

**Public Health Assessment**

**Ciba-Geigy Corporation**  
**CERCLIS Number: NJD001502517**

Dover Township, Ocean County, New Jersey

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Prepared by:

Hazardous Site Health Evaluation Program  
Consumer and Environmental Health Services  
Division of Epidemiology, Environmental and Occupational Health  
New Jersey Department of Health and Senior Services

Under a Cooperative Agreement with:  
The Agency for Toxic Substances and Disease Registry



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## **Abbreviations**

ATSDR	Agency for Toxic Substances and Disease Registry
CACCCC	Citizens' Action Committee on Childhood Cancer Cluster
CGC	Ciba-Geigy Corporation
CREG	Cancer Risk Evaluation Guideline
CV	Comparison Value
EMEG	Environmental Media Evaluation Guide
ESD	Explanation of Significant Differences
FS	Feasibility Study
HSL	Hazardous Substance List
LTHA	Longer-term Health Advisory
MCL	Maximum Contaminant Level
MRL	Minimal Risk Level
ND	Not Detected
NJDEP	New Jersey Department of Environmental Protection
NJDHSS	New Jersey Department of Health and Senior Services
NPL	National Priorities List
NTC	Non-target compound
PCE	Perchloroethylene (tetrachloroethylene)
PHA	Public Health Assessment
PHAP	Public Health Action Plan
PHRP	Public Health Response Plan
PRAP	Proposed Remedial Action Plan
RfD	Reference Dose
RI	Remedial Investigation
RMEG	Reference Dose Media Evaluation Guide
ROD	Record of Decision
SVOC	Semi-volatile organic chemical
TCE	Trichloroethylene
TIC	Tentatively identified compound
TRI	Toxic Release Inventory
TRWC	Toms River Water Company
USEPA	United States Environmental Protection Agency
VOC	Volatile organic chemical

## **Summary**

In response to concerns of the Dover Township community regarding an increased incidence of childhood cancers, the Agency for Toxic Substances and Disease Registry (ATSDR) and the New Jersey Department of Health and Senior Services (NJDHSS) developed a Public Health Response Plan to organize and conduct public health investigations. In addition to evaluating the chemical and radiological quality of the community water supply and analyzing New Jersey State Cancer Registry statistics, the NJDHSS and ATSDR initiated two Public Health Assessments for two National Priorities List (NPL) sites which are located in Dover Township: the Ciba-Geigy Corporation site (CERCLIS #NJD001502517) and the Reich Farm site (CERCLIS #NJD980529713). Based upon information collected by the NJDHSS and the ATSDR during health assessment activities for the Reich Farm site, and a high level of community concern, the NJDHSS and the ATSDR also conducted a Public Health Assessment to evaluate the public health issues associated with the Dover Township Municipal Landfill (CERCLIS #NJD980771570). The Public Health Assessments provide a review of environmental health issues and evaluate past and current human exposure pathways associated with these sites.

The Ciba-Geigy Corporation (CGC) NPL site is located in Dover Township, New Jersey. The site is surrounded by residential and light commercial areas. A chemical manufacturing plant (the Toms River Plant) occupied the site beginning in 1952. Solid and liquid wastes, including by-products from chemical (primarily dye and epoxy resin) manufacturing processes and wastewater treatment sludge, were disposed of in approximately 20 on-site areas. Contaminants, including volatile organic chemicals (VOCs), semivolatile organic chemicals (SVOCs), polycyclic aromatic hydrocarbons (PAHs), anthraquinone and azo dyes, and heavy metals (including arsenic, cadmium, chromium, mercury and lead) have been identified as being present in on-site source areas. During the period 1952 through 1966, treated process wastewater was discharged directly to the Toms River.

Groundwater in the vicinity of the CGC site has been contaminated with a variety of VOCs (chlorobenzene, chloroform, dichlorobenzenes, trichlorobenzenes, methylene chloride, trichloroethylene, trichloropropane, and tetrachloroethylene), metals (lead and mercury) and possibly other chemicals. Private residential wells used for irrigation near the CGC site were found to be contaminated with VOCs in the mid-1980s. Community water system supply wells at the Holly Street well field were documented to be contaminated with dyes, nitrobenzene, and possibly other compounds during the mid-1960s. Contaminated groundwater beneath the CGC site is being pumped out, treated, and returned to the aquifer by the Groundwater Extraction and Recharge System, which has been operational since 1996. A smaller scale pump-and-treat system had been in place since 1985. Plans for remediation of on-site source areas have been developed by the U.S. Environmental Protection Agency (USEPA).

The Ciba-Geigy Corporation site is considered by the ATSDR and the NJDHSS to have represented a **public health hazard because of past exposures**. This determination is based upon the following considerations, taken together: 1) the presence of a completed exposure pathway in the past through the community water supply to dyes and possibly other chemicals, to a potentially large population; 2) the presence of a completed exposure pathway through the use of private wells (for irrigation and possibly for potable use at some time in the past) in the Cardinal Drive/Oak Ridge Parkway to VOCs; 3) toxicological evaluations; 4) epidemiologic studies from other communities and workplaces suggesting that exposure to dyes and VOCs may increase the risk of certain cancers and other adverse health outcomes; and 5) the presence of an excess of childhood cancers in the community.

Current conditions indicate that although groundwater remains contaminated at levels of public health concern, completed human exposure pathways to contaminants from the CGC site have been interrupted. The exposure pathway associated with the community water supply wells of the Holly Street Well field was reduced and/or interrupted through the construction of an outfall pipeline to re-direct wastewater from the Toms River to the Atlantic Ocean. The exposure pathway associated with private wells in the Cardinal Drive/Oak Ridge Parkway areas has been interrupted through well sealing and limits on well construction. For these reasons the ATSDR and the NJDHSS have concluded that currently there are no documented completed human exposure pathways associated with the CGC site, and thus, are categorizing the CGC site as representing **no apparent public health hazard** under present conditions. However, because on-site source areas remain contaminated, remediation of these on-site source areas is essential to prevent further contamination of groundwater and the potential for future human exposure pathways to site-related contaminants.

Other potential exposure pathways in the past include inhalation of air contaminants from on-site manufacturing and waste disposal activities. With the closure of operations at the Toms River Plant in 1996, this air pathway is interrupted. In addition, site security measures have likely interrupted the potential for exposure of trespassers to on-site contaminated soils. Human exposure to contaminants in soils, sediments and surface waters in the marshland areas adjacent to the Toms River is unlikely. There is no evidence that breaks in the outfall pipeline have resulted in human exposure to CGC-related contaminants through contaminated soils, sediments or groundwater.

Although uncertainties in exposure and toxicological information make the assessment of public health implications difficult, further epidemiologic evaluation is warranted in order to evaluate the public health significance of past exposures from the site. The NJDHSS and the ATSDR are conducting an epidemiologic study of childhood cancer in Dover Township. This Public Health Assessment supports the consideration of exposure pathways related to the Ciba-Geigy Corporation site in that study.

The Public Health Assessment for the Ciba-Geigy Corporation site was released for public comment during the period February 29 to April 28, 2000. A summary of the comments received and the responses of the NJDHSS and the ATSDR are provided in Appendix E.

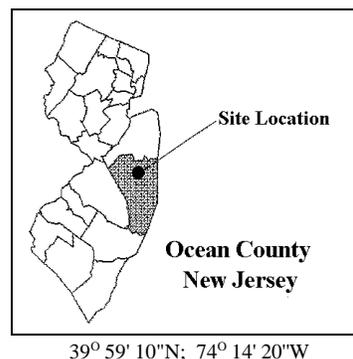
## Purpose and Health Issues

As part of the Public Health Response Plan (PHRP) developed by the New Jersey Department of Health and Senior Services (NJDHSS) and the Agency for Toxic Substances and Disease Registry (ATSDR) for the Dover Township Childhood Cancer Investigation (NJDOH and ATSDR, 1996), this Public Health Assessment will document and evaluate the public health significance of human exposure pathways associated with the Ciba-Geigy Corporation site.

## Background

### Demography and Land Use

The Ciba-Geigy Corporation (CGC) site (CERCLIS #NJ001502517) is located near State Route 37 in the West Dover section of Dover Township (Ocean County), New Jersey, approximately 1 mile west of the Garden State Parkway/U.S. Route 9, and 3 miles west of the business district of the Toms River section of Dover Township (see inset and Figure 1). The Toms River forms the northeastern boundary of the site. Winding River Park, an outdoor recreational area located within the flood plain of the Toms River, adjoins the site on the east and northeast. To the east of the Toms River is the Coulter Street/Whitesville Road residential area. The Cardinal Drive/Oak Ridge Parkway residential area adjoins the southeast border of the site along the west bank of the Toms River. A residential area, Pine Lake Park Estates (Manchester Township), borders the northwestern boundary of the site. Additional residential and commercial properties border the site on the south and southwest along State Route 37 (NUS, 1988a; CDM, 1993a). An elementary school (West Dover) is located near the southeast corner of the site.



The Ciba-Geigy Corporation (formerly Toms River Chemical Company, and now renamed Ciba Specialty Chemicals, a division of Novartis Corporation) owned and operated a chemical manufacturing plant (the Toms River Plant) on the property beginning in 1952. The property consists of approximately 1,400 acres, of which 320 acres are developed. The site boundaries encompass 1,359 acres. Approximately 43 acres (previously known as Tract 2), located east of the main site along Oak Ridge Parkway, were donated to Dover Township in 1959, and now comprise Winding River Park, a public recreation area. The former production area, wastewater treatment plant, power plant, and administrative buildings occupy approximately 100 acres. Various disposal areas and a landfill encompass approximately 220 acres. The remaining approximately 1,000 acres are undeveloped pine forest and wetlands. The entire CGC site is fenced, with controlled entrances from

Oak Ridge Parkway on the east and from State Route 37 on the west (NUS, 1988a; CDM, 1993a).

The Kirkwood-Cohansey geologic formation underlies the CGC site. There are several aquifer elements within this formation beneath the site (Figure 5), grouped into the Upper Sand (including the Upper Cohansey, Primary Cohansey, Lower Cohansey, Upper Kirkwood, and Kirkwood No. 1) and Lower Sand (including Kirkwood No. 2) Aquifers. The groundwater is acidic, and contains relatively high concentrations of dissolved iron and manganese. At the CGC site, groundwater in the Upper Sand Aquifer flows in a southeasterly direction towards, and discharges into, the Toms River. Groundwater in the Lower Sand Aquifer also flows southeasterly beneath the site, but apparently does not discharge to the Toms River (NUS, 1988a; CDM, 1993a). Within Dover Township, the Kirkwood-Cohansey aquifer is used extensively as a source of potable and irrigation water.

Population demographics based upon the 1990 census have been prepared by the ATSDR using area-proportion spatial analysis, and are presented in Figure 2. Within a one mile radius of the Ciba-Geigy site, there is a population of approximately 10,725 persons. There are approximately 4,300 private residences within this area.

### **Site History**

Beginning in 1952, the Toms River Plant initially produced anthraquinone-based dyes and intermediate products. Starting in 1959, the plant also manufactured azo dyes and intermediates, epoxy resins, and other specialty chemicals (NUS, 1988a; Delzell et al, 1989). During peak operations, the facility had a daily production capacity of about 220,000 pounds of dyestuff and intermediates, and about 105,000 pounds of epoxy resins (NUS, 1988a). Production of anthraquinone-based dyes ended in 1983, and azo dye production ended in 1988; epoxy resin manufacturing ended in 1990. Manufacturing operations at the plant ceased as of the end of 1996 when dye standardization activities were terminated.

The manufacturing processes (estimated to be as many as 600 over the years) generated liquid and solid wastes. According to the U.S. Environmental Protection Agency (USEPA), from about 1952 through 1977, solid and liquid process wastes were disposed of in approximately 20 known source areas. These source areas include a disposal landfill containing approximately 31,000 drums, a 12 acre filter-cake disposal area, a five acre lime sludge disposal area, a 40 acre borrow area, numerous lagoons and basins associated with former wastewater treatment plants totaling approximately 30 acres, and the production area itself (see Figure 3). Several of the disposal areas were unlined. Solid wastes, including residues from manufacturing processes, were disposed of in bulk or in drums in several of the on-site source areas. Wastewater treatment sludge was stockpiled on top of a closed cell of the landfill (NUS, 1988a; CDM, 1993a; Ciba, 1999b).

Since 1952, at least four different wastewater treatment methodologies have been utilized to remove metals, volatile organic chemicals (VOCs), and semivolatile organic chemicals (SVOCs) from

process wastes. Initially, treated wastewater was discharged directly into the Toms River. Starting in 1966, treated wastewater was discharged to the Atlantic Ocean near Ortle Beach via a 10 mile long pipeline which ran underground about 35,200 feet through mainland Dover Township, primarily along Mapletree Road and Bay Avenue. The route of the pipeline is illustrated in Figure 7. Use of the pipeline ended in 1991.

### **Summary of Previous Health Assessment Activity**

The first Public Health Assessment (PHA) for the Ciba-Geigy Corporation site was completed by ATSDR in 1988 (ATSDR, 1988a). Based on information available at the time, this assessment identified several human exposure pathways of concern: 1) oral and dermal exposure to lead in water from contaminated residential wells; 2) oral, dermal, and inhalation exposure to mercury in residential wells; 3) potential ingestion and inhalation of, and dermal exposure to, VOCs in residential wells; 4) dermal, oral, and inhalation exposure to contaminated on-site surface soils by on-site workers, clean-up personnel, or trespassers; 5) dermal, oral and inhalation exposure to contaminants in adjacent marshland sediments, surface water, and air in the vicinity of the Winding River Park; and 6) potential ingestion of garden plants irrigated with contaminated residential well water (ATSDR, 1988a).

In the 1988 ATSDR Public Health Assessment, concerns about contamination in off-site private residential wells were focused on the Cardinal Drive/Oak Ridge Parkway and the Coulter Street areas. In the Cardinal Drive/Oak Ridge Parkway area, residential wells (used for irrigation) were found to contain VOCs in the mid-1980s. In the Coulter Street area and other nearby residential areas, residential wells (used for drinking) were found to contain elevated levels of lead and/or mercury (NUS, 1988a). (At the request of the USEPA, ATSDR evaluated the levels of lead and mercury in these wells in two brief Health Consultations (ATSDR, 1988b, ATSDR, 1988c), and recommended the provision of alternate sources of potable water.) Subsequent to the 1988 PHA, the presence of lead and mercury in these wells was determined by the USEPA to be not related to the CGC site (ATSDR, 1992a).

The possibility of exposure by inhalation of airborne contaminants was also discussed in the 1988 Public Health Assessment. Analysis of ambient air (Radian, 1986; Radian, 1988) had identified several VOCs (benzene, chlorobenzene, chloroform, toluene, tetrachloroethylene, trichloroethylene, and 1,4-dioxane) in the air in the marshland areas adjacent to the Cardinal Drive/Oak Ridge Parkway vicinity. However, since the samples were taken in the marshland area, but no exposure point samples were taken, it was not possible to determine if a completed exposure pathway had existed. Sampling for airborne contaminants at nearby residences was recommended.

The first Public Health Assessment (ATSDR, 1988a) concluded that the CGC site “. . . is of public health concern because of the risk to human health caused by probable human exposure to hazardous substances at levels that may result in adverse human health effects over time.” ATSDR made several recommendations to further characterize and monitor the environmental media in the vicinity, including on-site source areas, on-site groundwater and off-site private residential wells, and

on- and off-site air.

In 1991, the ATSDR released an Addendum to the Public Health Assessment which evaluated contaminants identified in marsh sediments and the surface waters of the Toms River within Winding River Park (ATSDR, 1991a). The levels of contaminants which were considered, including VOCs, arsenic, cyanide, and the pesticides DDT and aldrin, were found to not pose a threat to public health.

A second Addendum was released by the ATSDR in 1991 which discussed tentatively identified compounds (TICs), including dye intermediates and other organic chemicals in on-site soils, which had not previously been characterized (by identity and/or concentration) as a result of limitations of the analytical procedures which had been used (ATSDR, 1991b). Since the identities of these soil contaminants had, in general, still not been determined, the ATSDR concluded that the nature of any threat to public health could not be estimated. Subsequently, many of these contaminants were identified and characterized in soils (CDM, 1993f, CDM, 1994a), but standard methods of analysis for detection of low levels of water-soluble dyes and intermediates in groundwater are not yet available.

A “Lead Initiative Summary Report” was published by ATSDR in 1992 (ATSDR, 1992a). This document revisited the issue of lead and mercury contamination of private residential wells in the Coulter Street area, and concluded that the exposure pathway to lead and mercury discussed in ATSDR’s 1988 Public Health Consultations (ATSDR 1988b; ATSDR, 1988c) was interrupted, and concurred with USEPA’s intervention actions. The ATSDR concurred with the USEPA conclusion that lead and mercury in private well samples from this area were unlikely to be related to the CGC site. A comprehensive additional Public Health Assessment was also recommended.

Additional Public Health Consultations were performed by ATSDR (ATSDR 1991a; ATSDR, 1992b; ATSDR, 1993). These consultations considered VOCs which had been identified in soils (using methods to measure VOCs in soil gas) taken in the Cardinal Drive/Oak Ridge Parkway area and in the Winding River Park. Contaminants that were identified included benzene, nitrobenzene, trichlorobenzene, toluene, vinyl chloride, xylenes, and methylene chloride (Weston, 1991). However, these data were deemed by the ATSDR to be insufficient to determine if a threat to public health existed, and consequently additional sampling in the Cardinal Drive Area was recommended by ATSDR and later conducted by the USEPA (Weston, 1993b). Most of the soil gas samples did not indicate any VOC contamination above detection limits; low levels of benzene and vinyl chloride were detected in a few samples (less than 8 parts per billion, or ppb). The ATSDR evaluated these data and determined that no public health threat existed and further sampling was not warranted (ATSDR 1993).

## **Site Visits**

As part of the activities conducted in support of this Public Health Assessment, staff of the NJDHSS and the ATSDR performed multiple visits to the CGC site and other associated locations within Dover Township during 1996, 1997, 1998, and 1999. As of December 1996, all manufacturing activities, including dye standardization, had ceased at the plant. Many of the buildings on the property have been demolished. The plant is now occupied by caretaker and remedial operations personnel. There was evidence of possible trespassing as a result of vandalism, specifically, holes had been cut in the perimeter fence.

## **Community Concerns**

Environmental contamination associated with the CGC site has resulted in a high level of community concern. Complaints regarding stack emissions and other odors associated with the plant had been lodged by the public for many years. Contamination of the surface waters of the Toms River by dyes and other chemicals was also evident in the 1950s and 1960s as a result of the practice of discharging process wastewater directly to the Toms River. An outfall pipeline which transported treated wastewater to the Atlantic Ocean was installed in 1966. However, the discharge of wastewater to the Ocean was itself controversial, and there were also complaints about leaks resulting from breaks in the pipeline during the 1980s. Use of the outfall pipeline for discharge of treated process wastewater to the ocean was terminated in 1991.

During the activities conducted for this Public Health Assessment, the NJDHSS and the ATSDR were requested to evaluate the public health significance of the CGC site regarding private wells in the area of the site, the community water supply well field located at Holly Street, air contaminants, sediments of the Toms River, and surface soils and private wells potentially contaminated by breaks in the outfall pipeline.

Residents of Dover Township have expressed concern to the NJDHSS and the ATSDR regarding the incidence of childhood cancer in the community. In the summer of 1995, the ATSDR asked the NJDHSS to perform an analysis of childhood cancer statistics in the community. The NJDHSS found an elevated occurrence of certain childhood cancers. Community concerns about the finding led the ATSDR and the NJDHSS to formulate a multi-activity Public Health Response Plan (PHRP) in June 1996 (NJDOH and ATSDR, 1996). The PHRP included an updating and reevaluation of information on childhood cancer incidence and assessments of environmental issues of concern to the community. Originally included in the PHRP were Public Health Assessments for the CGC site and the Reich Farm site (CERCLIS #NJ980529713). Subsequently, the NJDHSS and the ATSDR added a third Public Health Assessment for the Dover Township Municipal Landfill (CERCLIS #NJD980771570). The PHRP also included a Public Health Consultation, performed jointly with the New Jersey Department of Environmental Protection (NJDEP), that evaluated extensive water quality testing data collected in the period March 1996 to June 1999 from the community water system in Dover Township.

Other activities of the PHRP are the development of a community and health professionals

education program (see “Public Health Action Plan” section), compilation of a compendium of environmental contamination sources in Dover Township, and inclusion of New Jersey in a multi-state study of brain cancer incidence in proximity to National Priorities List sites.

Since March 1996 the NJDHSS and the ATSDR have participated in monthly public meetings of the Citizens Action Committee on Childhood Cancer Cluster (CACCCC) in order to discuss progress toward implementation of the PHRP, cancer incidence, environmental sampling data, and community concerns related to the on-going investigation.

Recently, the CACCCC requested ATSDR involvement in the remedial alternative selection process for the on-site source areas. The USEPA has selected a remedial plan, and the ATSDR has evaluated it (ATSDR, 2000).

The Public Health Assessment for the Ciba-Geigy Corporation site was released for public comment during the period February 29 to April 28, 2000. A summary of the comments received and the responses of the NJDHSS and the ATSDR are provided in Appendix E.

### **Statement of Issues**

Based upon past and current data and information on the CGC site, and other environmental concerns communicated to the NJDHSS and the ATSDR, this Public Health Assessment will evaluate specific exposure pathways, including those associated with: private well use in areas adjacent to the site and along the outfall pipeline; community water supply wells at the Holly Street well field; airborne contaminants; and surface water, soils and sediments.

### **Discussion**

This Discussion will review the history of remedial activities conducted in relation to the CGC site and the findings of investigations of environmental contamination. Based on these findings, an analysis of exposure pathways will be presented. The Discussion will conclude with an assessment of the public health implications of completed exposure pathways.

### **Remedial History**

A chronology of selected events related to the investigation and remediation of the CGC site is given in Table 1. Since the CGC site was added by the USEPA to the NPL in 1983, many studies have been conducted by Ciba-Geigy, USEPA, and their contractors to characterize the environmental consequences of activities at the site. Efforts have been focused on characterizing the nature and extent of on-site and off-site groundwater contamination (called Operable Unit 1 by USEPA) associated with the CGC site (Environ, 1986; NUS, 1988a) and on characterization of the on-site source areas of contamination (called Operable Unit 2) (CDM, 1993a).

## **Groundwater**

In January 1985, Ciba-Geigy installed a purge-well system to intercept contaminated groundwater migrating toward the Cardinal Drive/Oak Ridge Parkway residential area. The multiple-well system was reported to pump 0.5 million gallons per day from the Upper Sand Aquifer (NUS, 1988a).

Based on the Remedial Investigation and Feasibility Study (RI/FS) for Operable Unit 1 (NUS, 1988a; NUS, 1988b), the USEPA issued a Record of Decision (ROD) in 1989 which proposed to extract and treat up to approximately 4 million gallons per day of contaminated groundwater from the Upper Cohansey, Primary Cohansey and Lower Cohansey elements of the Upper Sand Aquifer under the CGC site (USEPA, 1989). The extracted water would be treated to achieve USEPA and New Jersey Surface Water Quality Standards for metals, total dissolved solids, and VOCs. Under the plan, metals would be removed by precipitation, dissolved solids would be removed by a reverse osmosis process, and VOCs would be removed by aeration. Identified (but unregulated) VOCs would be treated by aeration to achieve either 5 or 50 µg/l, depending on the chemical's USEPA Weight of Evidence classification for carcinogenicity. The treated water was to be discharged directly (by pipe) to the Toms River. In addition, the ROD also stated that all irrigation wells in the Cardinal Drive/Oak Ridge Parkway residential area should be sealed.

However, in 1993, after requests by interested parties for reconsideration of groundwater discharge options, USEPA issued an Explanation of Significant Differences (ESD) which altered the original proposed ROD by providing for on-site recharge of treated water to the Upper Sand Aquifer, rather than discharge to the Toms River (USEPA, 1993). The ESD also required that groundwater be monitored in the area east of Toms River to ensure that recharged groundwater or groundwater contaminants would not be drawn into nearby community water supply wells. Monitoring of groundwater along the northern boundary of the CGC site was also required. Table 2 shows the individual pollutants which would be monitored, their health-based ATSDR Comparison Values (CVs) and drinking water Maximum Contaminant Levels (MCLs), and the cleanup compliance standards which were specified in the ESD.

