0-91	101	Sd	Prod	33	1/66	8	8
179	Rte. 10	USGS	1966	-	113	6	0-103	135	Sd	Obs	20	12/66	48	8
180	Rte. 10	Norda	1984	208.82	72	4	0-50	-	Sd	Mon	49	11/84	-	-
181	Rte. 10	Norda	1984	216.37	67	4	0-55	-	Sd	Mon	57	11/84	-	-
182	Rte. 10	Norda	1984	200.61	47	4	0-25	-	Sd	Mon	40.85	11/84	-	-
183	Rte. 10	Norda	1984	203.89	62	4	0-40	-	Sd	Mon	44.53	11/84	-	-
184	Rte. 10	Norda	1984	199.84	57	4	0-35	-	Sd	Mon	39.68	11/84	-	-
185	Ridgedale	Sandoz	1966	-	84	12	0-68	84	Sd	Prod	34	8/66	8	12
186	Ridgedale	Sandoz	1966	-	132	12	0-112	-	Sd	Prod	26	10/66	8	6
187	393 Rte 10	Buttinghous	1962	-	100	6	0-60	-	Sd	Dom	8	5/63	4	-
188	Rte 10	Two Guys	1962	-	70	10	0-55	-	Sd	Prod	29	8/62	48	6
189	Rte 10	Brick Church	1959	-	157	6	0-78	-	Sd	Dom	50	4/59	4	20
190	Williams Py	Ther'sion 1	1984	-	48.5	3	0-33.5	-	Sd	Mon	39.5	8/84	-	-
191	Williams Py	Ther'sion 2	1984	-	48	3	0-33	-	Sd	Mon	38	8/84	-	-