Design of the revised groundwater extraction and treatment system was begun in 1993. Initially, 28 extraction wells were planned; after treatment, groundwater would be recharged to three areas on the CGC plant property (Environ, 1992). The final Groundwater Extraction and Recharge System, which became fully operational in March 1996, incorporates extraction (using a total of 43 wells), treatment (aeration and activated charcoal filtration), and recharge of up to 2.7 million gallons per day. To reduce the possibility of affecting groundwater flow to community water supply wells located east of Toms River, all treated groundwater has been directed to the northeast recharge area, or NERA (Figure 4).

## **On-Site Source Areas**

A Draft Feasibility Study (FS) for remediation of on-site source areas, initiated in 1995, was published in 1999 (Ciba, 1999b). The purpose of the FS is to provide an evaluation of remedial alternatives that will enable USEPA to select a remedy for each of the potential source areas that will be protective of human health and the environment, and that will facilitate the remedial goal of groundwater restoration. Seven alternatives for potential remedial actions were proposed for consideration. The alternatives ranged from no action to excavation and removal of all contaminated materials. Other options included natural attenuation with monitoring, containment, *in/ex situ* thermal treatment, *in/ex situ* bioremediation, and a combination of the various remedial methods. The remediation strategy selected by the USEPA includes a combination of removal and bioremediation techniques.

## **Environmental Contamination**

### **Groundwater: On-site and Off-site Monitoring Wells**

Many monitoring wells have been installed on and off the CGC site for the purpose of characterizing groundwater contamination and flow. Monitoring wells are screened in elements of the Upper Sand and Lower Sand Aquifers. The groundwater Remedial Investigation (RI) for Operable Unit 1 indicated that there were multiple on-site sources of groundwater contamination, since several of the original lagoons and other disposal areas were unlined (NUS, 1988a).

In the RI, numerous contaminants were identified in groundwater under the CGC site, including VOCs, and metals. As summarized in the 1988 ATSDR Public Health Assessment, on-site monitoring wells contained high levels of the following VOCs (maximum value noted): acetone (74,500 µg/l), benzene (3,950 µg/l), chlorobenzene (26,000 µg/l), chloroform (4,400 µg/l), toluene (14,000 µg/l), tetrachloroethylene (12,000 µg/l), trichloroethylene (25,000 µg/l) and vinyl chloride (89 µg/l). On-site monitoring wells also contained elevated levels of metals (maximum value noted): cadmium (318 µg/l), chromium (318 µg/l), lead (255 µg/l) and mercury (12 µg/l). Monitoring of off-site groundwater was accomplished using existing residential wells (see “Groundwater: Residential Private Wells Adjacent to the CGC Site” section below). These wells (used for irrigation) showed that groundwater contaminants had migrated from the CGC site below adjacent residential areas (NUS, 1988d).

In accordance with USEPA guidelines, only those chemicals that were on the Hazardous Substances List (HSL) were taken under consideration to be chemicals of concern. The chemicals were then evaluated for toxicity and assigned an “indicator” score. This process resulted in the selection of 11 individual species as indicator chemicals. These chemicals were subsequently considered in the quantitative baseline (i.e., no action) risk assessment performed for the USEPA (NUS, 1988c). The indicator chemicals which were selected were those known to have been used and disposed at the site, were found in monitoring wells or in private off-site wells, and had high “indicator” scores. The selected indicator chemicals were intended to represent the numerous other contaminants potentially present in the groundwater, but for which standard or routine analytical

methods were not available (for example, azo dyes, resins, or their reagents, such as epichlorohydrin, aniline, anthraquinone, benzidine, or their substituted analogs, hydrochlorides, or sulfonic acid salts). The selected indicator chemicals were:

Groundwater chemicals of concern (for potential carcinogenic risk): arsenic, benzene, chloroform, 1,2-dichloroethane, trichloroethylene, tetrachloroethylene.

Groundwater chemicals of concern (for potential non-carcinogenic effects): arsenic, barium, cadmium, chlorobenzene, nickel, 1,2,4-trichlorobenzene.

Between 1994 and 1996, four semi-annual sampling and monitoring plan (SAMP) events were conducted (Eckenfelder, 1996). The "SAMP 4" monitoring events evaluated approximately 133 on- and off-site monitoring wells screened in four aquifer elements; the Primary Cohansey (63 wells), the Lower Cohansey (26 wells), the Kirkwood No. 1 (36 wells), and the Lower Sand (8 wells). Contamination of groundwater by various metals (including cadmium, lead, and mercury) and VOCs (including benzene, chlorobenzene, dichlorobenzene, chlorotoluene, dichloroethylene, methylene chloride, tetrachloroethylene, trichlorobenzene, trichloroethylene, and trichloropropane) was found in both on- and off-site monitoring wells that are screened in the Primary Cohansey and Lower Cohansey elements of the Upper Sand Aquifer. Contamination of these aquifer elements has been found in several of the monitoring wells east of Toms River. No contamination of the Lower Sand Aquifer by VOCs or metals was found. Figure 6 presents the estimated extent of contamination by total VOCs which were reported in SAMP 4 to be present in the Primary Cohansey and Lower Cohansey aquifer elements, respectively, in 1996.

Longer term (annual) monitoring of the groundwater in the vicinity of the CGC site is being conducted under the provisions of the Site Wide Monitoring Program of the Long Term Monitoring Plan (Ciba, 1995). The results of the First Annual Report (Eckenfelder, 1997) were similar to those reported in SAMP 4; 22 of the wells reported in SAMP 4 were the same data included in the First Annual Report. Table 3 shows the contaminants which were found in samples taken during January 1998 as part of the Second Annual Report in several on-site monitoring wells located near known source areas (Eckenfelder, 1999). As indicated, the concentrations of numerous chlorinated hydrocarbons found in these wells which sample both the Primary and Lower Cohansey aquifers exceed drinking water MCLs and the ESD-mandated cleanup criteria.

In August and September 1997, NJDHSS (in cooperation with Ciba-Geigy) conducted a separate sampling of 31 monitoring wells on- and off-site which were screened in the Upper Sand (Primary Cohansey, Lower Cohansey and Kirkwood No. 1 elements) and Lower Sand aquifers. The nature and extent of groundwater contamination observed was consistent with previous investigations. The data from this sampling episode will be presented in a separate summary document.

### **Groundwater: Extraction Wells**

The ESD list of contaminants has also been analyzed quarterly in the untreated, blended water from the 43 extraction wells (Ciba, 1998). Table 4 shows the contaminants found in the untreated, extracted water during the period January through March 1999 (Ciba, 1999a). As with the individual monitoring wells, the blended extracted groundwater also contains numerous substances, including many chlorinated hydrocarbons, which exceed cleanup criteria or MCLs. Extracted water is treated to meet levels set in the ESD.

### **Groundwater: Residential Private Wells Adjacent to the CGC Site**

In the period 1985 to 1988, several private residential wells in the Cardinal Drive/Oak Ridge Parkway area to the southeast of the CGC site (reported to be used for irrigation and/or non-potable domestic purposes at the time) were found to have been contaminated with VOCs (NUS, 1988a). These VOCs included (maximum level noted): chloroform (251 µg/l), trichloroethylene (38 µg/l), benzene (100 µg/l), tetrachloroethylene (58 µg/l), chlorobenzene (79 µg/l) and xylenes (8 µg/l) (ATSDR, 1988a; NUS, 1988a). According to the USEPA, 15 private residential wells (used for irrigation) in the northern portion of the Cardinal Drive/Oak Ridge Parkway area were identified and sealed between 1986 and 1991.

Other residential areas to the southwest and northeast of the CGC site were also sampled and tested during this time. Lead and mercury above drinking water MCLs or action levels were detected in the Coulter Street area and other areas, but the pattern of detections did not suggest the CGC site as a source of the contaminants (NUS, 1988d).

### **On-site Source Areas**

Characterization of the on-site source areas (Operable Unit 2) have been addressed in a Remedial Investigation (CDM, 1993a) and Feasibility Study (Ciba, 1999b). Approximately 20 source areas have been shown to contain metals, VOCs and SVOCs. The USEPA has selected several indicator chemicals for on-site source area contamination:

Source area chemicals of concern: chlorobenzene, 2-chlorotoluene, 1,2-dichlorobenzene, naphthalene, nitrobenzene, tetrachloroethylene, trichloroethylene, 1,2,4-trichlorobenzene, 1,2,3-trichloropropane, toluene, phenanthrene, ethylbenzene, 1,2-dichloroethylene, arsenic, lead and mercury

The indicator chemicals have been used as the basis for source area surface soil pathways analysis and baseline source area risk assessment documents (CDM, 1993d; CDM 1993e). Additional documents describe the hundreds of surface and subsurface soil contaminants which have been identified, and their toxicological characteristics (CDM, 1994a). Several hundred unidentified species (or tentatively identified compounds; i.e., TICs) have also been found in samples taken from on-site property (see next section).

## **Studies of Non-Target Compounds in On-site Soils**

In addition to the indicator chemicals, the USEPA has investigated the presence of additional species, primarily organic dyes and their reagents, in surface and subsurface soils on the CGC site (CDM, 1993f; CDM, 1994a). The majority of these samples were taken in the production area and in the east equalization basin. Many non-target compounds (NTCs) have been found in the approximately 200 surface soil samples taken on the CGC site. Some of these NTCs have been tentatively identified (TICs) but not quantified. Approximately 147 NTCs (63 of which have been identified by CAS Registry Number) have been detected in surface soils (CDM, 1993f; CDM, 1994a). Among the TICs are the following: anthraquinone, aminoanthraquinone, chloroanthraquinone, dihydroxyanthraquinone and several other substituted variants; aniline and substituted species; 1-methyl-2-pyrrolidone; benzanthrone; and pentachlorothioanisole.

In addition, 378 NTCs (157 of which have been identified by CAS Registry Number) have been detected in 560 subsurface soil borings (of which 216 samples were taken in the production area, 60 in the drum disposal area, and 50 in the west equalization basin) taken on the CGC site (CDM, 1994b; CDM, 1994c). As with the surface soils, among the TICs found in subsurface soils are anthraquinone (and many substituted variants) and benzanthrone. Another analysis of several original sample results described approximately 108 NTCs (of which at least 66 were tentatively identified, including substituted anthraquinones and benzanthrone) that were present in on-site surface and subsurface soils (DS, 1997).

Although it should not be assumed that the dyes and intermediates identified in on-site soils are also present in the groundwater, the possibility does exist that partition between soil and aqueous phases and transport of these species may result in some of them being present in the groundwater beneath the CGC site. Many of the dyes and reagents were in fact used in the form of their (water-soluble) hydrochloride and sulfonic acid salts. Few of these compounds have been analyzed for in on- or off-site groundwater. Unfortunately, standard analytical methods for low-level quantitative detection of many organic dyes and their reagents in aqueous media are not available.

## **Surface Water and Sediments: The Toms River**

### *Toms River Surface Water*

The practice at the Toms River Plant of discharging process wastewater into the Toms River prior to the use of the ocean outfall pipeline in 1966 had a direct, negative impact on the water quality of the Toms River. New Jersey Department of Health inspection reports for June 1962 and October 1963 (NJDOH, 1962; NJDOH, 1963) indicate discharges to the Toms River resulted in conspicuous coloration (red/brown), noticeable odors, increased biological oxygen demand, and the presence of “phenolic substances” at 0.29 parts per million (ppm, or milligrams per liter). For the period of October 1965 to January 1966, the Toms River Chemical Company discharged diazotizable amines (measured as aniline) to the Toms River at the rate of 530 to 1,210 pounds per day (TRCC, 1965).

Nitrobenzene was also discharged into the Toms River by the Toms River Plant, for example, approximately 26,370 pounds of nitrobenzene were reported as discharged during April 1966 (TRCC, 1966c). After installation of the outfall pipeline in late 1966, direct discharge of liquid wastes to the Toms River was terminated. However, in January 1969, the Toms River Chemical Company estimated that approximately 200,000 gallons of liquid wastes per day continued to infiltrate the Toms River from sludge lagoons and disposal areas (NUS, 1988a; TRCC, 1969).

#### *Toms River Sediments*

Historically, the impact of the CGC site upon sediments of the Toms River has been reported by the USEPA to have resulted in increases in the presence of metals and VOCs, and a decrease in the number and diversity of macroinvertebrates and other pollution intolerant species. However, the termination of release of untreated process wastes has since resulted in an improvement in the quality of surface waters and sediments of the Toms River (CDM, 1994d).

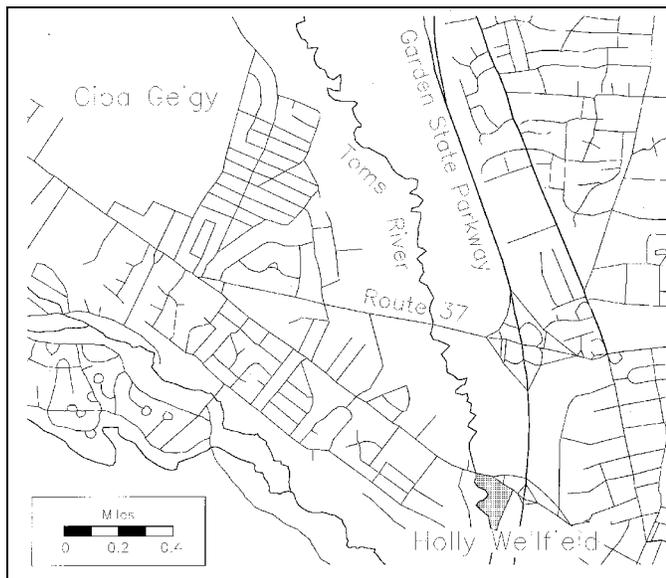
In September 1996, NJDHSS obtained samples of sediment at four locations (at depths of 0-6" and 6-12") along the Toms River downstream of the Ciba-Geigy plant, and at five locations along the intermittent stream adjacent to Long Swamp Road downstream from known breaks in the outfall pipeline. The locations of these samples are also shown in Figure 7. The results of analyses of these 18 samples are compared with NJDEP and Ontario Ministry of Environment and Energy guidelines in Table 6 (NJDHSS, 1997a). There are no established human health-based standards for contaminants in aquatic sediments; however, the concentrations of heavy metals and SVOCs found in these samples were not unusual for aquatic sediments in urban areas.

#### *Winding River Park*

The USEPA sampled surface water and sediments of the marsh within the Winding River Park in July 1990; these data were evaluated by the ATSDR in July 1991 (ATSDR, 1991a). As discussed above (see Summary of Previous Health Assessment Activity), site-related contaminants were documented as the result of surface discharge of groundwater, but concentrations were relatively low. ATSDR evaluated exposure potential through this pathway and determined that it did not represent a public health concern because exposures to marsh air, sediments, and water would tend to be infrequent and of short duration. Additional sampling of these media was performed by CDM from July 1991 to May 1992, with the contaminant profile found to be similar to that determined in previous sampling (CDM, 1993b; CDM, 1993c).

### **Community Water Supply Wells**

The Toms River Chemical Company's (TRCC) practice of discharging process wastes directly to the Toms River prior to 1966 affected community water supply wells of the Toms River Water Company (TRWC, later United Water Toms River). Three shallow supply wells (#13, #14, and #18; about 50 to 60 feet deep) of the Holly Street well field (located near the banks of the Toms River approximately 1.4 miles downstream of the wastewater discharge point; see inset) were found to be contaminated in the mid-1960s. In a "Water Analysis Record" from March 1965, raw water from Well #13 was described as having a distinct odor and as being visibly contaminated with "trade wastes (dye)." This document further indicated that water from Well #13 was treated with chlorine at 8 ppm to reduce coloration prior to distribution (TRWC, 1965). Analyses of Holly Street well field wells by TRCC, from May through October 1966, showed contamination of Wells #13, #14, and #18 with "diazotizables" (aniline-based dyes, measured as aniline) at concentrations ranging up to 160 µg/l (TRCC, 1966a; USEPA, undated). Nitrobenzene was also reported at concentrations up to 17 µg/l (TRCC, 1966b).



In 1965 and 1966, the Holly Street Well Field was a major source of water for the TRWC community water supply (the other major source was well #15 at Brookside Avenue). Holly Street Well # 13 was permitted in 1946 and reported as sealed in 1967 (Wayne, 1955; UWTR, undated). Well #14 was used until 1975 and well #18 was used until 1980. Both wells #14 and #18 were sealed in 1983.

### Airborne Contaminants

There were community complaints of odors related to emissions and site runoff related to the Toms River Plant throughout its period of operation. In September 1986, ambient air was sampled and analyzed (Radian, 1986; Radian, 1988) as a result of complaints of odors in the marshland areas of Winding River Park on the east side of the Toms River. Samples showed the presence of several VOCs used at the Toms River Plant which appear to be above background (maximum level noted): benzene (3.2 micrograms per cubic meter, or µg/m<sup>3</sup>), chlorobenzene (16.5 µg/m<sup>3</sup>), chloroform (15.1 µg/m<sup>3</sup>), toluene (180 µg/m<sup>3</sup>), tetrachloroethylene (8.8 µg/m<sup>3</sup>) and trichloroethylene (58 µg/m<sup>3</sup>).

Soil gas VOCs had been measured in the Cardinal Drive/Oak Ridge Parkway area (11 ppm total VOCs) and in the Winding River park (1,570 ppb total VOCs) (Weston, 1991). However, soil

gas and flux chamber measurements taken later at residences in the Cardinal Drive/Oak Ridge Parkway area showed low to no detectable levels of VOCs, indicating that the concentrations of these contaminants were not at levels of public health concern at that time (Weston, 1993).

Stack emissions from the Toms River Plant were regulated through permits by the NJDEP. A review of the USEPA Toxic Release Inventory (TRI) data show that stack emissions from the CGC plant in the period 1987 to 1990 included acetone, ammonia, copper compounds, epichlorohydrin, formaldehyde, methanol, methyl ethyl ketone, methyl isobutyl ketone, 4,4'-methylenedianiline, n-butyl alcohol, o-cresol, toluene, and xylenes.

### **Uncontrolled Discharges from the Outfall Pipeline**

Prior to 1966, process wastewater from CGC was discharged directly to the Toms River. However, during the 25 year period between 1966 and 1991, treated wastewater was discharged to the Atlantic Ocean through a 10 mile long pipeline (28" outside diameter, coated internally and externally with coal tar enamel). The underground pipeline ran predominantly along Mapletree Avenue and Bay Avenue, then under Barnegat Bay and Ortleigh Beach (an area of Dover Township located on a barrier island) before emptying approximately 3,500 feet out into the Atlantic Ocean (Figure 7). Use of the outfall pipeline for disposal of treated wastewater was terminated in 1991. The section of the pipeline from the CGC site to Bay and Vaughn Avenues was filled with water and closed in 1992. In 1994 the pipeline section which extended into the Atlantic Ocean was removed, and the section from Bay and Vaughn Avenues and the barrier island was transferred to the Ocean County Utilities Authority to be used as a supplemental sanitary sewer line.

Between 1984 and 1989, three incidents of uncontrolled discharge of treated wastewater occurred as a result of malfunctioning valves or from inadvertent construction damage to the pipeline. According to the NJDEP, potentially contaminated soils were removed and replaced with clean soils when the pipeline breaks were repaired. After an uncontrolled pipeline discharge in 1985, a pipeline monitoring program was proposed (AWARE, 1985).

Six monitoring wells were installed by the CGC along the pipeline in 1987, and monitoring was started in 1988. Elevated concentrations of chromium and lead were found in samples from four of the six installed monitoring wells over the course of several sampling episodes between 1988 and 1993 (Ciba, 1989; Ciba 1997), largely due to particulate matter in the samples. Forty-five private residential wells were sampled by the CGC at different times between 1987 and 1994. Samples from several private wells contained low levels of VOCs (below applicable MCLs); chromium, copper, lead and mercury were detected in other private well samples, in some cases above the applicable MCLs (Ciba, 1996). The sources of these substances are uncertain, but the geographic pattern of detected contaminants does not suggest that the outfall pipeline breaks were a likely source. Lead and copper have been commonly found to be present in private residential well water samples, most likely due to corrosion of plumbing by acidic groundwater. Mercury has also been frequently found in private residential wells in Dover Township and elsewhere in southern New Jersey.

### ATSDR/NJDHSS Exposure Investigation

In September 1996, the NJDHSS and ATSDR collected and analyzed 18 surface soil samples that were taken at locations along Bay Avenue in the vicinity of known outfall pipeline breaks or suspected leak areas (Figure 7) (NJDHSS, 1997a). The results of these analyses are given in Table 5. As shown, none of these surface soil samples exceed soil Comparison Values for metals and organic chemicals. A full summary of these data will be included in a separate document.

From February to May 1997, the NJDHSS and ATSDR sampled 54 private wells located throughout Dover Township for chemical and radiological testing (NJDHSS, 1997b; NJDHSS, 1997c). Ten of the 54 private wells were located near the CGC site (Figure 8); chemical testing results are shown in Table 7. None of these ten wells showed any contaminants which exceed drinking water MCLs or that were considered site-related. Similarly, 14 of the 54 private wells were within approximately one-quarter mile of the route of the former outfall pipeline. None of these wells exhibited contaminants that could be considered pipeline-related. Chromium was below the limit of detection in all 54 sampled wells.

Several of the 54 wells located in Dover Township were found to have elevated levels of lead and mercury. Low levels of chloroform were found in several of the tested wells. There was no pattern which would indicate that CGC or the outfall pipeline is the source of these contaminants. Gross alpha activity in excess of the MCL was found in many of the sampled wells, attributable to naturally occurring radium. A complete summary and evaluation of the private well data generated during the Exposure Investigation conducted by the NJDHSS and the ATSDR will be presented in a separate document.

### Pathways Analysis

To determine whether residents of Dover Township were or are exposed to contaminants from the CGC site, the ATSDR and the NJDHSS evaluate the environmental and human components that lead to exposure. An exposure pathway consists of five elements: (1) a source of contamination; (2) transport of the contaminants through an environmental medium; (3) a point of human exposure; (4) a route of human exposure; and (5) a receptor population.

The ATSDR and the NJDHSS classify exposure pathways into three groups: (1) *completed pathways*, that is, those in which it is likely that some persons in the receptor population were exposed, are being exposed, or will be exposed; (2) *potential pathways*, that is, those in which exposure might have occurred, may be occurring, or may yet occur; and (3) *eliminated pathways*, that is, those which can be eliminated from consideration because one of the five elements is missing and will never be present, or in which no contaminants of concern can be identified. Completed or potential pathways, discussed below, may be *interrupted* by remedial actions or public health interventions.

## **Completed Human Exposure Pathways**

### *Holly Street Community Water Supply Wells*

The ATSDR and the NJDHSS have determined that there was a completed human exposure pathway to CGC-related contaminants through ingestion of water from the community water supply wells of the Holly Street well field, as documented in 1965 and 1966. Although the full nature and magnitude of contamination is not known, there is evidence that certain Holly Street wells (#13, #14 and #18) were contaminated with aniline-based dyes and nitrobenzene in those years. The source of the CGC site-related contaminants appears to have been surface water from the Toms River drawn down into the groundwater and into the shallow Holly Street wells (TRCC, 1966b; CDM, 1994d).

The duration of exposure through this pathway cannot be determined, since data are lacking before 1965 and after 1966. The CGC began the process of discharging liquid chemical waste to the Toms River in 1952. Holly Street wells #13 and #14 were in operation beginning in 1946 and 1953, respectively. Holly Street well #18 was installed in 1965. It is possible, therefore, that wells #13 and #14 may have been contaminated before 1965, depending on the nature of groundwater and surface water interaction in those years. Construction of the outfall pipeline in 1966 reduced the amount of pollutant discharge to the river, but, as noted previously, discharge to the river continued from disposal areas at the CGC site. Holly Street well #13 was sealed in 1967. Well #14 was in operation until 1975 and was sealed in 1983. Well #18 was in operation until 1980, and was also sealed in 1983.

The total number of persons associated with this exposure pathway in the past is difficult to determine. Exposure potential is dependent upon the dynamics of the water system during the period in question, and the location of potentially affected residences relative to the Holly Street point of entry within the water system. Overall, approximately 35,500 persons were receiving community water in 1965. Because the Holly Street well field was one of two major water sources operating in 1965 and 1966, the number of people receiving at least some of their water from this source is potentially large.

### *Private Wells: Cardinal Drive/Oak Ridge Parkway Area*

The ATSDR and the NJDHSS have determined that there was a human exposure pathway associated with the use of private wells in the Cardinal Drive/Oak Ridge Parkway area. Private residential wells in this neighborhood that were found to be contaminated with VOCs were reported by the USEPA to be used for irrigation and/or non-potable domestic purposes at the time of sampling (1985 to 1988). Use of private well water for non-potable purposes may result in exposure through dermal contact and inhalation of volatile components, although the magnitude of exposure through use of wells for irrigation or other outdoor purposes is likely to be smaller than from the use of well water for household potable purposes. Since hook-up to the community water supply was not mandatory, it is possible that private wells in the Cardinal Drive/Oak Ridge Parkway area were used

for potable and other household purposes prior to the sampling period. For these reasons, the ATSDR and the NJDHSS consider it likely that use of private wells in the past constituted a completed exposure pathway through inhalation, dermal, and possibly ingestion routes.

Between 1986 and 1991, and in accordance with the ROD, the CGC offered to compensate homeowners for costs associated with sealing affected wells, and 15 wells were eventually sealed, thereby interrupting this exposure pathway. The number of persons exposed in the past through the private well pathway cannot be determined.

A summary of the completed human exposure pathways associated the CGC site is presented in the following table.

*Public Health Assessment: Ciba-Geigy Corporation*

<b>Completed Human Exposure Pathways Associated with the Ciba-Geigy Corporation Site</b>						
<b>Pathway Name</b>	<b>Source</b>	<b>Environmental Media</b>	<b>Point of Exposure</b>	<b>Route of Exposure</b>	<b>Exposed Population</b>	<b>Contaminants (Time Documented)</b>
Community water supply wells at Holly Street	CGC Site	Groundwater (via Surface Water)	Residences and other locations served by water from the Holly Street well field	Ingestion, inhalation, dermal contact	Residents receiving community water from Holly Street well field (Number unknown)	Dyes and nitrobenzene (1965-1966)
Private Wells, Cardinal Drive/Oak Ridge Parkway area	CGC Site	Groundwater	Residences with private wells	Dermal contact, inhalation, and possibly ingestion	Residents using contaminated private wells (Number unknown)	VOCs (1985-1988)

### *Private Wells in Other Areas*

Samples of some private residential wells in other areas near the site and along the outfall pipeline contained metals or low levels of VOCs. Although these contaminants are not CGC site-related, a completed human exposure pathway exists or existed in the past to these substances. Efforts to interrupt this pathway and to reduce exposure to lead and mercury were undertaken in the Coulter Street and other areas through well closures and provision of alternate sources of water. Residents participating in the NJDHSS/ATSDR private well sampling with elevated lead levels were provided informational material advising them on methods to reduce lead exposure.

## **Potential Pathways**

### *Airborne Contaminants*

In 1986, quantitative air monitoring was conducted in the vicinity of the marshland in the Winding River Park on the east bank of the Toms River (Radian, 1986; Radian, 1988). Several VOCs possibly related to the CGC site (benzene, chlorobenzene, chloroform, tetrachloroethylene, trichloroethylene, toluene) were detected, indicating the potential for exposure to airborne VOCs during recreational use of the park or in nearby residential areas.

Odor complaints were periodically received by the Dover Township Board of Health (and later the Ocean County Health Department) from residents east and south of the CGC property. These complaints were typically investigated using standard instruments (flame ionization and photoionization detectors); no evidence of significant airborne contamination was documented. However, since these survey instruments are relatively insensitive (minimum detection limits are about 1 ppm for most VOCs), the potential inhalation pathway involving airborne emissions from CGC property may not have been fully characterized. Since CGC has been inactive since 1996, the likelihood of current exposure to any airborne contaminants emanating from the plant site appears to be minimal.

### *Contaminated Soils*

There had been a potential for trespassers to be exposed to site-related contaminants through direct contact with contaminated soils on-site (ATSDR, 1988a). However, this potential pathway is likely to be interrupted through site security measures at the CGC site.

### *Winding River Park*

Although sediments and surface water of the marshland in Winding River Park exhibited site-related contamination, this pathway was not considered by the ATSDR to be of public health significance because exposures to marsh air, sediments, and water would tend to be infrequent and of short duration (ATSDR, 1991a, CDM, 1993b).

## **Public Health Implications**

The public health implications of completed exposure pathways in the past will now be considered. Several contaminants were confirmed to be present in water from private wells and community water supply wells at levels above health-based Comparison Values. (See Appendix for definitions and uses of Comparison Values.) The NJDHSS and the ATSDR have further evaluated the public health significance of past exposures to these contaminants through an examination of relevant toxicologic and epidemiologic information. In addition, this section will include a brief summary of the findings of an analysis of childhood cancer incidence data for Dover Township.

### **Childhood Cancer Incidence in Dover Township**

The NJDHSS and the ATSDR reviewed cancer incidence data in the period 1979 to 1995 for Dover Township as part of the Public Health Response Plan. Findings are described in a separate Public Health Consultation by the NJDHSS and the ATSDR (NJDHSS, 1997d). Dover Township was the only municipality in Ocean County in which overall childhood cancer incidence (ages up to 19 years) was statistically elevated. Ninety cases were observed in the 17-year period, compared to 67 that would have been expected if childhood cancer rates were the same in the Township as in the entire State of New Jersey. Leukemia incidence was elevated in Dover Township, particularly in females under the age of five years. In the Toms River section of the township, overall childhood cancer was elevated (24 observed vs. 14 expected). Both leukemia and brain/central nervous system cancers were elevated, with the excess occurring primarily in female children under age five.

### **Toxicologic and Epidemiologic Evaluation for Adults and Children**

#### *Community Water Supply Well Pathway*

The nature, magnitude and duration of exposure to CGC site-related contaminants through the distribution of water to the community from the Holly Street well field is not fully known. As noted before, diazotizable amines (measured as aniline) and nitrobenzene were measured in certain wells in 1965 and 1966, but concentrations in the distribution system have not been documented. Contaminant concentrations measured at the well are not necessarily accurate representations of levels to which individual households or sections of Dover Township may have been exposed.

The full nature of the contamination is not known. Dye manufacturing operations at the Toms River Plant involved the use and production of many classes of chemicals. Anthraquinone dye production involved the use of anthracene, aniline, benzene, nitrobenzenes, chlorobenzenes, chlorotoluenes, acids, metals, and other chemicals. Azo dye production involved the use of naphthalene, nitrobenzenes, aniline, phenol, benzidine, naphthylamine, o-toluidine, solvents, acids, and other chemicals. The following discussion describes the known toxicological characteristics of certain dyes and intermediates that are associated with Toms River Plant operations, and the results of epidemiologic follow-up of workers formerly employed at the facility.

## Azo Dyes

Azo dyes are a family of synthetic chemicals of varying structure and complexity. Dyes may be metabolized in the body into benzidine or other aromatic amines. Studies of experimental animals exposed to certain azo dyes and to benzidine demonstrate the potential for carcinogenicity. Target organs for carcinogenicity appear to be the liver, kidney and bladder. Epidemiologic studies of workers exposed occupationally to benzidine and azo dyes have found increased risks of bladder cancer (ATSDR, 1997a). Benzidine is classified by the International Agency for Research on Cancer as a human carcinogen, while certain benzidine-based dyes have been classified as probable human carcinogens (ATSDR, 1997a). No specific information is available regarding risks to children from exposure to these chemicals.

## Aniline

The target organs of aniline toxicity in humans are reported to be the spleen and hematopoietic (blood) system. Methemoglobinemia may result from high levels of exposure. Animal studies (rats) have shown decreased mean pup weights and fetal hypoxia as a result of maternal methemoglobinemia from high doses (ATSDR, 1997a).

The USEPA has concluded that aniline is a probable human carcinogen based upon the induction of spleen and body cavity tumors in rats. No adequate studies were located by the ATSDR regarding cancer in humans after exposure to aniline. One epidemiologic study (Ward, 1996) investigated the excess occurrence of bladder tumors in workers in the chemical dye industry, but results were confounded by exposure to other agents (o-toluidine and 4-aminobiphenyl). Based on the animal toxicology data, the ATSDR estimates that one additional case of cancer would be expected in a population of 100,000 persons from a lifetime of exposure to 60 µg/l of aniline in drinking water (ATSDR 1997a). However, because of uncertainty regarding several exposure factors, an individual's theoretical increased risk of cancer could be higher or lower.

## Nitrobenzene

Little is known of the toxicologic effects of oral exposure to nitrobenzene. The primary systemic effect resulting from oral exposure to nitrobenzene is methemoglobin formation (resulting in decreased tissue oxygenation and a decrease in overall metabolism) (ATSDR, 1990). No other information is available regarding hepatic, renal, immunologic, developmental, reproductive, or genotoxic effects associated with oral exposure to nitrobenzene. The ATSDR reports no toxicological studies regarding carcinogenesis in animals or humans resulting from oral exposure to nitrobenzene.

## Other Dye Intermediates

Literature searches by USEPA contractors of several chemical and toxicological databases

located toxicity information on a number of the TICs in surface and sub-surface soils, and toxicity profiles have been prepared for Ciba-Geigy on 14 of these surface soil TICs (CDM, 1994b; CDM, 1995). In general, toxicological information on these species is sparse.

#### Toms River Plant Epidemiologic Study

A study of mortality of former Toms River Plant workers found excess deaths from bladder, kidney, and central nervous system cancers in those workers who had previously been employed by the Cincinnati Chemical Works (CCW), which had produced and used the known bladder carcinogens benzidine and *o*-naphthylamine (Delzell et al, 1989). Increased mortality from lung cancer was also observed among former maintenance workers at the Toms River Plant, and stomach and central nervous system cancers among azo dye production workers at the Toms River Plant. A recent update of this study (Sathiakumar and Delzell, 1998), with additional years of follow-up of former workers, generally confirmed the earlier findings.

#### *Private Well Pathway: Cardinal Drive/Oak Ridge Parkway Area*

A completed human exposure pathway to CGC site-related VOCs (benzene, chloroform, trichloroethylene, and tetrachloroethylene) likely existed through the use of private wells for irrigation and possibly potable purposes in the past, in the Cardinal Drive/Oak Ridge Parkway area. Actual exposure levels to VOCs would be dependent on the specific uses of contaminated water. The following is a discussion of toxicologic and epidemiologic studies of exposure to these VOCs, with emphasis on weight-of-evidence considerations related to childhood cancer.

#### Chloroform

Chloroform occurred at concentrations in the groundwater significantly above the respective ATSDR cancer risk evaluation guide (CREG) value of 6 µg/l. The liver is the primary target of chloroform toxicity in humans and laboratory animals exposed orally, as indicated by blood biochemistry tests of liver enzymes. The kidneys are also major targets of chloroform toxicity in humans, as indicated by increased blood urea nitrogen and creatinine levels. Epidemiological studies have suggested an association between bladder and possibly colorectal cancers in humans and consumption of chlorinated drinking water from surface sources (which may contain chloroform and other trihalomethanes at concentrations ranging from tens to hundreds of micrograms per liter), but the results are not conclusive (Cantor, 1997). Chloroform is usually the predominant trihalomethane found in chlorinated drinking water.

Although the data on human subjects are equivocal, chloroform has been classified as a probable human carcinogen on the basis of experimental animal studies (ATSDR, 1998). Mice that are exposed to high doses of chloroform can develop liver cancer, but the cancer appears to be secondary to chloroform-induced tissue damage and repair. Based upon a large number of genotoxicity assays, neither chloroform nor its metabolites appear to have a direct mutagenic activity,

implying that low dose exposures to chloroform that do not cause direct liver toxicity, would not produce a carcinogenic effect.

### Benzene

Occupational exposure to benzene and benzene-containing mixtures can result in damage to the blood-forming system (ATSDR, 1997d). Several studies of rubber workers have shown an increased risk of acute myelogenous leukemia and possibly other cancers. Experimental animal studies also indicate that high-level benzene exposure can lead to the development of multiple tumor types. Benzene is classified as a known human carcinogen (ATSDR, 1997d). It is not known what effects exposure to benzene might have on the developing human fetus. Studies with pregnant animals show that breathing benzene has harmful effects on the developing fetus. These effects include low birth weight, delayed bone formation and bone marrow damage (ATSDR, 1997d). Although some of the wells in the Cardinal Drive/Oak Ridge Parkway area contained benzene above the MCL of 1 µg/l, the exposure levels in the occupational epidemiologic studies were much higher than those that could have been experienced by residents.

### Trichloroethylene and Tetrachloroethylene

The effects of exposure to trichloroethylene (TCE) and tetrachloroethylene (perchloroethylene, or PCE) have been evaluated in scientific studies for their possible impact upon human health. TCE and PCE are classified as probable human carcinogens by the International Agency for Research on Cancer (IARC, 1995) based on the weight of evidence from laboratory animal experiments and limited human epidemiologic studies. Laboratory animals have been exposed to these chemicals via contaminated air, drinking water, and food. The results of these studies indicate that the nervous system and liver, and to a lesser degree the kidney and heart, are the primary organs of adult animals affected by these VOCs (ATSDR, 1997f; ATSDR, 1997g). Following long-term, high level exposure, TCE has been shown to produce liver cancer in mice and kidney and testicular tumors in rats (ATSDR, 1997f; IARC, 1995). Chronic, high level PCE exposure produces liver cancer in mice and kidney tumors and mononuclear cell leukemia in rats (ATSDR, 1997g; IARC, 1995). The exposure levels needed to cause these adverse impacts in laboratory animals are many times higher than exposure levels that could have occurred through the use of contaminated drinking water (ATSDR, 1997f; ATSDR, 1997g).

Extrapolating animal toxicity data to predict human risk is often controversial and is especially so in the case of TCE, since some of the mechanisms implicated in its effects on animals do not exist in humans. For instance, TCE-induced peroxisome proliferation, a potential precursor to liver cancer, is common in rodents but not in humans. In addition, kidney tumors seen in male rats following exposure to TCE and other chlorinated VOCs are believed to be caused by the accumulation of alpha-2µ-globulin in intracellular lysosomes. This histopathological alteration does not occur in humans, so the relevance of this pathological mechanism to human carcinogenesis is uncertain.

Epidemiological studies of occupationally-exposed workers suggest an association between long-term inhalation exposure to high levels of TCE and increased risk of liver and biliary tract cancer and non-Hodgkin's lymphoma (IARC, 1995; ATSDR, 1997f). Increased risks of esophageal cancer, cervical cancer, and non-Hodgkin's lymphoma have been observed in workers exposed to high levels of PCE (IARC, 1995; ATSDR, 1997g). Participants in the ATSDR TCE Exposure Subregistry (approximately 4,300 individuals with exposure to TCE in drinking at levels ranging from 2 to 19,000 µg/l for as long as 18 years) have reported a variety of health problems at rates above national averages. However, only the rate for strokes was reported to increase with increasing concentration of TCE in drinking water. Results from the Subregistry have not documented any increased occurrence of cancer in the study population (ATSDR, 1999).

Children may be particularly susceptible to the toxic effects of chemicals; fetuses may also be sensitive to toxic effects if the chemicals can cross the placental barrier. Recent epidemiologic studies suggest that fetal exposure to VOCs in drinking water could result in adverse health effects. The NJDHSS evaluated the effects of VOCs in drinking water on birth outcomes in an area of northern New Jersey (Bove et al., 1995). This exploratory study found that maternal residence during pregnancy in areas with TCE-contaminated drinking water was associated with an increased risk of birth defects of the neural tube and oral cleft. Exposure to PCE during pregnancy was associated with an increased risk of oral cleft defects. The authors concluded that their study by itself cannot determine whether the drinking water contaminants caused the reported adverse birth outcomes. A recent ATSDR study of exposure to VOCs in drinking water and occurrence of adverse pregnancy outcomes was conducted at the U.S. Marine Corps Base at Camp LeJeune, North Carolina (ATSDR, 1997e). Decreased mean birth weight and increased small for gestational age babies were reported for two potentially susceptible subgroups: infants of mothers older than 35 years of age and infants of mothers with histories of fetal death. This study provides limited evidence for a causal relationship between exposure to VOCs and the reproductive and developmental effects evaluated.

A study of childhood leukemia conducted in Woburn, Massachusetts concluded that the incidence of childhood leukemia was associated with the mother's potential for exposure to water from specific wells contaminated with TCE and PCE, particularly for exposure during pregnancy (MDPH, 1997). The study did not find any association between the development of childhood leukemia and the child's exposure to contaminated water after birth. The Woburn study should be interpreted with caution, however, since small numbers of study subjects led to imprecise estimates of risk. A study by the NJDHSS found a statistically elevated rate of childhood leukemia in towns served by community water supplies contaminated with TCE and PCE in the years 1979 to 1987 (before current drinking water regulations had been implemented), compared to towns without a history of such contamination (Cohn et al., 1994). Overall, the associations drawn from these limited epidemiological data in humans are suggestive, yet inconclusive, that exposure to these VOCs through drinking water may cause birth defects or childhood leukemia in children exposed while a fetus. ATSDR and others are conducting or sponsoring research to clarify this possible relationship.

*Private Well Pathways in Other Areas (Not CGC-Site-related)*

Lead and mercury were detected in several private residential wells as described above, although these contaminants are unlikely to be CGC site-related. Lead is toxic to the nervous system, particularly in the fetus and young children whose nervous systems are undergoing rapid development (ATSDR, 1997b). To protect against the neurotoxic effects of lead, the USEPA has promulgated an Action Level of 15 µg/l for lead in drinking water for community water systems. If lead concentrations in well water were sustained above the Action Level throughout the day, they could pose a public health hazard, particularly to a developing fetus or a young child. Carcinogenicity studies of rodents exposed to high levels of lead are equivocal. The available data on the carcinogenicity of lead following ingestion by laboratory animals indicate that lead acetate and lead phosphate are carcinogenic, and that the most common tumor response is renal tumors. However, the animal studies are limited in their usefulness since they involved small group sizes (ATSDR, 1997b). As a result, it is not possible to extrapolate from the carcinogenic effects of high level acute oral exposure in rats to low level chronic exposure in humans (ATSDR, 1997b).

The health effects of mercury are variable and dependent upon its form: metallic mercury, inorganic mercuric compounds, or organic mercury. The target organs for mercury toxicity are the kidney and nervous system. The ATSDR Toxicological Profile for Mercury presented no studies regarding carcinogenesis in humans with respect to oral exposure to inorganic or organic mercury (ATSDR, 1997c). Animal research studies have shown a significant increase of renal tumors in rats exposed orally to organic mercury (methyl mercuric chloride or phenylmercuric acetate). Oral exposure to mercuric chloride has also shown an increase in renal tumors in rats.

## **Conclusions**

### **Hazard Category for the Ciba-Geigy Corporation Site**

Based upon a weight-of-evidence analysis of the health and environmental information compiled, each Public Health Assessment assigns a hazard category (see Appendix) in response to the public health risk posed by the site being evaluated. Each category relates to a set of additional actions or interventions that may be considered by the ATSDR, the NJDHSS or other public health agencies, as well as recommendations for further action to the USEPA, the NJDEP, or other environmental agencies.

The Ciba-Geigy Corporation Toms River Plant site is considered by the ATSDR and the NJDHSS to have represented a **public health hazard because of past exposures**. This determination is based upon the following considerations, taken together: 1) the presence of a completed exposure pathway in the past through the community water supply to dyes and possibly other chemicals, to a potentially large population; 2) the presence of a completed exposure pathway through the use of private wells (for irrigation and possibly for potable use at some time in the past)

in the Cardinal Drive/Oak Ridge Parkway to VOCs; 3) toxicological evaluations; 4) epidemiologic studies from other communities and workplaces suggesting that exposure to dyes and VOCs may increase the risk of certain cancers and other adverse health outcomes; and 5) the presence of an excess of childhood cancers in the community.

Certain wells at the Holly Street well field of the community water supply were documented to be contaminated in 1965 and 1966 with dyes or dye intermediates, nitrobenzene, and possibly other chemicals. The nature, magnitude and duration of exposure to these contaminants is not fully known, and the toxicological characteristics of some of the chemicals are not well understood. Since the Holly Street well field was a principal source of water for the community water supply at that time, a large number of persons were likely exposed to contaminated water. Groundwater beneath the CGC site has been contaminated with high levels of VOCs, metals, and possibly other chemicals. Contaminated groundwater has migrated off-site, and private irrigation wells in the Cardinal Drive/Oak Ridge Parkway area adjacent to the CGC site were found to be contaminated with VOCs and metals in the mid-1980s. Use of private irrigation wells may result in exposure through dermal contact or inhalation of VOCs or dermal contact; if wells in the area had been used for potable purposes in earlier years, exposure potential could have been higher. Although uncertainties in exposure and toxicological information make the assessment of public health implications difficult, further epidemiologic evaluation is warranted in order to evaluate the public health significance of past exposures to contaminants from the site.

Current conditions indicate that although groundwater remains contaminated at levels of public health concern, completed human exposure pathways to contaminants from the CGC site have been interrupted. The exposure pathway associated with the community water supply wells of the Holly Street well field was reduced and/or interrupted through the construction of an outfall pipeline to re-direct wastewater from the Toms River to the Atlantic Ocean. The exposure pathway associated with private wells in the Cardinal Drive/Oak Ridge Parkway areas has been interrupted through a well testing and sealing initiative by the CGC and the USEPA, and regulatory efforts by the Ocean County Health Department to monitor the installation of, and ensure the quality of, new wells in potentially affected areas. For these reasons the ATSDR and the NJDHSS have concluded that currently there are no documented completed human exposure pathways associated with the CGC site, and thus, are categorizing the CGC site as representing **no apparent public health hazard** under present conditions. Should the ATSDR or the NJDHSS become aware of additional information regarding CGC-related human exposure pathways, this determination may be reconsidered.

On-site source areas remain contaminated. Disposition of on-site contaminants is being addressed by the USEPA through a remedial action plan (for Operable Unit 2). Because there remains a potential for future exposure pathways to site-related contaminants if on-site areas remain unremediated, the ATSDR and the NJDHSS support remedial actions serving to interrupt exposure pathways.

Other potential exposure pathways in the past include inhalation of air contaminants from on-site manufacturing and waste disposal activities. With the closure of operations at the Toms River Plant, the air pathway is interrupted. In addition, site security measures have likely interrupted the potential for exposure of trespassers to on-site contaminated soils. Human exposure to contaminants in soils, sediments and surface waters in the marshland areas adjacent to the Toms River is unlikely. There is no evidence that breaks in the outfall pipeline have resulted in human exposure to CGC-related contaminants through contaminated soils, sediments or groundwater, although other contaminants were evident in some of the private residential wells sampled.

## **Recommendations**

### **Cease/Reduce Exposure Recommendations**

The ATSDR and the NJDHSS support continuing efforts by the USEPA and Ciba Specialty Chemicals to contain and remove contaminants in the Upper Sand Aquifer associated with the Ciba-Geigy Corporation site. In addition, the ATSDR and the NJDHSS support restrictions on the use and construction of private wells in areas known to be affected by CGC site-related contamination.

The ATSDR and the NJDHSS also support efforts to remediate on-site source areas to reduce the threat of further contamination of groundwater and prevent future exposure. The ATSDR determined that the USEPA's proposed remedial alternative for soils at the CGC site will be protective of the public health over the long term (ATSDR, 2000).

Because certain metals and low levels of VOCs (not related to the CGC site) were detected in some of the private wells sampled during the former outfall pipeline monitoring program, owners of these wells should be contacted to ascertain whether wells are currently active. If so, the owner should be offered the opportunity to test the well for current water quality.

Existing security measures should be reviewed in order to preclude unauthorized access to contaminated on-site areas.

### **Public Health Recommendation**

Based upon review of completed human exposure pathways at the CGC site, and in conjunction with the concerns of the community regarding the incidence of childhood cancer, consideration of CGC site-related exposure pathways in the on-going epidemiologic investigation by the NJDHSS and the ATSDR is warranted. Estimates of exposure to water through this pathway should include the use of private wells and community water supply wells. To account for the complex dynamics of a community water system, water system models should be employed to trace the flow of water from the Holly Street well field to points in the distribution system.

## **Public Health Action Plan**

The Public Health Action Plan (PHAP) for Ciba-Geigy Corporation site contains a description of the actions to be taken at or in the vicinity of the site. The purpose of the PHAP is to ensure that this Public Health Assessment not only identifies public health hazards, but provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of ATSDR and NJDHSS to monitor this plan to ensure its implementation. The public health actions undertaken or planned are as follows:

### **Public Health Actions Undertaken by the ATSDR/NJDHSS**

#### **Ciba-Geigy Corporation Site**

- 1) The NJDHSS and the ATSDR have evaluated available information to determine the public health significance of past and present human exposure pathways associated with the CGC site.
- 2) The NJDHSS acquired and conducted analyses of samples of monitoring wells associated with the CGC site. These data have been reviewed and are being summarized by NJDHSS in a separate document.
- 3) The ATSDR Division of Toxicology has reviewed existing toxicological literature with respect to several dyes and dye intermediates used at the Toms River Plant.
- 4) The ATSDR has evaluated the health protectiveness of remedial plans developed by the USEPA for on-site source areas.

#### **General**

- 1) The NJDHSS and the ATSDR conducted analyses of private wells as part of an exposure investigation. Test results were communicated to participants, together with an offer of assistance in interpreting data, recommendations for minimizing exposure, and educational materials regarding the health issues associated with results.
- 2) The NJDHSS and the ATSDR have prepared a Public Health Consultation describing a review and analysis of childhood cancer incidence data for Dover Township during the period 1979 to 1995 (NJDHSS, 1997d).
- 3) The NJDHSS and the ATSDR (Division of Health Studies) are conducting an epidemiologic

study of childhood cancers in Dover Township. The study will examine whether environmental exposures (including but not limited to completed pathways associated with the CGC site) and other risk factors are associated with the incidence of these diseases. The ATSDR is developing a community water supply distribution system model which will be used in the epidemiologic study to estimate past exposure to water from the Holly Street well field and other points of entry. An Interim Report of this study was released to the public in December 1999.

- 4) In response to concerns about childhood brain cancer in several states, the ATSDR has initiated a multi-state epidemiologic study to explore the role of environmental risk factors in the development of childhood brain cancer. Findings from this study may be applicable to diverse areas and populations.
- 5) The ATSDR (Division of Health Education and Promotion) and the NJDHSS have implemented a variety of physician and community education initiatives as part of the Public Health Response Plan, including:

*Health Care Provider Education*

- \* The NJDHSS distributed Resource Guides for Health Care Providers to approximately 100 physicians in Ocean County.
- \* The NJDHSS developed and distributed a series of Health Care Provider Updates to approximately 430 physicians and physician groups and 30 school nurses in the area. The first Update in the series (August 1996) reviewed the Public Health Response Plan. A survey of educational needs was sent with the first Update; 77 physicians responded to the survey, with 33 requesting additional informational materials. Physicians were most interested in professional seminars and patient education materials on general pollution issues. Six additional Health Care Provider Updates have been completed and distributed by the NJDHSS: information on the Ciba-Geigy and Reich Farm Health Public Health Assessments, the initial results of the community water supply investigation, cancer incidence statistics, the epidemiological study protocol, and a summary of the Interim Report of the childhood cancer epidemiologic study.

*Community Education*

- \* Health Care Provider Updates and Resource Guides have been made available to area residents upon request.
- \* Progress reports of the Dover Township childhood cancer investigation were developed for distribution to concerned citizens in September 1997 and May 1998 by the NJDHSS and the ATSDR.

- \* In cooperation with the ATSDR, the Environmental and Occupational Health Sciences Institute provided curriculum training in environmental health issues for primary school teachers of the Toms River school district.

## **Public Health Actions Planned**

### **General**

- 1) The ATSDR and the NJDHSS are preparing, in the form of a Public Health Consultation, a summary and evaluation of the 1997 exposure investigation data and their public health significance.
- 2) The ATSDR and the NJDHSS will coordinate with the Ocean County Health Department to offer water quality testing to owners of private residential wells that were part of the former outfall pipeline monitoring program.
- 3) The NJDHSS will contact local health officials and community leaders to assess the need for future community educational activity. Site-specific educational materials will be prepared and disseminated as necessary. Periodically, new Progress Reports and Health Care Provider Updates will be developed and distributed.
- 4) The ATSDR and the NJDHSS will reevaluate and revise this Public Health Action Plan (PHAP) as warranted. New environmental, toxicological or health outcome data, or the results of implementing the above proposed actions may determine the need for additional actions at the CGC site by the NJDHSS and/or the ATSDR.

## **Certification**

This Public Health Assessment for the Ciba-Geigy Corporation site was prepared by the New Jersey Department of Health and Senior Services (NJDHSS) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the Public Health Assessment was begun.

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Gregory V. Ulirsch  
Technical Project Officer  
Superfund Site Assessment Branch (SSAB)  
Division of Health Assessment and Consultation (DHAC)  
ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this Public Health Assessment and concurs with its findings.

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Richard E. Gillig  
Chief, SSAB, DHAC  
ATSDR

## **Preparers of Report**

### **Prepared By:**

Health Assessment Project  
Hazardous Site Health Evaluation Program  
Consumer and Environmental Health Services  
Division of Epidemiology, Environmental and Occupational Health  
New Jersey Department of Health and Senior Services

### **ATSDR Regional Representative:**

Tom Mignone  
Regional Representative, Region II  
Regional Operations  
Office of the Assistant Commissioner

### **ATSDR Technical Project Officer:**

Gregory V. Ulirsch  
Technical Project Officer  
Superfund Site Assessment Branch (SSAB)  
Division of Health Assessment and Consultation (DHAC)

### **Any questions concerning this document should be directed to:**

Health Assessment Project Manager  
Consumer and Environmental Health Services  
New Jersey Department of Health and Senior Services  
210 South Broad Street  
P. O. Box 360  
Trenton, New Jersey 08625-0360

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**Appendix A**

**Description of Comparison Values**



## **Description of Comparison Values**

ATSDR's comparison values are media-specific concentrations that are considered to be 'safe' under default conditions of exposure. They are used as screening values in the preliminary identification of site-specific chemical substances that the health assessor has selected for further evaluation of potential health effects.

Generally, a chemical is selected for evaluation because its maximum concentration in air, water, or soil at the site exceed one of ATSDR's comparison values. However, it cannot be emphasized strongly enough that comparison values are not thresholds of toxicity. While concentrations at or below the relevant comparison value may reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a comparison value would be expected to produce adverse health effects. Indeed, the whole purpose behind conservative, health-based standards and guidelines is to enable health professionals to recognize and resolve potential public health problems before they become actual health hazards. The probability that adverse health outcomes will actually occur as a result of exposure to environmental contaminants depends on site-specific conditions and individual lifestyle and genetic factors that affect the route, magnitude, and duration of actual exposure, and not solely on environmental concentrations.

Screening values based on non-cancer effects are generally based on the level at which no health adverse health effects (or the lowest level associated with health effects) found in animal or (less often) human studies, and include a cumulative margin of safety (variously called safety factors, uncertainty factors, and modifying factors) that typically range from 10-fold to 1,000-fold or more. By contrast, cancer-based screening values are usually derived by linear extrapolation with statistical models from animal data obtained at high exposure doses, because human cancer incidence data for very low levels of exposure are rarely available. Cancer risk estimates are intended to represent the upper limit of risk, based on the available data.

Listed and described below are the types of comparison values that the ATSDR and the NJDHSS used in this Public Health Assessment:

**Cancer Risk Evaluation Guides (CREGs)** are estimated concentrations of contaminants in an environmental medium (such as drinking water) that are expected to cause no more than one excess cancer case for every million persons who are continuously exposed to the concentration for an entire lifetime (equaling a risk of  $1 \times 10^{-6}$ ). These concentrations are calculated from the USEPA's cancer slope factors, which indicate the relative potency of carcinogenic chemicals. Only chemicals that are known or suspected of being carcinogenic have CREG comparison values.

**Environmental Media Evaluation Guides (EMEGs) and Reference Dose Media Evaluation Guides (RMEGs)** are estimates of chemical concentrations in an environmental medium (such as drinking water) that are not likely to cause an appreciable risk of deleterious, non-cancer health effects, for fixed durations of exposure. These guides may be developed for special sub-populations such as children. EMEGs are based on ATSDR's minimal risk level (MRL) while RMEGs are based on the USEPA's reference dose (RfD).

Other health-based guides may also be used as comparison values, including drinking water maximum contaminant levels (MCLs) established by the USEPA or the NJDEP.



**Appendix B**

**ATSDR Public Health Hazard Categories**



**ATSDR's Interim Public Health Hazard Categories**

Category/Definition	Data Sufficiency	Criteria
<p><b>A. Urgent Public Health Hazard</b></p> <p>This category is used for sites where short-term exposures (&lt; 1 yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.</p>	<p>The determination represents a professional judgment based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.</p>	<p>Evaluation of available relevant information* indicated that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the presence of serious physical or safety hazards.</p>
<p><b>B. Public Health Hazard</b></p> <p>This category is used for sites that pose a public health hazard due to the existence of long-term exposures (&gt; 1 yr) to hazardous substances of conditions that could result in adverse health effects.</p>	<p>This determination represents a professional judgment based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.</p>	<p>Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have in the future, an adverse impact that requires one or more public health interventions. Such site-specific exposures may include the presence of serious physical or safety hazards.</p>
<p><b>C. Indeterminate Public Health Hazard</b></p> <p>This category is used for sites in which "critical" data are <i>insufficient</i> with regard to extent of exposure and/or toxicologic properties at estimated exposure levels.</p>	<p>This determination represents a professional judgment that critical data are missing and ATSDR has judged the data are insufficient to support a decision. This does not necessarily imply all data are incomplete, but that some additional data are required to support a decision.</p>	<p>The health assessor must determine, using professional judgment, the "criticality" of such data and likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.</p>

*Public Health Assessment: Ciba-Geigy Corporation*

Category/Definition	Data Sufficiency	Criteria
<p><b>D. No Apparent Public Health Hazard</b></p> <p>This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.</p>	<p>This determination represents a professional judgment based on critical data which ATSDR considers sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.</p>	<p>Evaluation of available relevant information* indicates that, under site-specific conditions of exposure, exposures to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.</p>
<p><b>E. No Public Health Hazard</b></p> <p>This category is used for sites that, because of the absence of exposure, do <b>NOT</b> pose a public health hazard.</p>	<p>Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are now occurring, and none are likely to occur in the future.</p>	

\* *Such as environmental and demographic data; health outcome data; exposure data; community health concerns information; toxicologic, medical and epidemiologic data; monitoring and management plans.*

**Appendix C**

**Tables**



Table 1. Chronology of selected activities at the Toms River Chemical Company/Ciba-Geigy Corporation (CGC) Toms River Plant, 1952 to 1999.

Year	Activity
1952	Anthraquinone dye manufacturing started; wastewater discharged to Toms River
1959	Azo dye and epoxy resin manufacturing started
1960	First wastewater treatment plant replaced; wastewater continues to be discharged to river
1966	Treated wastewater discharged to Atlantic Ocean through outfall pipeline
1977	Second wastewater treatment plant replaced
1983	Site added to National Priorities List
1984	Pipeline break at Bay Avenue/Vaughn Avenue
1985	Pipeline break at Bay Avenue/Vaughn Avenue Ciba-Geigy installed purge-well system to intercept and treat groundwater contamination 59 monitoring wells installed at CGC site
1986	Pipeline break at Oak Ridge Parkway Treatment of wastewater with PACT (powdered activated charcoal treatment)
1987	USEPA residential well sampling begins (58 wells)
1988	ATSDR Public Health Assessment and two Health Consultations published Operable Unit 1 (groundwater) Remedial Investigation published Coulter Street/Whitesville Road well sampling Pipeline break Bay Avenue/Hooper Avenue Dye manufacturing ceased Ground water baseline risk assessment (11 indicator chemicals) published
1989	Pipeline break at Mapletree Avenue/Old Freehold Road USEPA issues Record of Decision for Operable Unit 1 (groundwater) Occupational epidemiology study published
1991	Wastewater discharge to Atlantic ocean terminated ATSDR Health Assessment Addenda published - marsh sediments/surface waters; soil TICs Epoxy resin manufacturing ceased
1992	ATSDR Lead Initiative Summary Report published ATSDR Health Consultation published - soil gases
1993	Revised Draft Source Area Remedial Investigation and Baseline Risk Assessment published Cardinal Drive soil gas study USEPA issues Explanation of Significant Differences
1994	On-site soil TIC investigation

*Public Health Assessment: Ciba-Geigy Corporation*

Year	Activity
1995	NJDHSS childhood cancer incidence analysis for Dover Township, 1979-1991
1996	On-site groundwater treatment system operational NJDHSS and ATSDR issue Public Health Response Plan NJDHSS sampling of community water supply and exposure investigation begins On-Site groundwater monitoring (SAMP 4)
1997	NJDHSS sampling of on- and off-site monitoring wells NJDHSS releases Public Health Consultation on childhood cancer incidence, 1979-1995 Design of NJDHSS epidemiologic study of childhood cancer in Dover Township initiated
1998	Long Term Monitoring Plan implemented
1999	Feasibility study issued for Operable Unit 2 (on-site source areas)

Note: See page iv for abbreviations used in the table.

Table 2. Comparison Values (CVs) and cleanup standards for groundwater pollutants to be monitored under the Ciba-Geigy site Record of Decision (ROD), as amended by the Explanation of Significant Difference (ESD), in micrograms per liter (µg/l, or parts per billion).

Contaminant	ATSDR Child CV or USEPA Health Advisory	ATSDR Adult CV or USEPA Health Advisory	ATSDR CREG	Drinking Water MCL	ESD Cleanup Standard
Benzene	--	--	1	1	1
Chlorobenzene	4000	10000	NA	4	3
Chloroform	100	400	6	100	3
Dibromochloromethane	300	1000	0.4	100	5.5
1,2-Dichloroethane	2000	7000	0.4	2	2
Carbon tetrachloride	7	20	0.3	2	2
Ethylbenzene	1000	4000	NA	700	32
Toluene	200	700	NA	1000	26
1,1-Dichloroethylene	90	300	0.06	2	2
trans-1,3-Dichloropropene	--	--	--	--	Monitor
Tetrachloroethylene	100	400	0.7	1	1
Trichloroethylene	20	70	3	1	1
1,1,2,2-Tetrachloroethane	3000	10000	0.2	--	2
1,1,1-Trichloroethane	40000	200	NA	26	15
Methylene chloride	600	2000	5	2	2
Dichlorobenzene	1000	75	--	75	77 (ortho-) 31 (meta-) 10 (para-)
Bis(2-ethylhexyl)phthalate	200	700	3	6	30
Naphthalene	400	20	NA	--	15
Nitrobenzene	5	20	NA	--	10
Phenol	6000	20000	NA	--	10

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Contaminant	ATSDR Child CV or USEPA Health Advisory	ATSDR Adult CV or USEPA Health Advisory	ATSDR CREG	Drinking Water MCL	ESD Cleanup Standard
1,2-Dichloroethylene	200 (trans-)	700 (trans-)	NA	10	10 (trans-) 5 (cis-)
1,2,4-Trichlorobenzene	100	70	NA	8	5
Vinyl Chloride	0.2	0.7	--	2	2
Xylenes	2000	7000	NA	44	20
1,2-Dichloropropane	900	3000	NA	5	1
1,2,3-Trichloropropane	60	200	NA	--	20
Acrylonitrile	100	400	0.06	--	50
Benzidine	30	100	0.0002	--	50
Methyl ethyl ketone	6000	20000	NA	--	150
Acetone	1000	4000	NA	--	700
4-Chlorotoluene	2000	100	NA	--	Monitor
2-Chloroethylvinylether	--	--	--	--	Monitor
2-Chlorotoluene	200	700	NA	--	Monitor
PCBs	0.2	0.7	0.02	0.5	0.5
Styrene	2000	7000	NA	100	50
1,1,2-Trichloroethane	40	100	0.6	5	2
Arsenic	3	10	0.02	50	8
Barium	700	2000	NA	2000	--
Cadmium	7	20	--	5	3
Chromium	200	100	NA	100	50
Copper	--	--	NA	1300 (action level)	10
Selenium	20	70	NA	50	10
Iron	--	--	NA	300	300

*Public Health Assessment: Ciba-Geigy Corporation*

<b>Contaminant</b>	<b>ATSDR Child CV or USEPA Health Advisory</b>	<b>ATSDR Adult CV or USEPA Health Advisory</b>	<b>ATSDR CREG</b>	<b>Drinking Water MCL</b>	<b>ESD Cleanup Standard</b>
Lead	--	--	NA	15 (action level)	10
Manganese	--	--	NA	50	--
Mercury	--	--	NA	2	2
Nickel	200	700	NA	100	22
Zinc	3000	10000	NA	5000	15

Note: See page iv for abbreviations used in the table.

- None established

NA Not applicable

Public Health Assessment: Ciba-Geigy Corporation

Table 3. Results of chemical analyses of selected on-site groundwater monitoring wells at the Ciba-Geigy Corporation site, 1998. Results in micrograms per liter ( $\mu\text{g}/\text{l}$ , or parts per billion). Data source: Eckenfelder, 1999.

Contaminant	Primary Cohansey			Lower Cohansey			MCL	ESD	CREG	Other Comparison Values
	Well 0131	Well 0134	Well 0137	Well 0194	Well 1104	Well 1119				
1,2,3-Trichlorobenzene	490	640					--	8	--	40 (RMEG)
1,2,3-Trichloropropane	40	81	20	50	32	210	--	20	--	40 (LTHA)
1,2,4-Trichlorobenzene	1800	4300	1.4		0.8		8	5	--	70 (LTHA)
cis-1,2-Dichloroethylene	3.4		12	72	24	950	10	5	--	70 (LTHA)
1,2-Dichlorobenzene	370	3900	16	2.1	6.4		600	77	--	600 (LTHA)
trans-1,2-Dichloroethylene			1.2	7.3	3.1	10	10	10	--	100 (LTHA)
1,3-Dichlorobenzene	12	75	4.6				600	31	--	600 (LTHA)
1,4-Dichlorobenzene	160	300	9.7		0.1		75	10	--	75 (LTHA)
Acetone				1300	NM	NM	--	700	--	1000
Benzene	26		12	9.3	2	11	1	1	1	--
Chlorobenzene	1200	120	140	9.3	22	37	4	2	--	100 (LTHA)
Ethylbenzene	2.4		2.4				700	32	--	700 (LTHA)
Methylene chloride	6.3	15	0.8	1.7		7.3	2	2	5	600
Naphthalene	95	85			1.1		--	15	--	20 (LTHA)
o-Chlorotoluene	940	3000	0.6				--	Monitor	--	100 (LTHA)

Public Health Assessment: Ciba-Geigy Corporation

Contaminant	Primary Cohansey			Lower Cohansey			MCL	ESD	CREG	Other Comparison Values
	Well 0131	Well 0134	Well 0137	Well 0194	Well 1104	Well 1119				
p-Chlorotoluene	69	150					--	Monitor	--	100 (LTHA)
Styrene							100	50	--	100 (LTHA)
Tetrachloroethylene	<b>42</b>	<b>230</b>					1	1	0.7	100
Toluene	4.7	5	6.9		2.5		1000	26	--	200
Trichloroethylene	<b>25</b>	<b>35</b>	<b>1.6</b>	<b>340</b>	<b>100</b>	<b>1200</b>	<b>1</b>	1	3	2
Xylenes	<b>11</b>	<b>6.9</b>	1.9				44	2	--	2000 (LTHA)
Arsenic		<b>12</b>		NM	NM	NM	<b>50</b>	8	0.02	3
Cadmium				NM	NM	NM	<b>5</b>	3	--	7
Chromium				NM	NM	NM	100	50	--	100
Lead	<b>10.5</b>			NM	NM	NM	15 (action level)	10	--	--
Mercury	<b>3.93</b>	0.14	0.052	NM	NM	NM	2	2	--	2 (LTHA)
Nickel				NM	NM	NM	100	22	--	100 (LTHA)
Zinc	<b>32</b>	12		NM	NM	NM	5000	15	--	2000 (LTHA)

Note: See page iv for abbreviations used in the table.

**BOLD** Exceeds MCL, ESD, or Comparison Value  
 -- Not Established  
 LTHA Longer Term Health Advisory

No entry  
 NM Not detected  
 Not measured

*Public Health Assessment: Ciba-Geigy Corporation*

Table 4. Concentrations of contaminants in untreated, blended groundwater extracted from Ciba-Geigy site extraction well, average value from January to March 1999, results in micrograms per liter ( $\mu\text{g}/\text{l}$ , or parts per billion). Data source: Ciba, 1999a.

Contaminant	Blended, Untreated Water	MCL	ESD	CREG	Other Comparison Values
1,1,1-Trichloroethane	0.8	26	15	--	200 (LTHA)
1,1-Dichloroethylene	0.3	2	2	0.06	90
1,2,3-Trichlorobenzene	<b>18</b>	--	8	--	40 (RMEG)
1,2,4-Trichlorobenzene	<b>99</b>	8	5	--	70 (LTHA)
cis-1,2-Dichloroethylene	<b>42</b>	10	5	--	70 (LTHA)
1,2-Dichlorobenzene	<b>190</b>	600	77	--	600 (LTHA)
1,2-Dichloroethane	0.3	2	2	0.4	700 (LTHA)
1,2-Dichloropropane	<b>1.2</b>	5	1	--	900
trans-1,2-Dichloroethylene	1.9	10	10	--	100 (LTHA)
1,3-Dichlorobenzene	5.8	600	31	--	600 (LTHA)
1,4-Dichlorobenzene	<b>21</b>	75	10	--	75 (LTHA)
Benzene	<b>3.8</b>	1	1	1	--
Chlorobenzene	<b>170</b>	4	3	--	100 (LTHA)
Chloroform	1.6	100	3	6	100
Ethylbenzene	1.5	700	32	--	700 (LTHA)
Naphthalene	12	--	15	--	20 (LTHA)
Nitrobenzene	<b>31</b>	--	10	--	5 (RMEG)
o-Chlorotoluene	150	--	Monitor	--	100 (LTHA)
p-Chlorotoluene	12	--	Monitor	--	100 (LTHA)

Note: See page iv for abbreviations used in the table.

**BOLD** Exceeds MCL, ESD, or Comparison Value  
 -- Not Established

LTHA = Longer Term Health Advisory  
 RMEG = Reference Dose Media Evaluation Guide

*Public Health Assessment: Ciba-Geigy Corporation*

Table 5. Results of metal and selected organic chemical analyses in soil samples collected by the New Jersey Department of Health and Senior Services, 1996. Results in milligrams per kilogram (mg/kg, or parts per million). Data source: NJDHSS, 1997a.

Contaminant	Old Freehold & Mapletree	Sea Court Mall	Bay and Vaughn	Bay and West	Child Comparison Value
Arsenic	1.12-4.49	ND-0.943	1.68-4.58	1.6-6.3	20, 0.5 (CREG)
Cadmium	ND-2.91	ND-2.72	ND	ND-2.06	40
Chromium	13.9-19.5	2.95-5.92	8.24-15.5	7.16-28.5	50000 (RMEG)
Lead	ND-63.3	ND-21.5	49.9-188	10.8-38.7	None
Mercury	0.035-0.084	ND-0.121	0.037-0.05	0.03-0.102	100
Fluoranthene	0.25 J	ND	0.52J	0.11-0.3J	2000 (RMEG)
Pyrene	0.16-0.19 J	ND	0.4J	0.15-0.22J	2000 (RMEG)
Diethylphthalate	0.22-0.28 J	0.29J	ND	ND	40000 (RMEG)

Note: See page iv for abbreviations used in the table.

J Estimated value  
 ND Not Detected  
 RMEG Reference Dose Media Evaluation Guide  
 CREG Cancer Risk Evaluation Guide

Public Health Assessment: Ciba-Geigy Corporation

Table 6. Results of metal and selected organic chemical analyses in sediment samples collected by the New Jersey Department of Health and Senior Services, 1996. Results in milligrams per kilogram (mg/kg, or parts per million). Results are compared to NJDEP Sediment Guidance or to Ontario (ONT) Ministry of the Interior Sediment Guidelines. Data source: NJDHSS, 1997a.

Contaminant	Sea Court	Breezy Oaks	Raleigh	Bachelor	Bay Lea	Lakehurst	Lakehurst	JC82	JC82	NJDEP	ONT
Fluoranthene	<b>1.19</b>	<b>3.88</b>	ND	<b>7.72</b>	<b>1.77</b>	0.62	ND	<b>0.68</b>	ND	0.65	--
Pyrene	<b>1.15</b>	<b>2.70</b>	ND	<b>7.76</b>	<b>1.77</b>	<b>1.12</b>	ND	ND	ND	0.35	--
Bis(2-ethylhexyl)phthalate	1.31	1.16	0.62	17.11	0.96	1.46	ND	0.75	ND	--	--
Benzo(b)fluoranthene	ND	0.72	ND	5.91	ND	0.91	ND	0.63	ND	--	--
Benzo(k)fluoranthene	<b>1.40</b>	<b>0.26</b>	ND	ND	<b>2.26</b>	<b>0.55</b>	ND	ND	ND	--	0.24
Diethylphthalate	ND	ND	0.29	ND	0.32	1.67	0.82	ND	ND	--	--
Benzo(a)Pyrene	ND	ND	ND	ND	<b>0.92</b>	<b>0.89</b>	ND	ND	ND	--	0.37
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	<b>0.79</b>	<b>1.31</b>	ND	ND	ND	--	0.20
Benzo(ghi)perylene	ND	ND	ND	ND	<b>0.73</b>	ND	ND	ND	ND	--	0.17
Arsenic	<b>9.84</b>	<b>7.82</b>	3.54	<b>17.9</b>	<b>11.5</b>	<b>30.6</b>	2.66	<b>7.26</b>	<b>6.77</b>	--	6
Chromium	<b>10.1</b>	<b>6.61</b>	<b>7.10</b>	<b>31.1</b>	<b>21.5</b>	<b>22.6</b>	<b>8.91</b>	<b>12.7</b>	<b>140</b>	--	0.6
Cadmium	<b>2.36</b>	<b>2.00</b>	<b>2.32</b>	<b>4.79</b>	<b>2.13</b>	ND	ND	<b>2.14</b>	ND	--	0.6
Lead	<b>43.1</b>	<b>35.7</b>	12	<b>921</b>	<b>130</b>	<b>80.6</b>	18.8	<b>39.6</b>	<b>36.8</b>	--	31
Mercury	0.06	0.05	0.03	<b>0.50</b>	0.08	<b>2.31</b>	<b>1.08</b>	<b>1.20</b>	<b>0.84</b>	0.15	--

Note: See page ii for abbreviations used in the table

**BOLD** Exceeds NJDEP or Ontario Sediment Guidelines

ND Not detected

-- No guidance available for comparison

Table 7. Results of metal and selected organic chemical analyses in private residential well samples collected by the New Jersey Department of Health and Senior Services, 1996, near the Ciba-Geigy Corporation site (see Figure 8). Results in micrograms per liter ( $\mu\text{g}/\text{l}$ , or parts per billion). Data source: NJDHSS, 1997a; NJDHSS, 1997c.

Well	Lead	Mercury	Chloroform	TCE	MTBE
A	14.9		0.9		
B	4.4		3		0.5
C	1.9				
D	3.2		0.9		
E	1.7				
F	2.8		1		0.5
G	11.3			0.4	
H	3.2				
I	3.6		1		
J	4.7	0.07			
Drinking Water MCL	15 (action level)	2	100*	1	70

Note: See page iv for abbreviations used in the table.

TCE Trichloroethylene

MTBE Methyl tertiary-butyl ether

\* Total for Chloroform and three other trihalomethanes



**Appendix D**

**Figures**



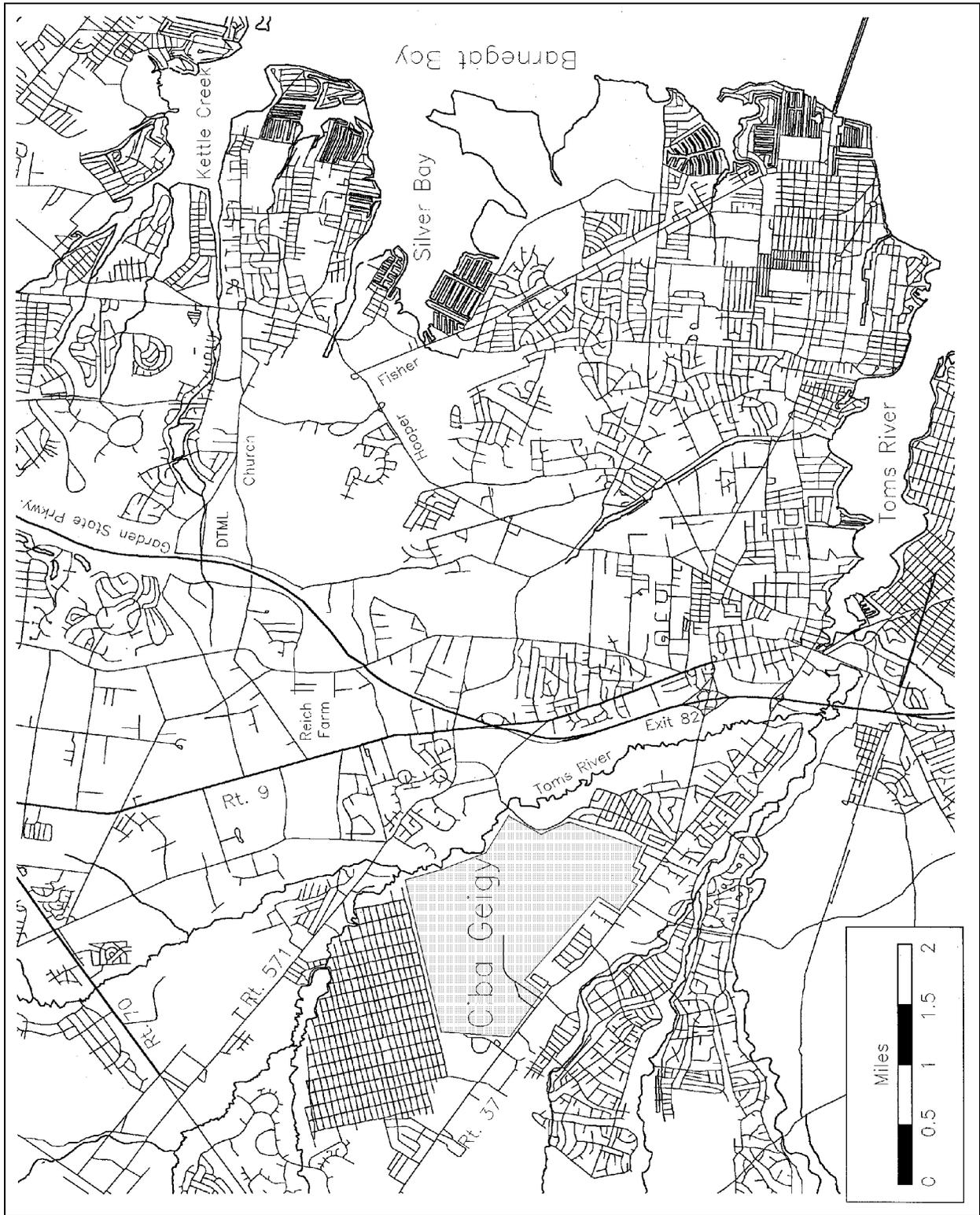


Figure 1 - Location of the Ciba Geigy Corp. Plant in Dover Township, N.J.

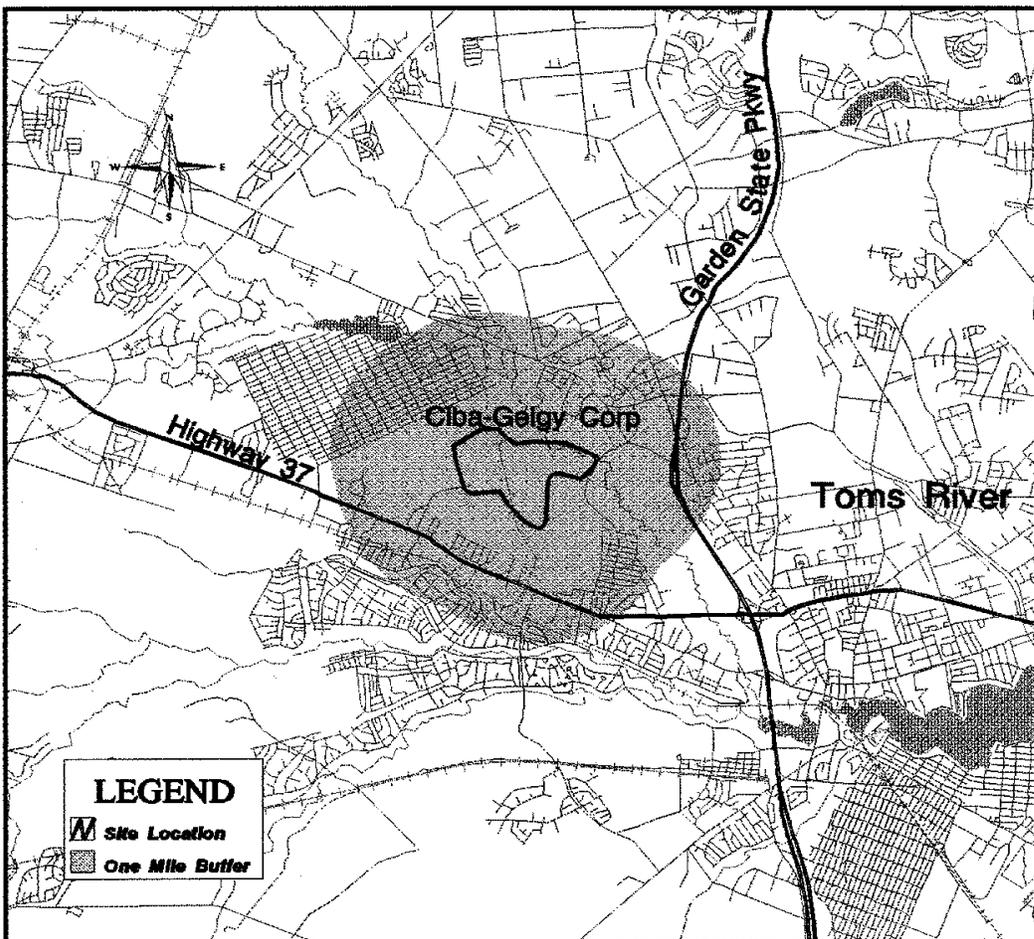


Figure 2 - Demographic Statistics within one mile of the Ciba Geigy Corp. Site

Population of Dover Township	76,371 (1990)
Total Population with 1 Mile	10,725
White	10,226
Black	86
American Indian	1
Asian	125
Hispanic	240
Other	47
Children Aged 6 and Under	855
Adults Aged 65 and Older	2,879
Females Aged 15-44	1,971
Age 18 and Older	8,036
Age Under 18	2,447
Total Housing Units	4,300

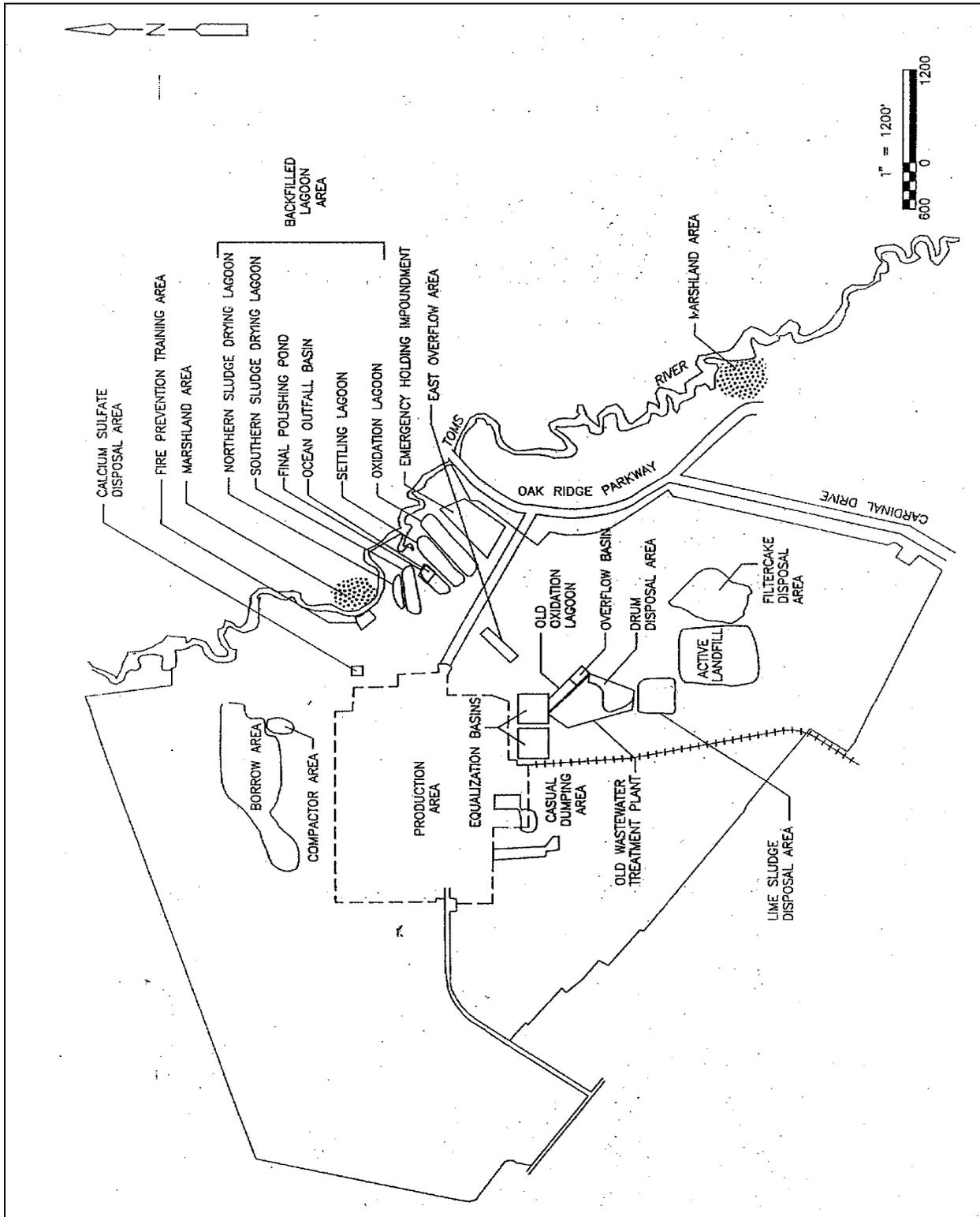


Figure 3 - Ciba Geigy Corp. Toms River plant site

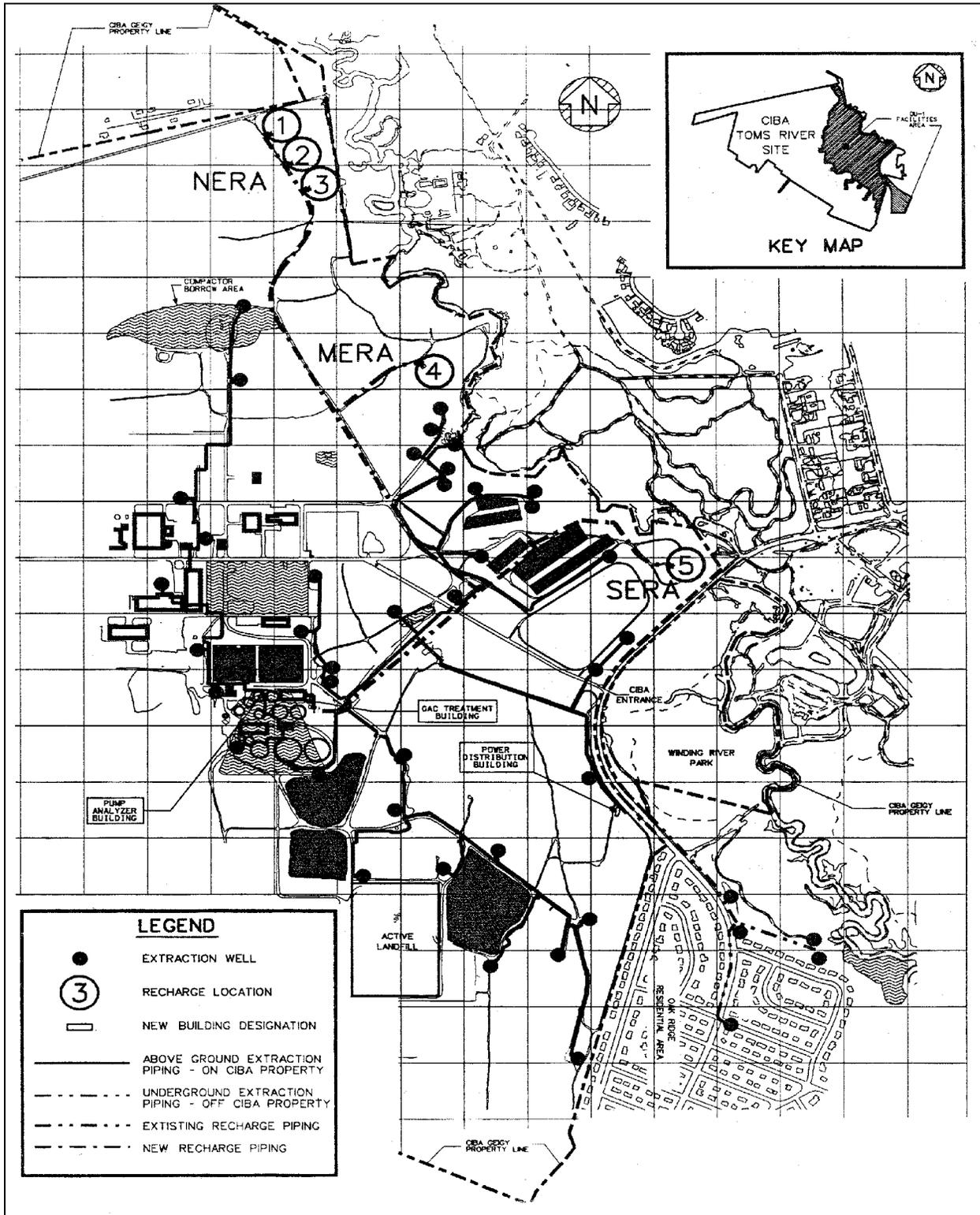


Figure 4 - Ciba Geigy; Groundwater Extraction and Recharge

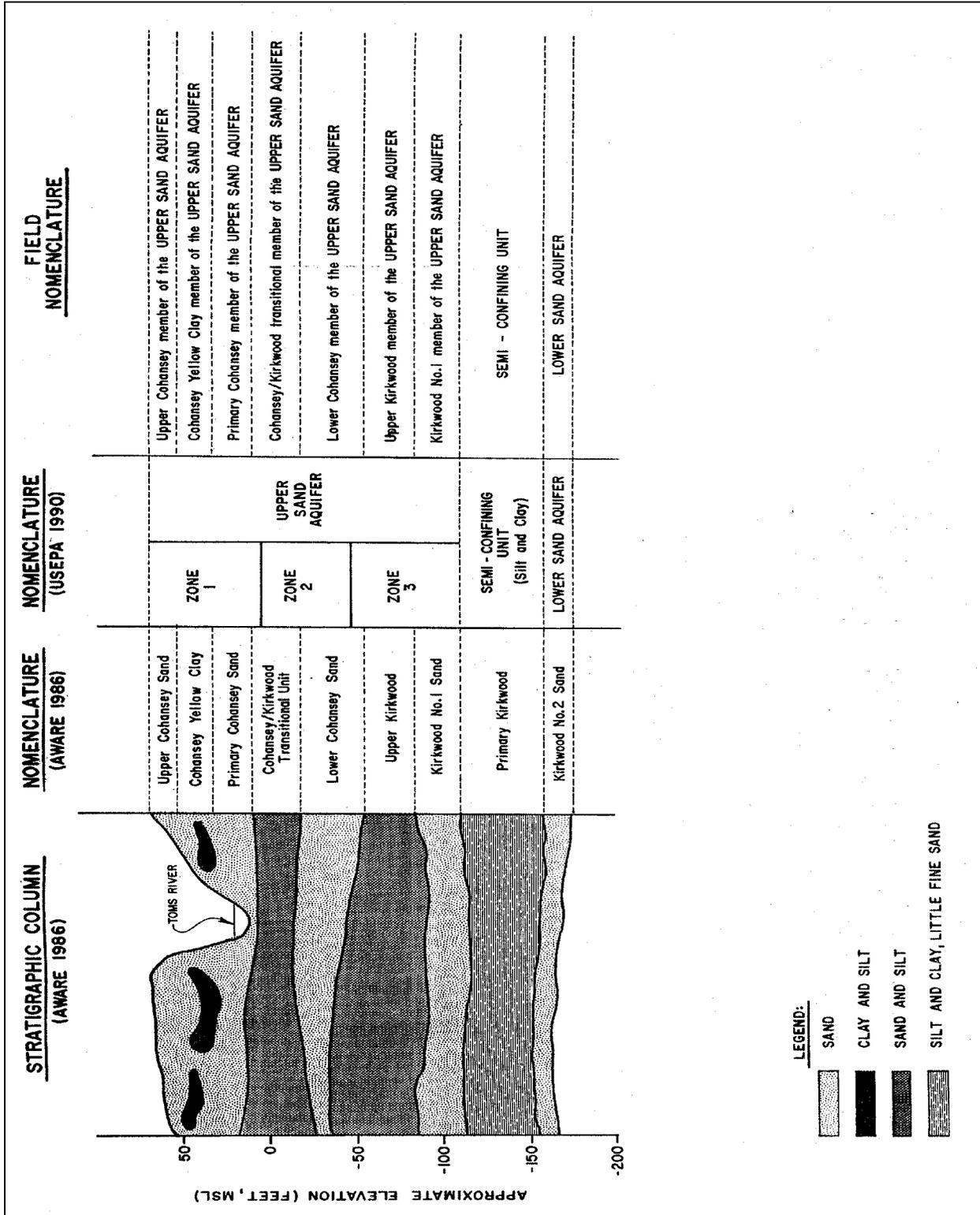


Figure 5 - Groundwater Stratigraphy near Ciba Geigy, Toms River, N.J.

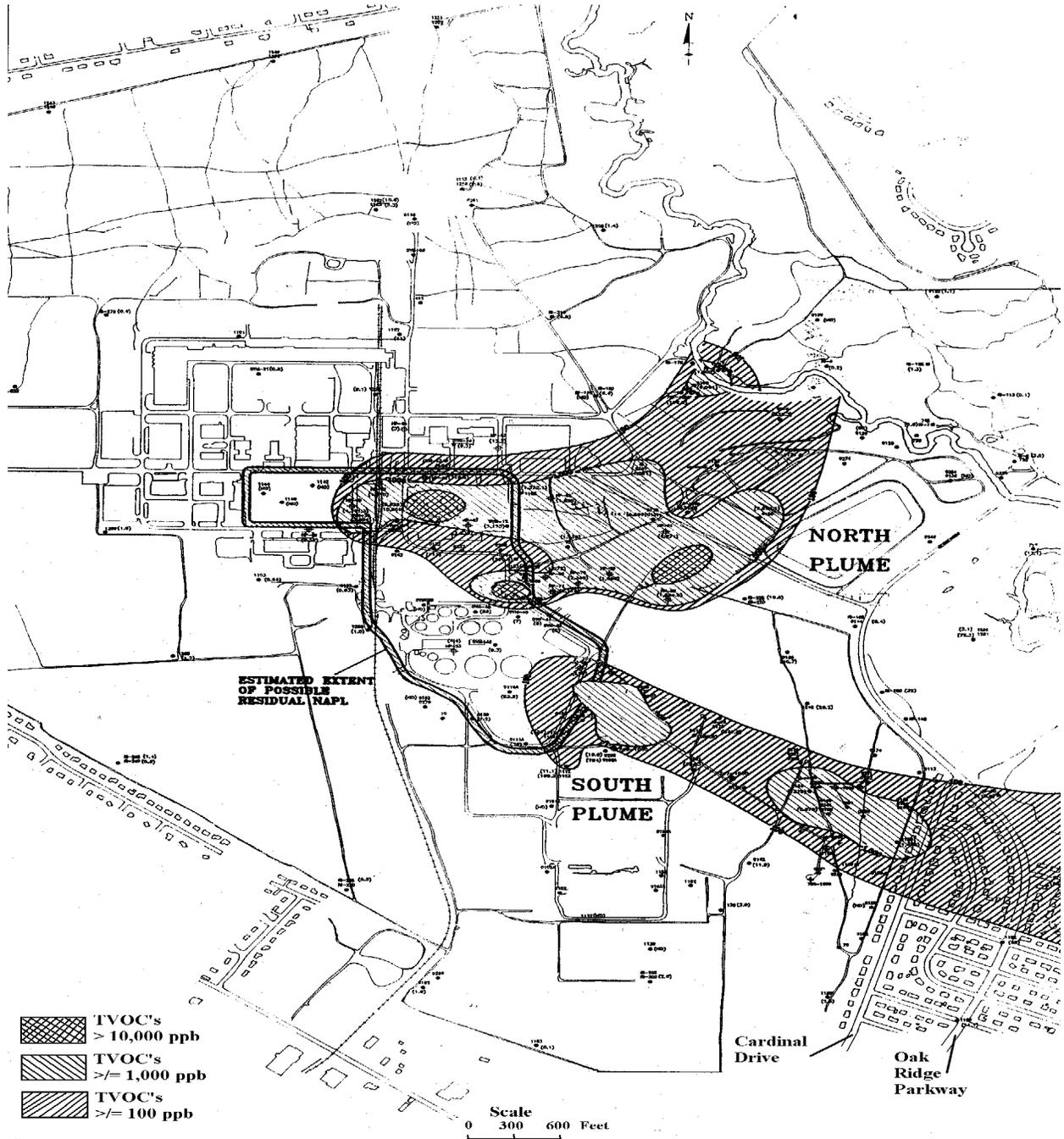


Figure 6 - Groundwater Contamination Plumes, Ciba-Geigy Corporation Site

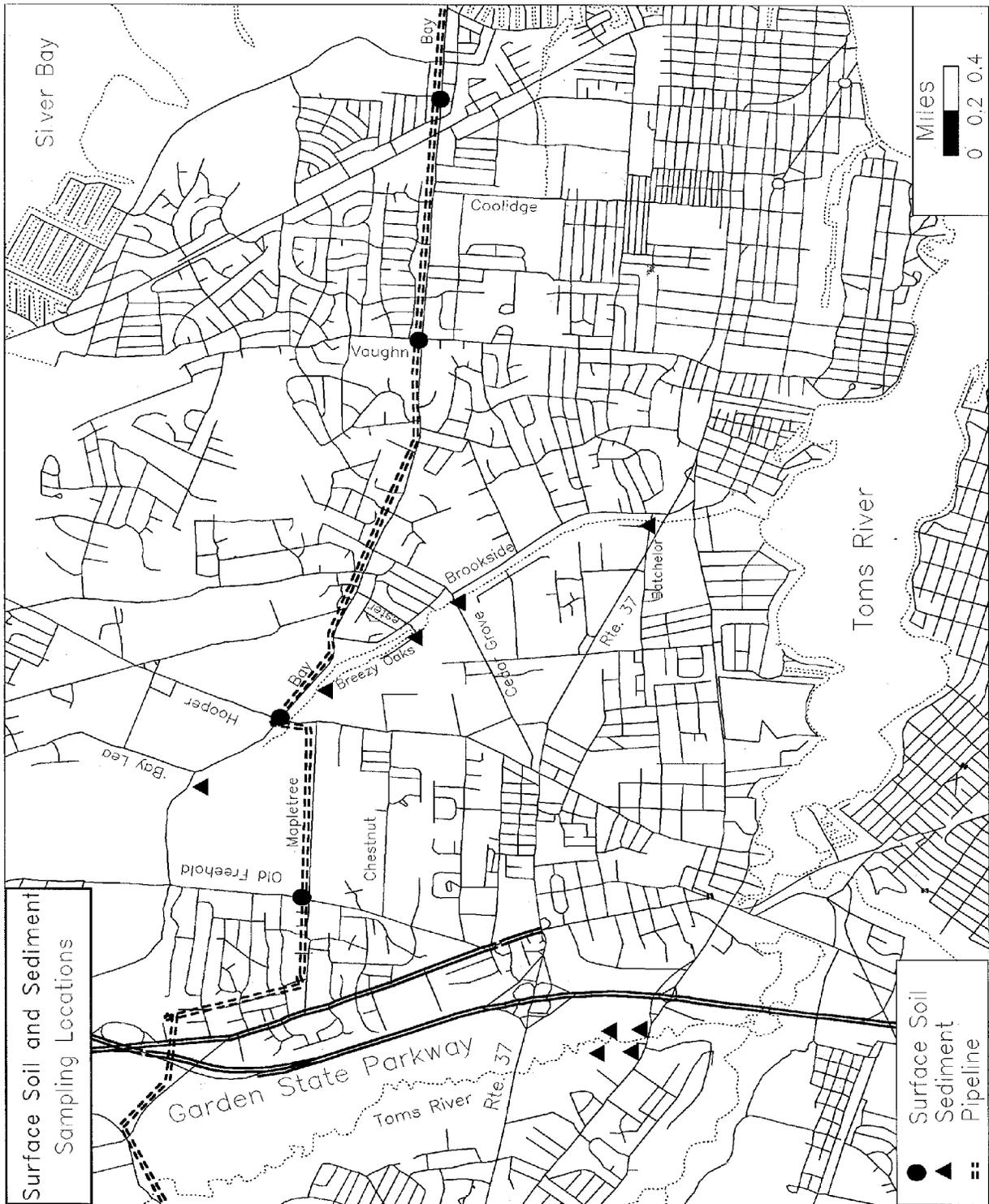


Figure 7 - Location of Ciba Geigy outfall Pipeline, with surface soil and sediment sampling locations of the ATSDR/NJDHSS exposure investigation.

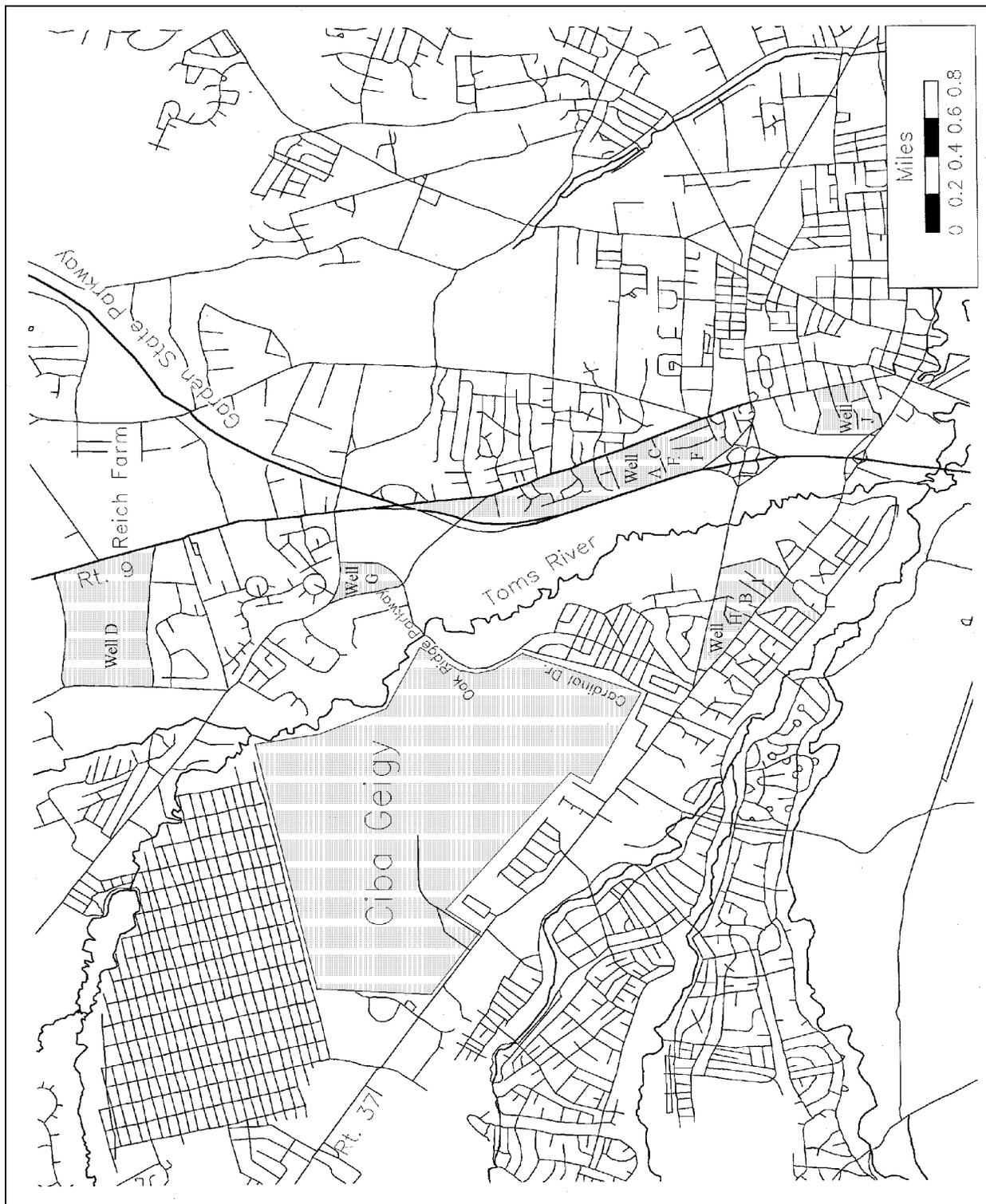


Figure 8 - General locations of Private Wells Associated with the Ciba Geigy Corp. site, sampled during the ATSDR/NJDHSS Exposure Investigation.

**Appendix E**



## Appendix E

### Summary of Public Comments and Responses Ciba-Geigy Corporation Public Health Assessment

This summary presents the comments received from interested parties on the public comment draft of the Ciba-Geigy Corporation Public Health Assessment, and the subsequent responses of the NJDHSS and the ATSDR. The public was invited to review the draft Public Health Assessment during the public comment period which occurred February 29 through April 28, 2000. Questions regarding this summary or any aspect of this Public Health Assessment may be addressed to the New Jersey Department of Health and Senior Services at (609) 633-2043.

Comments are grouped by commenter, without personal identifiers. Note that page numbers in the comments and responses refer to the public comment draft of the Public Health Assessment.

#### **Commenter A:**

*Comment in cover letter:*

*“One issue that needs to be addressed is deep well injection of waste, please address this issue in the revised health assessment.”*

Response to comment in cover letter:

The Public Health Assessment focuses on analysis of human exposure pathways associated with the CGC site. There are no human exposure pathways issues associated with “deep well injection of waste” to the knowledge of the NJDHSS and the ATSDR.

*Comment 1:*

*“You still have potential contact with the plume in Winding River Park as the plume makes its way to the surface within the park.”*

Response 1:

The draft Public Health Assessment addressed the issue of Winding River Park on pages 6 and 14. The ATSDR evaluated available data regarding contamination in the Winding River Park area and found it not to constitute a threat to public health (cited as ATSDR, 1991a in the Public Health Assessment). The final version of the Public Health Assessment will include an expanded discussion of surface water and sediment contamination data for the marshland portion of the park. Further details of the characterization of the Winding River Park are given in the documents cited in the Public Health Assessment.

Comment 2:

*“There had been discharges from the water retention basins since then.”*

Response 2:

The Public Health Assessment notes (page 12) that discharges to the river occurred after the construction of the ocean outfall pipeline.

Comment 3:

*“The Ciba site still represents a “public health hazard” due to contact with the groundwater plume in Winding River Park. Please address this issue.”*

Response 3:

The ATSDR has evaluated exposure pathways associated with Winding River Park and found it not to constitute a threat to public health. Please refer to Response 1.

Comments 4 and 5:

*“The cleanup itself may become the potential for future human exposure to site related contaminants.”*

Response 4 and 5:

An evaluation of the Proposed Remedial Action Plan for Operable Unit 2 (on-site soils) for the CGC site was prepared by ATSDR, separate from this Public Health Assessment. The ATSDR Public Health Consultation reviewed the USEPA’s plan for potential public health implications. The Public Health Consultation (completed in August 2000) will be mentioned in the final version of the Public Health Assessment.

Comment 6:

*“...Ciba officials on their last tour mentioned that they have a lot of problems with hunters, etc. There is no 24 hour coverage of the site by Ciba personnel.”*

Response 6:

The health risk to trespassers on the Ciba site was evaluated in the “Revised Draft Baseline Public Health Risk Assessment for Source Area Surface Soils” (Reference CDM, 1993e), and was found to be minimal. However, the NJDHSS and the ATSDR do concur that unauthorized access and contact with contaminated areas on the site is possible. Therefore, it has been characterized as a potential pathway. The NJDHSS and the ATSDR will add a recommendation that site security measures be maintained to control trespassing.

*Comment 7:*

*“Breaks in the pipeline went undetected until the public reported them.”*

Response 7:

The Public Health Assessment evaluated potential human exposure pathways with the CGC site, including issues associated with the pipeline (page 14). Breaks in the ocean outfall pipeline do not appear to have resulted in groundwater contamination affecting private wells.

*Comment 8:*

*The comment suggests that mention should be made of the location of a nearby elementary school, and that changes should be made in the directions of certain features relative to the site.*

Response 8:

The Public Health Assessment will note the location of the elementary school. The location of Winding River Park will be changed to “east and northeast.”

*Comment 9:*

*“Why is the number of drums being underestimated? Why isn’t Cell 1 part of the remediation of the Ciba site? What guarantees do we have that there are no liquids or hazardous waste in this cell?”*

Response 9:

The most recent estimate provided to the NJDHSS and the ATSDR by the USEPA is that there are a total of 31,000 intact and non-intact drums on the site. Questions regarding the delineation and remediation of the site should be addressed to the USEPA.

*Comment 10:*

*“Please explain the source for mercury in these wells, since it is not mentioned.”*

Response 10:

The USEPA has determined that mercury detected in private wells in the Coulter Street area was not site (CGC) related (see page 5 of the PHA). Low levels of mercury are known to be present in many places throughout the Cohansey-Kirkwood aquifer, which is used for drinking water across southern New Jersey. The source or sources of mercury are not well defined.

*Comment 11:*

*“The marshland is east or parallel to the homes, which would make the airborne contaminant information valid.”*

Response 11:

In its 1988 Public Health Assessment, the ATSDR felt that air samples in the residential area would provide better information on human exposure potential than would marshland samples.

*Comment 12:*

*“What is the status of this additional Public Health Assessment? Please provide a copy.”*

Response 12:

Following the recommendation found in the “Lead Initiative Summary Report,” two additional Public Health Consultations were performed by ATSDR, in 1992 and 1993. This Public Health Assessment is the next and most recent public health evaluation by the ATSDR and the NJDHSS.

*Comment 13:*

*“What are the results of this additional sample? Please provide a copy.”*

Response 13:

Soil gas and flux emission samples were taken in the Cardinal Drive/Oak Ridge Parkway vicinity and are described in the Public Health Assessment on page 14.

*Comment 14:*

*“When will we receive this document?” (Referring to a document summarizing monitoring well data)*

Response 14:

A Public Health Consultation which presents data collected by the NJDHSS on the monitoring wells at Ciba-Geigy, Reich Farm, and the Dover Township Municipal Landfill will be completed in early 2001.

*Comment 15:*

*“Why not sample to ensure there are no airborne contaminants?”*

Response 15:

The incidents which are discussed on page 18 of the PHA occurred in the past. Sampling for airborne contaminants at the present time would shed no light on potential air exposures in the past. The Environmental

and Occupational Health Sciences Institute (EOHHSI), in cooperation with the NJDHSS and the ATSDR, recently released a report of ambient air monitoring of volatile organic chemicals. Two locations, including the West Dover Elementary school near the Ciba-Geigy site, were sampled biweekly for one year. Results did not indicate that unusual levels of volatile organic chemicals were present in Dover Township air.

*Comment 16:*

*“Ciba officials have stated that they still have a lot of problems with hunters, etc. No 24 hour staff on site.”*

Response 16:

See Response 6.

*Comment 17:*

*“You only mention the Cincinnati workers. This study also applied to elevated cancer rates among Toms River site workers.”*

Response 17:

According to the references cited in the Public Health Assessment, the excess in bladder cancer, kidney cancer and central nervous system cancer death was limited to the former Cincinnati Chemical Works workers who later worked at Toms River Chemical/Ciba-Geigy. The Public Health Assessment (page 20) also states that lung cancer death was elevated among maintenance workers, and that stomach cancer and central nervous system cancer was elevated among azo dye production workers at the Toms River plant.

*Comment 18:*

*“The completed human pathways to contaminants has not fully been interrupted, the issues with Winding River Park plume exposure is still possible with children and adults using this park.”*

Response 18:

See Response 1, 3 and 13.

*Comments 19 and 20:*

*“Please change the categorizing of the Ciba-Geigy site to “Urgent Health Hazard” based on the above and the cleanup of OU-2 options. No matter which option is chosen airborne contaminants have a very strong possibility of being released.”*

Response 19 and 20:

Based upon data and information reviewed for this PHA, the CGC site was evaluated to represent a

public health hazard because of past exposures, and currently represents no apparent public health hazard. There are currently no completed exposure pathways that would meet the conditions for categorization as an “Urgent Public Health Hazard” (see Appendix B of the Public Health Consultation).

*Comment 21:*

*“Please change this to “must evaluate.”*

Response 21:

See Response 4 and 5.

*Comment 22:*

*“When will these separate documents be released?”*

Response 22:

See Response 14.

*Comment 23:*

*“As stated previously, there is a need to educate the public as to the Health Hazards, both on and off the Ciba site.”*

Response 23:

A “Citizens Guide to the Ciba-Geigy Public Health Assessment” has been prepared and distributed. Seven Health Care Provider Updates have been prepared to assist health care providers in understanding the overall childhood cancer investigation underway in Dover Township. In addition, the NJDHSS and the ATSDR have been participating at the regular meetings of the Citizens’ Action Committee on Childhood Cancer Cluster. The Public Health Assessment notes that NJDHSS will continue to assess the need for future community and health care provider education.

*Comment 24:*

*The comment includes several suggestions to improve the tables. “Table 6, Please explain the reason why the soil samples for the Bay Lea area are so high, the pipe line did not run through this area.” “Table 7, Is there a known reason for mercury to show up in the downtown area of Toms River, letter J.”*

Response 24:

Where appropriate, tables in the PHA have been modified to reflect the suggestions.

As stated in the Public Health Assessment, the values for polycyclic aromatic hydrocarbons and

metals appear to be typical of sediments in urban areas (for example, from road tars or automobile emissions). There is no connection with the pipeline.

Regarding mercury, see Response 10.

*Comment 25:*

*“Overall this report is missing some important facts.*

- 1. No mention of Ciba officials being indicted for illegal waste disposal.*
- 2. The chemical leachate from solvents buried in Cell 1 were known to penetrate the liner ... How can the cleanup of this cell be ignored?*
- 3. No mention of the cliff dumping (disposal) prior to the early 1970s...*
- 4. 1978, (December), Ciba-Geigy Corporation headquarters designated the Toms River as the disposal site for off-specification, non-salable and damaged materials...*
- 5. ...DEP study shows CG/TRC effluent highly toxic...*
- 6. 1983, the drummed chemical waste, buried in “Chem Bury Dump” ... was determined to be the cause of ground water contamination...*
- 7. ...a bioassay test was performed using Mysid shrimp, 100% mortality occurred within 24 hours...*
- 8. ...DEP orders Cell 2 closed when inspections uncovered buried drums...*
- 9. Four hundred and nine (409) drums of pit drainings were excavated from Cell 2. Three hundred fifty-two (352) drums contained liquid.”*

Response 25:

The purpose of this Public Health Assessment is to analyze and report human exposure pathways that are associated with the Ciba-Geigy Corporation plant site. Completed past exposure pathways that were identified include (1) exposure to groundwater contaminated with dyes and nitrobenzene that was pumped by the Toms River Water Company into the community water supply at the Holly Street well plant in 1965-1966, and (2) exposure to VOCs in groundwater that was found in private wells (used for irrigation) in the Cardinal Drive/Oak Ridge Parkway vicinity near the southeast boundary of the Ciba-Geigy property in 1985-1988. Other issues that are raised in this comment relating to the site source areas are described in detail in remedial investigations and other study reports conducted under the authority of the USEPA or the NJDEP. Many, but not all, of these documents are referenced in the Public Health Assessment.

**Commenter B:**

*Comment 1:*

*“The health assessment does not fully address the implications of the chlorine dioxide treatment used on Holly Street wells from 1965 through 1981.”... “The Toms River Water Company continued to believe that phenolic compounds might be present in the water in the 1970s.” ... “The public health aspects of chlorine dioxide treatment through 1981 and phenolic contamination of the drinking water into the 1970s are not addressed by the PHA.”*

Response 1:

On page 16, the draft Public Health Assessment states that the full nature, magnitude and duration of contamination of the Holly Street wells are not known. Compound specific data exists for nitrobenzene and diazotizable dyes in the 1965 to 1966 time period. The term “phenolic compounds” is not specific and may apply to a wide group of chemicals with a similar structure (phenol derived) and from a variety of sources. Potential reaction products through contact with chlorine cannot be predicted accurately.

*Comment 2:*

*“The report does not even mention that Wells 14 and 18 were also treated with chlorine dioxide as well as Well 13.”*

Response 2:

In the discussion of analytical data on contaminants in the community water supply in 1965 (page 13), the Public Health Assessment states, “...water from Well #13 was treated with chlorine at 8 ppm to reduce coloration...” This information is documented for well #13 in the citation given in the text of the Public Health Assessment. It is standard practice to add chlorine (in the form of chlorine gas, sodium hypochlorite, chlorine dioxide, or chloramine) or ozone to drinking water as disinfecting agents to reduce the threat of water-borne infectious diseases. However, the chlorine dose used to reduce color in well #13 is higher than is typically used for routine disinfection.

*Comment 3:*

*“The PHA utterly failed to address the significance of analytical data from the Holly Street wells in the 1970s and 1980s.” In addition, “No effort was made to determine whether the Silvia, infra red oil and grease readings found on Holly Street wells might be related to continual infiltration of contaminated river water to those wells.”*

Response 3:

The Sylvia and oil and grease methods are not compound specific, quantitative, or standardized. The NJDHSS and the ATSDR established a completed human exposure pathway in the past on the basis of compound specific data regarding nitrobenzene and azo dyes. On pages 15 and 16, the PHA states that the full nature of the contaminant profile, the magnitude of potential contaminants present, and the duration of the pathway associated with the Holly Street wells are unknown.

*Comment 4:*

*“A 1986-1987 joint research project of the U.S. EPA and the DEP used Synchronous Excitation fluorescence to analyze swamp water taken from Winding River Park. This showed the presence of Ciba effluent in Winding River Park in 1986, suggesting that even at that late date the river was still contaminated with varying concentrations of dyes and pesticides.”*

Response 4:

The NJDEP/USEPA Progress Report “Evaluation of Analytical Parameters to Monitor Fluorescence Components in Industrial Effluent,” dated March 3, 1987, reported spectra for samples taken from the Raritan River, Arthur Kill, Winding River Park, and ocean surf that were spiked with Rhodamine dye and analyzed using the Synchronous Excitation Fluorescence detection method. It is not possible to determine the identity or concentration of any contaminants from the one figure in the report that shows spectra from samples taken in the Winding River Park.

*Comment 5:*

*“To better evaluate the history and nature of exposure of the people of Toms River to contamination coming from the Toms River through the Holly Street well pathway, we suggest several borings be taken of the soil in the area between the river and the Holly Street wells.”*

Response 5:

Analysis of water from the wells is a more direct method of determining the quality of potable water in the Holly Street wells. It does not appear likely that deep soil samples would reveal useful information about historic movement of contaminants, particularly those that are water soluble.

*Comment 6:*

*“Finally, the report never addresses the fact that a 1981 Ames test of Ciba’s effluent produced a very positive mutagenicity response.”*

Response 6:

Aniline and similar nitrogen-containing aromatic compounds are known to elicit a positive Ames test. The Public Health Assessment does address the potential public health implications of these chemicals in completed human exposure pathways. The NJDHSS and the ATSDR mention in the Community Concerns section (page 6) that the ocean discharge was a subject of community concern. Aspects of potential exposures associated with the pipeline breaks (surface soils, sediments, and groundwater) were evaluated in the Public Health Assessment and the associated exposure investigation. The ATSDR and the NJDHSS have reviewed the available information on potential exposure through the marine environment, but deemed it insufficient to characterize a potential exposure pathway.

*General Comment:*

*Regarding the Disposal Safety, Inc. document entitled “Tentatively Identified Compounds of the Ciba-Geigy Site”, authored by William P. Eckel, the comment states that “[I]t is incredible that the New Jersey Department of Health, Department of Environmental Protection, and the ATSDR could reach a conclusion that there is no present health threat posed by the Ciba site whether there has not been an adequate analysis of the fate and transport of the chemicals disposed of there.”*

Response:

The NJDHSS and the ATSDR concluded that the Ciba-Geigy site was a public hazard because of past completed human exposure pathways and evaluation of the public health implications of contaminants in those pathways (page 24 of the Public Health Assessment). While it is known that the source areas of the Ciba-Geigy site remain contaminated by chemicals, the NJDHSS and the ATSDR have concluded that, currently, there is no completed human exposure pathways associated with the site. The “no apparent public health hazard” category reflects this status. While the CGC site continues to present an environmental threat, no one is currently being exposed.

In the Public Health Assessment, the ATSDR and the NJDHSS support the on-going “efforts by the USEPA and Ciba Specialty Chemicals to contain and remove contaminants on the Upper Sand Aquifer...restrictions on the use and construction of private wells in areas known to be affected by CGC site-related contamination...[and]...efforts to remediate on-site source areas to reduce the threat of further contamination of groundwater and prevent future exposure.”

**Commenter C:**

*Comment 1:*

*“Direct Toms River discharge of Ciba production waste occurred from 1952-1966. Despite the introduction of the Atlantic discharge pipeline use in 1966, natural discharge of groundwater from the Ciba site to the Toms River continued after the pipeline was installed. The five (5) eastern Ciba property boundary hydraulic control wells along the Ciba/Cardinal Drive fence line, installed in approximately 1985, did not prevent off-site migration of the Southern contaminant plume, nor did they circumvent continuous contaminated groundwater discharge to the Toms River. Perhaps the elimination of the phrase “and/or interrupted” from page 24, PHA paragraph 4, would be more accurate.”*

Response 1:

The document will be modified to reflect this comment, based upon the following information. The installation of the pipeline eliminated the wastewater that was intentionally directed to the Toms River. However, the PHA cites that it was known in 1969 (Reference TRCC, 1969) that there was a discharge of wastes to the Toms River to the extent of roughly 200,000 gallons per day (120,000 gallons seeping from existing unlined basins in the biological treatment plant, and approximately 70,000 gallons per day from sludge lagoons). However, although waste waters from CGC were known to have seeped into the Toms River after the outfall pipeline was installed, there is no compound specific evidence that water from the Toms River was drawn into the Holly Street wells after 1965-1966. The PHA does state that the full nature, magnitude, and total duration of this pathway is unknown, based upon information available to the NJDHSS and the ATSDR. The private well pathway in the Cardinal Drive/Oak Ridge Parkway area was interrupted when those wells ceased to be used for irrigation purposes in 1989-1990.

*Comment 2:*

*Toms River Company wells #13, #14, and #18 were documented to have contributed Ciba contaminants via the Toms River to the public water distribution system in the mid-sixties. Information from a variety of sources has yielded the table below. Note that #13, #14, #18, #19, and #21 (currently in use) are or were all shallow Cohansey wells located in the Holly Plant. It would appear from the listed sealing data of 1983 for #14, #18, & #19 that these three shallow Cohansey wells were in operation for at least part of the same time frame.” In addition, “[A]lthough it was known in 1965-1966 that shallow wells located next to the Toms River in the Holly Plant Wellfield drew river water into the distribution system, as these wells were deemed unusable, they were replaced by shallow wells still located adjacent to the Toms River in the Holly Plant Wellfield.”*

Response 2:

The dates of use for the Toms River Water Company (now United Water Toms River) wells are given in Table 1 in the document, “Public Health Consultation: Drinking Water Quality Analyses, March 1996 to June 1999, United Water Toms River,” by the NJDHSS, the NJDEP, and the ATSDR.

Comment 3:

*“Please consider that contaminants, over the course of years, possibly many years, may have adhered or adsorbed to the insides of the distribution lines. This was probably inconsistent due to the lack of uniformity of distribution line materials. Perhaps the naturally acidic groundwater, or change in treatment techniques could have acted upon the build-up of contaminants on the insides of the distribution system lines, causing the contaminants to desorb or solubilize into the water. This could have been problematic particularly in the dead-ends of the system distribution lines, or lines delivering water to seasonally higher use areas of the township.”*

Response 3:

The composition of pipes in the current UWTR system is known (see the ATSDR report, “Analysis of the 1998 Water-Distribution System Serving the Dover Township Area, New Jersey,” ATSDR (2000), page 35 and Table 8 on page 37). However, there is no information available to evaluate this comment.

Comment 4:

*“Recent site investigation has shown that the Holly Plant wellfield is not currently impacted by the former coal gasification plant. Prior to the installation of the GSP (1954), could earlier wells (#1 through #12, before 1946 Water Company ownership by General Water Works) have been impacted by PAHs from Adafre Street Coal Gasification Plant activities?”*

Response 4:

The NJDHSS and the ATSDR did not review information regarding wells #1-#12 and the time period in question in the context of the Public Health Assessment for the Ciba-Geigy Corporation site, since the period predates the existence of the Toms River Chemical Company. In addition, this period precedes the time frame of the childhood cancer epidemiologic study (1962 through 1996).

Comment 5:

*“Do records exist reflecting historic location information of Holly Plant wells #1 -#12?”*

Response 5:

The NJDHSS and the ATSDR have no information on the locations of Wells #1 through #12. However, as noted above, use of these wells ended before the time frame of the childhood cancer epidemiologic study (1962 through 1996).

Comment 6:

*“I would suggest standing water areas to the East and West of the Toms River, adjacent or contiguous to Ciba property, or known areas of contaminant up-welling (next to the River) be fenced and posted to prevent children from dermal, inhalation or accidental ingestion of contaminants documented to be found in these Marshland areas, including, but not limited to, Winding River Park, Equestrian Park and Albocondo Campground.”*

Response 6:

The ATSDR and the NJDHSS did not conclude that there is a completed human exposure pathway associated with these areas. As such, the Public Health Assessment does not contain the recommendation suggested above. In 1991, the ATSDR evaluated available data regarding contamination in the Winding River Park area and found it not to constitute a threat to public health (cited as ATSDR, 1991a in the Public Health Assessment). The final version of the Public Health Assessment will include an expanded discussion of surface water and sediment contamination data for the marshland portion of the park.

Comment 7:

*“It should be noted in the Public Health Assessment that no formal Groundwater Impact Area has been established off-site by either the NJDEP nor the USEPA. A suggestion should be made in the PHA for USEPA or NJDEP to do so. This action could also be used to establish boundaries for posting, fencing and for preventing any private well installation for any purpose within the established boundary.”*

Response 7:

The Public Health Assessment concluded on page 24 that the “...exposure pathway associated with private wells in the Cardinal Drive/Oak Ridge Parkway areas has been interrupted through a well testing and sealing initiative by the CGC and the USEPA, and regulatory efforts by the Ocean County Health Department to monitor the location, and ensure the quality of, new wells in potentially affected areas.” Further (page 25), the ATSDR and NJDHSS “...support restrictions on the use and construction of private well areas known to be affected by CGC site-related contamination.” Although there is no formal designation of a Groundwater Impact Area, the potential exposure pathway has been interrupted through existing mechanisms.

Comment 8:

*“In-situ thermal treatment was formally dropped in the Draft Feasibility Study, Page 7-13.”*

Response 8:

The ATSDR has reviewed the Proposed Remedial Action Plan (PRAP) for Ciba-Geigy Operational Unit 2 (Source Areas) and prepared a separate Public Health Consultation which has been shared with the community. The section of the Public Health Assessment (page 9) discussing the *in/ex situ* treatment option will be updated and revised.

*Comment 9:*

*“Page 13, PHA, notes that water from TRWC well #13 was treated with 8 ppm of Chlorine to reduce the color prior to distribution. By today’s standards, that would be translated as 8,000 ppb, exceeding the current TTHM standard of 100 ppb ceiling for total disinfection by-products by 80 times. Keeping in mind that the current Safe Drinking Water Standard of 100 ppb has been proposed to be lowered, the addition of 8,000 ppb in 1965, for the purpose of disguising the Ciba production (dye) coloration is disturbing news. Perhaps an exposure risk evaluation should be included for this section based on currently known toxicology. Is it known when the practice of treating with 8 ppm with chlorine for the purpose of eliminating discoloration ended?”*

Response 9:

It is standard practice to add chlorine (in the form of chlorine gas, sodium hypochlorite, chlorine dioxide, or chloramine) or ozone to drinking water as disinfecting agents to reduce the threat of water-borne infectious diseases. However, the chlorine dose used to reduce color in well #13 (as documented in the Public Health Assessment) is higher than is typically used for routine disinfection. Because the full nature and magnitude of contaminants present in the Holly Street wells in the mid-1960s is uncertain, the effect of higher than normal doses of chlorine on the chemical species present is also uncertain.

The comment confuses the amount of chlorine added to drinking water for disinfection (typically 1 or 2 parts per million, or ppm), with limits set for total trihalomethanes (a chemical by-product of water chlorination). The total trihalomethane drinking water standard of 100 parts per billion (ppb) refers to the sum of the concentrations of four halogenated methanes, including chloroform, bromoform, dichlorobromomethane, and chlorodibromomethane.

*Comment 10:*

*“Please consider a recommendation of disallowing any proposed remedial selection that would create a completed exposure pathway from fugitive dust. If not tented, every potential remedy selection involving soil excavation presents an opportunity for fugitive dust emissions.”*

Response 10:

See Response 8. In addition, the ATSDR has recommended in its Public Health Consultation that appropriate site control measures be utilized for vapors and fugitive dusts.

*Comment 11:*

*“The addition of ATSDR’s expertise by providing risk assessment for selected remedial actions expected to be identified in the anticipated USEPA Proposed Remedial Action Plan for the Ciba site, OU-2, Source Area Remediation, is gratefully welcomed by the community.”*

Response 11:

See Response 8.

*Comment 12:*

*“The ATSDR and the NJDHSS will coordinate with the OCHD to offer water quality testing to owners of private residential wells that were part of the former outfall pipeline monitoring program. Please clarify what is being proposed by this statement.”*

Response 12:

During the time frame 1987 through 1993 approximately 50 homeowners with private wells participated in a study of private potable wells in the vicinity of the ocean outfall pipeline. It is recommended in this Public Health Assessment that the NJDHSS and the ATSDR coordinate with the Ocean County Health Department to determine if any of those wells are still in use, and if the owners are interested in having their wells tested for potential contaminants, especially VOCs, chromium, and mercury.

*Comment 13:*

*The comment identified typographical errors in the PHA.*

Response 13:

The PHA has been modified to correct the typographical errors.

*Comment 14:*

*“Please explain why the following chemicals list the ATSDR Child CV or USEPA Health Advisory as a higher value than the ATSDR Adult CV or USEPA Health Advisory?: Ethylbenzene, Dichlorobenzene, 1,2,4-Trichlorobenzene, Chromium, 1,1,1-Trichloroethane, Napthalene, 4-Chlorotoluene”*

Response 14:

The Comparison Values questioned above are the USEPA’s Longer-term Health Advisory, and Lifetime Health Advisory. They are defined as follows. “Longer-term HA” refers to the concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects up to approximately 7 years (10% of an individual’s lifetime) of exposure, with a margin of safety. The “Lifetime HA” is the concentration of a chemical in drinking water that is not expected to cause any adverse

noncarcinogenic effects over a lifetime of exposure, with a margin of safety. Because of the way these comparison values are defined, it is possible for the child Longer-term HA to have a higher value than the adult Lifetime HA.

*Comment 15:*

*“Please consider adding the year (date) tract 2 was donated by Ciba to Dover Township and include a map showing the extent of the Ciba donation of tract 2 to Dover Township.”*

Response 15:

The PHA will be revised to reflect that the 43 acres of Tract 2 were leased/donated by Ciba-Geigy to Dover Township in 1959.

**Commenter D:**

*Comment 1:*

*“Is marsh area isolated from public and does it have warning signs for the public with regards to possible contamination exposure risk?”*

Response 1:

Based upon a review of available information, the ATSDR and the NJDHSS did not conclude that there is a completed human exposure pathway associated with this area. As such the Public Health Assessment does not contain the recommendation suggested above. In 1991, the ATSDR evaluated available data regarding contamination in the Winding River Park area and found it not to constitute a threat to public health (cited as ATSDR, 1991a in the Public Health Assessment). The final version of the Public Health Assessment will include an expanded discussion of surface water and sediment contamination data for the marshland portion of the park.

*Comment 2:*

*Summary of Previous Health Assessment Activity Page “[P]aragraph 2 refers to lead and mercury not related to CGC. Where was it from?”*

Response 2:

The Lead Initiative Summary Report (Reference ATSDR, 1992a) indicates that lead found in potable water samples from private wells was reported by the USEPA as not related to the CGC site. Lead is commonly found in tap water because it may be introduced through corrosion by the acidic groundwater acting upon the lead-based solder that was used to join sections of copper pipe. Low levels of mercury have been

frequently found in the groundwater of the Cohansey-Kirkwood aquifer system throughout southern New Jersey and is not considered to be related to the CGC site in this instance.

*Comment 3:*

*Summary of Previous Health Assessment Activity “[P]aragraph 3 refers to sampling of airborne contaminants, was it done and if so, Where are the results?”*

Response 3:

Soil gas and flux emission samples were taken in the Cardinal Drive/Oak Ridge Parkway vicinity and are described in the Public Health Assessment on page 14.

*Comment 4:*

*Summary of Previous Health Assessment Activity “[P]aragraph 4 recommends further characterization and monitoring of private residential wells, and on and off-site air, Where is the data?”*

Response 4:

In the 1988 Public Health Assessment, the ATSDR recommended characterization of several environmental media. The USEPA has conducted extensive remedial investigations, particularly in relation to on-site source areas and groundwater; these data are discussed and summarized in the Remedial History and Environmental Contamination sections of the February 2000 draft Public Health Assessment. The NJDHSS and the ATSDR included private well sampling in an exposure investigation in 1997. Approximately ten private wells were located in areas near the Ciba-Geigy site, though none were in areas known to be affected by site-related groundwater contamination (because of well use and construction restrictions). Data are found in Table 7 of the Public Health Assessment. Regarding air tests done by the USEPA, see Response 3 above.

*Comment 5:*

*Summary of Previous Health Assessment Activity “[P]aragraph 5 concludes many contaminants listed posed no threat to public health at levels indicated, Please supply those levels to us.”*

Response 5:

See Response 1. This paragraph refers to the contaminants that were tested for in the marshland and the surface waters of the Toms River, and that were reported and evaluated in the 1991 Addendum to the 1988 Public Health Assessment referenced as ATSDR, 1991a.

*Comment 6:*

*Summary of Previous Health Assessment Activity “[P]aragraph 6 refers to soil contaminants identities are not known, so estimates of risk can not be determined at this time; therefore err on the side of CAUTION.”*

Response 6:

This paragraph refers to the results that were reported in Addendum 2 to the 1988 Public Health Assessment. Since the identities of many species that were analyzed in the soils on the Ciba-Geigy site were not known, it was not possible to determine any threat that might be posed by unidentified compounds. As indicated, subsequent sampling and analysis by CDM (References CDM, 1993f, and 1994a) identified hundreds of additional species in the soils on the Ciba-Geigy site. The NJDHSS and the ATSDR have not identified a human exposure pathway associated with exposure to contaminated soils, but support the efforts of the USEPA to remediate these areas to prevent further contamination of the underlying groundwater.

*Comment 7:*

*Summary of Previous Health Assessment Activity “[P]aragraph 8 refers to additional Public Health Assessment, Was it done, if so where are the results?”*

Response 7:

After the recommendation found in the “Lead Initiative Summary Report,” two additional Public Health Consultations were performed by ATSDR, in 1992 and 1993. The draft Public Health Assessment (February 2000) is the next and most recent public health evaluation by the ATSDR and the NJDHSS.

*Comment 8:*

*Summary of Previous Health Assessment Activity “[P]aragraph 9 states data was insufficient to determine health risk, USEPA conducted tests what were the results?”*

Response 8:

The results of the sampling episode are discussed on page 14 of the draft Public Health Assessment. In response to this and other comments, the section describing the results has been clarified in the revised and final Public Health Assessment.

*Comment 9:*

*“The use of wells #13, #14, and #18 with known contamination being used in the public supply with only treatment of chlorine to reduce coloration, raises the question, ‘Who was minding the store, excuse me, our health? What agency or agencies should have been treating, monitoring and or eliminating this exposure for God knows how many years to this town? How much danger was added to the chemical mix with that much chlorine being added? I think the amount is significant enough to have you answer this question. When did the chlorine get eliminated, if ever?”*

Response 9:

In the middle 1960s, there were no federal or state standards for drinking water quality applicable to community water supplies. In 1974, the federal Safe Drinking Water Act (Public Law 93-523) was passed. According to the National Research Council:

Until passage of the Act, the Federal Government was authorized to prescribe drinking water standards only for water supplies used by interstate carriers, and they were enforceable only with respect to contaminants capable of causing communicable disease. Public Law 93-523 authorized the Environmental Protection Agency to establish Federal standards for protection from all harmful contaminants and established a joint Federal-State system for assuring compliance with these standards and for protecting underground sources of drinking water (Drinking Water and Health, Volume 1 (page 905), National Academy of Sciences Press, 1977).

The USEPA (created in 1970) promulgated the first enforceable federal standards applicable to community water supplies in 1975. Before that time, there were a limited number of Public Health Service standards applicable to interstate water carriers (such as buses and ships), but only those related to communicable diseases were enforceable; chemical quality guidelines that existed were not enforceable.

It is standard practice to add chlorine (in the form of chlorine gas, sodium hypochlorite, chlorine dioxide, or chloramine) or ozone to drinking water as disinfecting agents to reduce the threat of water-borne infectious diseases. However, the chlorine dose used to reduce color in well #13 (as documented in the Public Health Assessment) is higher than is typically used for routine disinfection. Because the full nature and magnitude of contaminants present in the Holly Street wells in the mid-1960s is uncertain, the effect of higher than normal doses of chlorine on the chemical species present is also uncertain.

*Comment 10:*

*“Who was responsible for the monitoring besides CIBA & the water company?”*

Response 10:

See Response 9.

*Comment 11:*

*“What about wells #19, and #21 their depth does not make me feel comfortable, especially since we KNOW CIBA continued to dump in the Toms River, even after the pipeline opened. It doesn’t take much contamination to effect a fetus or embryo, does it?”*

Response 11:

Wells #19 and 21 are Cohansey wells (depths of approximately 60 feet) located at the Holly Street well field. Well #19 operated from 1967 through 1983 when it was sealed; well #21 began operations in 1969 and continues to operate. However, there are no data which show that these wells were/are being contaminated by the surface waters of the Toms River.

Children and fetuses may be more susceptible to the toxic effects of chemical exposures if such exposures can interfere with developmental processes. Children may also be more likely to be exposed to some chemicals than adults. In the Public Health Implication section of the Public Health Assessment, special susceptibilities of children to chemical exposures are discussed if such information is known.

*Comment 12:*

*“Where is ALL the information on Wells #1-#12?”*

Response 12:

The NJDHSS and the ATSDR have no information regarding wells #1-#12. None of these wells were in operation during the time frame of the childhood cancer epidemiologic study being conducted by the NJDHSS and the ATSDR (1962 through 1996).

*Comment 13:*

*“With regard to stack emissions regulated through permits by NJDEP there is reference to TRI, but doesn’t indicate if those Safe levels were ever exceeded. Please provide that information.”*

Response 13:

TRI data is presented in the Public Health Assessment as a qualitative description of chemical releases. The Toxic Release Inventory (a listing required by the Emergency Planning and Community Right to Know Act of 1986) requires that each reportable chemical that exceeds the threshold for its designated number of pounds be reported to the USEPA and the State. Releases are reported as: air emissions, surface water discharges, releases to land, and underground injection. TRI data are available through the USEPA web site (<http://www.epa.gov/tri/>).

*Comment 14:*

*“There is constant reference to ingestion of these chemicals, have you forgotten inhalation through showering and bathing? What about steam from humidifiers?”*

Response 14:

For volatile chemicals in drinking water, the inhalation route of exposure may be as important (or more important) than ingestion. For non-volatile or semi-volatile chemicals, however, the ingestion route of exposure is likely to be predominant. In addition, dermal exposure (through skin absorption) may be an important consideration, depending on the permeability of the skin to the specific chemical. Each of these routes of exposure are noted in the “Completed Human Exposure Pathway” table on page 17.

By creating fine aerosols, humidifiers may cause an inhalation hazard if the source water is contaminated with an infectious agent. There is insufficient information to evaluate the role of humidifiers in exposure to chemical contaminants in drinking water.

**Commenter E:**

*General Critique*

*Comment 1:*

*“It is important to define whether or not an excess in childhood cancer rates may have existed earlier than that which may be attributed to Reich Farm site contaminants in the Parkway public wellfield.”*

Response 1:

The NJDHSS has maintained a population-based registry of incident (newly diagnosed) cancers since 1979. Before that time, there are no data on incident cancers in New Jersey, although mortality (deaths) from cancer may be determined from death certificate data. It is important to point out that mortality statistics are not the same as incidence statistics, since they represent not only incidence rates but also survival rates from a disease. Geographical comparisons of mortality data can be influenced by access to and utilization of health care, as well as incidence in the population. Local rates may also be affected by geographic movement of cases between the time of diagnosis and time of death. The NJDHSS and the the ATSDR have completed a thorough analysis of all available childhood cancer incidence data for Dover Township (“Health Consultation: Childhood Cancer Incidence: A Review and Analysis of Cancer Registry Data, 1979-1995, for Dover Township (Ocean County), New Jersey”) for the period 1979-1995. The epidemiologic study of childhood cancer in Dover Township, which is expected to be completed in 2001, includes incident cases of childhood cancer in the period 1979-1996.

*Comment 2:*

*“Although many aspects of Ciba-Geigy’s manufacturing operations are summarized in the draft PHA, they are not spelled out in sufficient detail to assess the potential public health impact of accordant waste streams as they entered Toms River, Holly Street wells, Atlantic Ocean pipeline discharges, leaks from the pipeline and groundwater. Although Ciba-Geigy manufactured or utilized a dizzying array of potent chemicals, much more is known about the toxicities, including the potential carcinogenicities, of many important derivatives of aniline-based and benzidine-based azo dyes and anthraquinone vat dyes than noted in this draft PHA.”*

Response 2:

The PHA discusses the toxicology of contaminants in documented exposure pathways. The PHA further states that the full nature and magnitude of potential contaminants present is unknown; thus limiting further toxicological evaluation in the context of documented exposure pathways. However, the current knowledge regarding the general toxicities of the aniline-, benzidine-, and anthraquinone-based dyes and their reagents is summarized in Reference ATSDR, 1997a, “Chemical Specific Health Consultation - Toxicological Issues Related to Chemicals Identified by NJDHSS,”

*Specific Comments*

*Comment 1:*

*“It is unclear from the draft PHA whether or not historically some of these groundwater contaminants may have migrated beyond the Toms River prior to the installation of groundwater retrieval through pumping ... Monitoring wells on the east (other) side of the Toms River have picked up contaminants carried by the ‘north plume’.” The comment further claims that contaminants in well 20 and the Parkway well field may be related to the Ciba-Geigy site.*

Response 1:

Other than through the exposure pathways identified in the PHA, there is no data to suggest the existence of other off-site groundwater pathways associated with the Ciba-Geigy site. Monitoring wells on the east side of the Toms River have shown and continue to show contamination by chlorinated chemicals that were transported in the groundwater plumes from the Ciba-Geigy plant. (References Eckenfelder, 1996, 1997, and 1999). See Figure 6 in the Public Health Assessment.

*Comment 2:*

*“Although conceivably groundwater contaminants migrating under the Toms River could explain all detection outlined above, additional illegal repositories for Ciba-Geigy wastes could have been used for disposal including Reich Farm itself.”*

Response 2:

The purpose of this Public Health Assessment is to analyze and report human health exposure pathways that are associated with the Ciba-Geigy Corporation plant site. Completed exposure pathways that were identified include (1) exposure to ground water that was pumped by the Toms River Water Company into the community water supply at the Holly Street well plant in 1965-1966, and (2) exposure to VOCs in contaminated ground water that was found in private wells (used for irrigation) in the Cardinal Drive/Oak Ridge Parkway vicinity near the southeast boundary of the Ciba-Geigy property between 1985-1988. Wastes from operations at the Ciba-Geigy site have been identified in approximately 20 on-site locations. There is no evidence of disposal of hazardous chemical wastes from Ciba-Geigy at the Reich Farm.

*Comment 3:*

*“For what period of time and with what frequency did Ciba-Geigy waste discharges directly to the Toms River enter the Holly St. wells?” In addition, “Did chemical wastes from Ciba-Geigy in the Toms River only enter Holly St. wells through groundwater contamination, or were there surface water incursions during high tide or flood conditions as well?” In addition, “Were there additional chemicals in Toms River due to discharges to or overflows from the settling, equilibration or neutralization basins further upstream and did these persist after installation of the ocean pipeline?” Also, “What were the probable chemicals which entered the Toms River public water supply by this exposure route during this period? What were the probable average and maximal concentrations of each of these chemicals in the public water supply?” Finally, “In addition, what toxic air discharges occurred from the Toms River and from lagoons along the river at the Ciba-Geigy site?”*

Response 3:

Dyes and nitrobenzene were documented in Holly Street wells 13, 14, and 18 in 1965 and 1966. It is believed that these contaminants entered the wells through the drawdown of surface water (the Toms River) during drought conditions; the Public Health Assessment states that the duration of human exposure through use of these wells is not known. As stated on page 13, samples of water from these wells contained “diazotizable” amines and nitrobenzene at concentrations as high as 160 ppb and 17 ppb respectively. On pages 15 and 16, it is stated that the complete nature and magnitude of contaminants potentially present in the wells is unknown, and that because of the varying dynamics of a community water supply with multiple interconnected sources, quantitative estimations of exposure are not available. There is no information regarding impacts to the Holly Street wells under flood conditions.

On page 12, the PHA cites (NUS 1988a, TRCC 1969) that approximately 200,000 gallons per day of liquid waste of unknown composition from lagoons and disposal areas, entered the Toms River subsequent to utilization of the pipeline. Sampling for airborne contaminants in the vicinity of the marshland and the Toms River was conducted by the USEPA Environmental Response Team in 1990. “Benzene, toluene and xylene were detected at levels in the low ppb range that could not be attributed to background conditions.” (See reference CDM, 1993b “Baseline Characterization of the Toms River and Wetlands in the Vicinity of the Ciba-Geigy Toms River, New Jersey Plant”). This potential exposure pathway was evaluated by the ATSDR and found not to constitute a public health threat (see reference ATSDR, 1991a).

*Comments 4 and 5:*

*“There are several potent probable human carcinogens which have been identified in various Ciba-Geigy waste streams, on-site contaminants and off-site contaminants. Although these substances have considerably higher carcinogenic potencies than TCE, PCE and other given more coverage in the draft PHA, the following probable carcinogens and their derivatives (see Table 1 appended) are given scant attention in the draft document and more toxicity information should be provided so the public might be adequately informed. ... [List:] Epichlorohydrin, Trichloropropane, Aniline, Benzidine, Anthraquinone ... Many of the azo dyes produced in large quantities by Ciba-Geigy are based upon aniline and benzidine and are themselves carcinogenic in test animals and probably in humans.”*

Response 4 and 5:

See Response 2.

*Comment 6:*

*“Although the draft PHA notes that surface water contamination occurred at the Holly St. wells, the frequency and duration of this contamination is not estimated. Is the Toms River bay an estuary up to the level of Holly St. and, if so, were tidal influences an important contributor to surface water contamination of this wellfield? What was the frequency of flood which may have influenced the Holly St. wellfield during the duration of its operations? What proportion of Toms River public drinking water was supplied by the Holly St. wells? Was this proportion equally distributed over the Toms River system, or did local residents*

*receive all of their drinking water from this source?”*

Response 6:

The Toms River is not tidally influenced at the location of the Holly Street wells. There is no information regarding impacts to the Holly Street wells under flood conditions. As stated above, the “drawdown” of river water into the wells was believed to be the result of drought conditions. The proportion of water in the community water supply distribution system will have varied with time (as new sources were developed and the relative volume of Holly Street water changed) and with season (for example, different well pumping patterns are used to meet higher summertime water demand), and by geographic location. The ATSDR is in the process of developing sophisticated computer models of the water distribution system on a monthly basis to estimate the proportion of water from each source (including the Holly Street wells) from 1962 through 1996. These models will be used to estimate exposure to different water sources in the epidemiologic study now underway by NJDHSS and ATSDR.

*Comment 7:*

*“The profound mutagenic potency of Ciba-Geigy’s effluents in Ames’ tests following concentrations over resins confirms that probable carcinogens were being dumped routinely into Toms River and, thence, into Holly St. wells.”*

Response 7:

The influx of surface waters from the Toms River that contained diazotizable dyes into the wells of the Holly Street plant has been documented for the time period 1965-1966. The potential toxicity of these compounds is discussed in the ATSDR chemical-specific health consultation (see response to General Comment 2) and has been considered in the evaluation of the public health implications of the site (pages 19 and 20 of the Public Health Assessment).

*Comments 8 and 9:*

*“There is no mention in the draft PHA of deliberate or spontaneous fires which occurred on the Ciba-Geigy site, both mobilizing convection of VOCs into air and, potentially, creating more toxic contaminants, such as dioxins, through combustion.” ... “Similarly, the installation of a hazardous waste incinerator on-site presented the Toms River community with an additional source of airborne pollutants.”*

Response 8 and 9:

Stack emissions as well as other air emissions from the Ciba-Geigy site are identified as a potential exposure pathway in the Public Health Assessment (pages 13, 14 and 18).

*Comment 10:*

*“Frank Tyson was the waste hauler for many of Ciba-Geigy wastes for off-site disposal. Following installation of their hazardous waste incinerator, Mr. Tyson continued to haul trichloropropane (TCP) off-*

*site. In Pennsylvania, these TCP wastes were dumped illegally and became the major contaminants of the Tyson's Superfund site. Is it possible that Mr. Tyson (or others) dumped some of Ciba-Geigy's wastes at other illegal sites in Dover Township?":*

Response 10:

As stated above, there is no evidence of disposal of chemical wastes from Ciba-Geigy at Reich Farm or other locations in Dover Township.

*Comment 11:*

*"How much manufacturing of dyes occurred during the 1988-96 time frame and, given that the pipeline was abandoned in 1991, what happened to waste materials 1991-96?"*

Response 11:

As stated in the Public Health Assessment (page 4), "Production of anthraquinone-based dyes ended in 1983; epoxy resin manufacturing ended in 1990. Manufacturing operations at the plant ceased as of the end of 1996 when dye standardization activities were terminated." Questions regarding Ciba-Geigy's production processes and output should be directed to the company. Once use of the pipeline ended in 1991, treated wastewaters were disposed on-site during the period from 1991 to 1996. The Groundwater Extraction and Recharge System (GERS) became fully operational in March 1996.

*Comment 12:*

*"Subsequent to the 1991 ATSDR Second Addendum to the 1988 PHA were not appropriate aniline-, benzidine-, anthraquinone- or other azo-based dyes or their derivatives quantified in marsh sediments or surface waters with Winding River Park? If so, why were potential threats to public health not estimated?"*

Response 12:

The ATSDR evaluated available data regarding contamination in the Winding River Park area and found it not to constitute a threat to public health. Subsequent to that 1991 evaluation, surface waters and sediments in the Winding River Park area were sampled and tested by the USEPA and its contractor (CDM). Samples were tested for volatile and semi-volatile organic chemicals and for metals. The draft Public Health Assessment did not describe these data, but the final version of the Public Health Assessment will include an expanded discussion of surface water and sediment contamination data for the marshland portion of the park. Dyes or dye-related chemicals were not assessed; there are no standardized methods for determining the concentrations of these dyes at low levels in an aqueous matrix.

*Comment 13:*

*"The "Environmental Contamination" section beginning on page 9 is, unnecessarily presented as*

a chronology. Hence, for example, one doesn't learn about important compounds such as trichloropropane (TCP) until a page later, and then no maximal concentration is indicated."

Response 13:

Environmental contamination data are presented by medium; with each medium-specific discussion, sampling and analysis events are usually presented chronologically to facilitate understanding the data in the sequence in which it was obtained. These data are later synthesized in the Pathways Analysis and subsequent sections. A chronology of some of the major events at Ciba-Geigy is also presented in Table 1.

Comment 14:

*"The maximal concentrations of chlorinated VOCs in groundwater on-site indicates the high probability for dense-nonaqueous-phase-liquid (DNAPL). This fact should be indicated, since it represents a special challenge for cleanup and may prolong potential exposures to the public."*

Response 14:

The plan for remediation of groundwater determined by the USEPA is described in the Record of Decision for the groundwater Operable Unit 1, and is summarized on page 9 of the draft Public Health Assessment. There are no known human exposure pathways, at present, related to the groundwater contamination plumes, although, as stated in the Public Health Assessment, "The ATSDR and the NJDHSS support continuing efforts by the USEPA and Ciba Specialty Chemicals to contain and remove contaminants in the Upper Sand aquifer associated with the Ciba-Geigy Corporation site."

Comment 15:

*"Similarly, it should be noted that the high organic content in groundwater on-site enhances the water solubility of poorly soluble compounds, such as TCP, TCE, PCE and the chlorobenzenes."*

Response 15:

The actual concentrations of volatile organic chemicals found in on-site monitoring wells are illustrated in Table 3, and the concentrations of these contaminants in the untreated blended groundwater extracted for treatment are given in Table 4.

Comment 16:

*"Although the maximal concentration of vinyl chloride in groundwater on-site is noted as 89µg/l (p.9), ominously, soil gas VOCs were measured as high as 1,625 ppm in Winding River Park (p.14). Given the mobility of vinyl chloride and its likely production from higher chlorinated ethylenes (PCE/TCE) by biodegradation in marshy soil at this location, what proportion of these off-site VOCs (not otherwise specified) was vinyl chloride?"*

Response 16:

The 1988 Public Health Assessment by the ATSDR presents data indicating that vinyl chloride was not detected in off-site groundwater or air. More recent sampling of monitoring wells under the provisions of the Site-Wide Monitoring Program of the Long Term Monitoring Plan has shown no vinyl chloride to be present in off-site monitoring wells (see References Eckenfelder, 1996, and Eckenfelder, 1997). Total volatile organic chemical levels in soil gas in the Cardinal Drive area were measured at up to 1,570 ppb (the final version of the Public Health Assessment will be corrected) in 1991. Vinyl chloride was detected at a maximum of 44 ppb in that investigation (Weston, 1991). Later soil gas samples (1993) showed lower levels of volatile organic chemicals (Weston, 1993).

Comment 17:

*“Ciba-Geigy memos from the mid-1960s indicate that diazotizable amines were a minor component (0.5%) of the chemical contaminants of Toms River surface water or Holly St. groundwater following contamination by surface water. Hence, the concentration of 160 µg/l diazotizable amines (page 13) translates as 32 mg/l total chemical contaminant concentration. Furthermore, there is some concern that the toxicities of some of these contaminants were worsened during chlorine bleaching.”*

Response 17:

The maximum documented concentration of diazotizable amines was found to be 160 µg/liter, as measured in Well 14 in 1966 (Reference TRCC, 1966a). The Public Health Assessment states that the complete nature and magnitude of potential contaminants present is unknown, and for this reason it is not possible to determine the chemical nature of potential chlorine reaction products. The NJDHSS and the ATSDR cannot judge the reliability of the extrapolation presented in the comment.

Comment 18:

*“It might be useful to note that Mr. Zahuta, author of the above-noted memos, was instructed to test for chemical contamination of Toms River surface water and Holly St. well water because of the noticeable chemical plant odors in the domestic water of the TRC executives who lived in Toms River.”*

Response 18:

The Public Health Assessment notes (page 13) that, “In a ‘Water Analysis Record’ from March 1965, raw water from Well #13 was described as having a distinct odor and as being visibility contaminated with ‘trade wastes (dye).’”

Comment 19:

*“Aniline is one of the weaker probable carcinogens in Toms River and the Holly St. wells. However, if one applies the risk conversion of 60 µg/l aniline → a lifetime risk of 10<sup>-5</sup> in drinking water (draft PHA, 1<sup>st</sup> paragraph, page 20), then the 32 mg/l equivalent calculated dose would correspond to a 5 x 10<sup>-3</sup> lifetime (0.5 percent) risk.*

Response 19:

See Response 17 regarding the extrapolation presented in the comment. In addition, aniline would have been measured as a component of the total diazotizable concentration.

*Comment 20:*

*“There is no reason to assume that unusual surface water contamination of Holly St. wells took place in 1965-66. It is more reasonable, certainly from a conservative public health perspective, to assume that these wells were contaminated from early in the 1950s (#13 opened in 1946; #14 in 1953) through 1980 (when #18 was shut down). At peak usage, these wells provided more than half of the public water to 35,000 in Toms River and this conclusion should not be obfuscated (as it is at present, 3<sup>rd</sup> paragraph, page 24).”*

Response 20:

The Public Health Assessment states that, “The ATSDR and the NJDHSS have determined that there was a completed human exposure pathway to CGC-related contaminants through ingestion of water from the community water supply wells of the Holly Street well field, as documented in 1965 and 1966. ... The duration of exposure through this pathway cannot be determined, since data are lacking before 1965 and after 1966.” As stated in this Public Health Assessment (page 16), “Overall, approximately 35,000 persons were receiving community water in 1965. Because the Holly Street well field was one of two operating in 1965 and 1966, the number of people receiving at least some of their water from this source is potentially large.” In the Conclusions section (page 24), the Public Health Assessment states, “Since the Holly Street well field was a principal source of water for the community water supply at that time, a large number of persons were likely exposed to contaminated water.”

*Comment 21:*

*“At the bottom of page 25, it is stated that “water systems models should be employed to trace the flow of water from the Holly St. well field to points in the distribution system.” Isn’t this being done?”*

Response 21:

It is being done. Modeling of the Toms River Water Company (now United Water Toms River) distribution system is being conducted by the ATSDR, as part of a drinking water source exposure assessment for the childhood cancer epidemiologic study.

*Additional Correspondence*

*Comment:*

*“The 1997 Disposal Safety report demonstrates our continuing inability to recognize and quantify many chemicals known to have been used or manufactured at the Ciba-Geigy plant and probably in waste streams that entered groundwater and surface water. As noted in the report, the 130 chemicals normally*

*assessed during a waste site analysis ... are but a minority of the hundreds of chemicals at complex sites, including the Ciba-Geigy site in Toms River. Specifically, Disposal Safety noted that 156 organic chemicals and 6 types of dyes which were probable constituents of Ciba-Geigy wastes are not priority pollutants and therefore, have not been included in any risk assessments, including the draft PHA.” The comment then quotes the Disposal Safety report: ‘A proper and thorough investigation of the universe of chemicals produced and released into the environment at the Toms River Chemical site over the years, and the fate of those chemicals, will be an invaluable contribution to the Cancer Cluster study. Without it, questions about the role of Ciba’s operations, if any, in causing the cancer cluster will persist.’”*

Response:

The NJDHSS and the ATSDR concluded that the Ciba-Geigy site was a public hazard because of past completed human exposure pathways and evaluation of the public health implications of contaminants in those pathways (page 24 of the Public Health Assessment). The Public Health Assessment describes the efforts of the USEPA and its contractor (CDM) to investigate the presence and identity of non-target chemicals (pages 11 and 12). CDM tentatively identified 63 of 147 non-target compounds in surface soils, including anthraquinone- and aniline-based chemicals. Similarly, CDM tentatively identified 157 of 378 non-target chemicals in subsurface soils on the Ciba-Geigy site. A brief summary of toxicological information on azo dyes, aniline and nitrobenzene is presented in the Public Health Assessment; further information is available in an ATSDR document (cited as ATSDR, 1997a in the draft Public Health Assessment).

The epidemiological case-control study of childhood cancers in Dover Township presently being conducted by the NJDHSS and the ATSDR is considering exposure pathways associated with the Ciba-Geigy Corporation site. These assessments include exposures to drinking water sources, air pollutant emissions, and residential proximity.

**Commenter F:**

*Comment 1:*

*“This report is an ongoing exercise of misplaced loyalty and bias in favor of commercial interest. The inability of NJDHSS to implicate Ciba in the face of political pressure is unjust and a gross misrepresentation of the citizens in Toms River. The fact that Ciba was permitted to indiscriminately poison residents and the environment on a grand scale is indisputable. Therefore the Pleasant Plains Homeowners & Businessowners Assoc. considers the report not only invalid and a waste of taxpayers money but also insult to our injury!”*

Response 1:

The purpose of this Public Health Assessment is to analyze and report human health exposure pathways that are associated with the Ciba-Geigy Corporation plant site. Completed exposure pathways that have been identified include (1) exposure to drinking water contaminated with dyes and nitrobenzene originating from the Ciba-Geigy plant and entering the community water supply at the Toms River Water Company’s Holly Street wells in 1965-1966, and (2) exposure to VOCs in contaminated groundwater that was found in

private wells used for irrigation in the Cardinal Drive/Oak Ridge Parkway vicinity near the southeast boundary of the Ciba-Geigy property between 1985-1988.

In addition, the Public Health Assessment notes that there were potential human exposure pathways through air pollutants emitted from the Ciba-Geigy plant and waste areas on site, and through direct exposure to contaminated soils on site.

This pathway analysis is an important consideration in the on-going investigation of the role of potential environmental exposures in the epidemiologic study of childhood cancer in Dover Township.

**Commenter G:**

*Comment 1:*

*“Please note there are exposure pathways overlooked. There is a periodic groundwater to surface discharge of contamination in Winding River Park when the groundwater table rises. This is/has been a potential pathway for adults and children.” Furthermore, “the assessment did not indicate that a groundwater to surface soil pathway in yards and parks had been evaluated.”*

Response 1:

The draft Public Health Assessment addressed the issue of Winding River Park on page 6 and 14. The ATSDR evaluated available data regarding contamination in the Winding River Park area and found it not to constitute a threat to public health (cited as ATSDR, 1991a in the Public Health Assessment). The final version of the Public Health Assessment will include an expanded discussion of surface water and sediment contamination data for the marshland portion of the park. Further details of the characterization of the Winding River Park are given in the documents cited in the Public Health Assessment. The NJDHSS and the ATSDR did not identify a pathway associated with a “groundwater to surface soil” transport mechanism in yards in the Cardinal Drive/Oak Ridge Parkway area. The Public Health Assessment did cite an evaluation, on page 14, of a soil gas investigation in the Cardinal Drive area. The reference for this soil gas investigation will be added to the final version of the Public Health Assessment.

*Comment 2:*

*“Under community concerns, there was no mention of NJDEP studies conducted by NJDEP and Battelle in 1985-1987, and by the NJDEP and USEPA in 1986, of the contamination from the ocean outfall reaching the beach. In addition, “[T]he studies found that through wind driven currents, there were times when the effluent did not dilute or disperse and could impinge the surf zone.”*

Response 2:

The NJDHSS and the ATSDR mention in the Community Concerns section (page 6) that the ocean

discharge was “controversial” and a subject of community concern. Aspects of potential exposures associated with the pipeline breaks (surface soils, sediments, and groundwater) were evaluated in the Public Health Assessment and the associated exposure investigation. The ATSDR and the NJDHSS have reviewed the available information on potential exposure through the marine environment, but deemed it insufficient to characterize a potential exposure pathway.

*Comment 3:*

*“The Health Assessment notes that only TAL compounds on the hazardous substances list were evaluated and the list was narrowed to indicator chemicals. The Disposal Safety reports in the references went into great detail on the larger number of compounds present, many of which were identified in the Disposal Safety Report. The toxicity of significance was not addressed, yet many of these compounds are more toxic than the TAL analyses.” Further, “The Assessment discusses the presence of numerous TICs and dye intermediate compounds present in soils and states there are no standard analytical methods for low level quantitative detection of these materials in aqueous media.” Consequently, “[S]ince this is an important issue, this should be addressed.”*

Response 3:

The Public Health Assessment cites and discusses the USEPA’s efforts (conducted by CDM) to identify non-target compounds (page 11 and 12). The Disposal Safety report, published in 1997, complements the conclusions of CDM, that numerous non-target compounds were present in the on-site surface and sub-surface soils.

It is important to note that there are no documented completed human exposure pathways associated with on-site soils and groundwater. Although numerous non-target compounds have been shown to be present in both on-site media, there are no data on non-target compounds within documented exposure pathways. Recognizing the limitations of available information, the NJDHSS and the ATSDR concluded (page 24): “Certain wells at the Holly Street well field of the community water supply were documented to be contaminated in 1965 and 1966 with dyes or dye intermediates, nitrobenzene, and possibly other chemicals. The nature, magnitude and duration of exposure to these contaminants is not fully known, and the toxicological characteristics of some of the chemicals [are] not well understood.”

*Comment 4:*

*“In the table (p.17), the exposure pathways of dyes and nitrobenzene is believed to begin prior to 1965-1966.”*

Response 4:

The full nature, magnitude and duration of this pathway is unknown. The NJDHSS and the ATSDR have no documented compound specific evidence of a completed pathway involving exposure to dyes and nitrobenzene before 1965.

*Comment 5:*

*“The discussion of the community water supply pathway ignored the 1970's documentation using the Sylvia method. This was a fluorescence analytical procedure which documented material occurring in the finished water. This material was believed to be derived from aniline derivatives and diazotizable amines, some of which would have had the potential to form chloramines in the delivered water.”*

Response 5:

The pathway associated with the Holly Street wells was based upon documented, compound specific data describing water quality. The results for samples that were taken from the municipal supply wells in 1975 that were analyzed using the Sylvia method do not identify or quantitate any contaminants that might have been in the samples, limiting the usefulness of these data in terms of exposure assessment. However, the Public Health Assessment acknowledges that the duration of the exposure pathway through the community water supply is not known.

**Commenter H:**

*Comment 1:*

*This comment questions the concentration of chlorine of 8 mg/liter and speculates that it was in fact 0.8 mg/liter. In addition, the comment also questions that “the alleged purpose of the “high” chlorine dose was to reduce the color...”*

Response 1:

The Remarks section of the Toms River Water Company sampling record (Reference TRWC, 1965, Water Analysis Record, Well 13, March 23, 1965) indicates the following: “Well No. 13 is contaminated with Toms River Water. This water requires 8. P.P.M. Chlorine to reduce the color. After the addition of chlorine the odor is more pronounced.”

*Comment 2:*

*This comment cites a 1996 NJDEP report that states that a Cohansey well in the Holly Street Well Field (Well #21) “was deemed by the NJDEP to not be under the influence of surface waters. Well 21 is of comparable depth to wells 13, 14, and 18 and drilled into the same aquifer. The existing water-quality and hydrogeologic data for the Holly Street Well Field collected as part of a Ground-Water Under Direct Influence (GWUDI) assessment indicate that the existing Cohansey Well (#21) is not under the influence of surface water...” In addition, “the local hydrogeologic conditions are considered such that the Toms River is not the sole source of local recharge to the Cohansey Aquifer and Well 21,...” Furthermore, “Given the specific focus of the GWUDI evaluation, it can not be concluded that Well 21 does not indirectly receive recharge from the Toms River through the Cohansey Aquifer, nor that water quality concerns related to the surface water would not impact the local ground-water resource.”*

Response 2:

*Public Health Assessment: Ciba-Geigy Corporation*

This comment seems to imply that, since Well 21 was found to not be under the influence of surface waters in 1996, this should also be the case for Wells 13, 14, and 18 in the 1960s. Well 13 was installed in 1946, and ceased operations and was sealed in 1967. Well 14 was installed in 1953 and sealed in 1983. Well 18 was installed in 1965 and sealed in 1983. Well 19, another Cohansey well in the Holly Street well field, was installed in 1967 and sealed in 1983. Well 21 was installed/operated in 1968/1969 and continues to operate. Wells 13, 14, and 18 were documented to contaminated with dyes and nitrobenzene in 1965 and 1966, apparently transported by surface waters of the Toms River (see page 12, 13 and 16 of the draft Public Health Assessment).