United States
Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R02-92/194
September 1992
PB93-963819

EPA

Superfund
Record of Decision:

Dover Municipal Well 4, NJ

NOTICE

The appendices listed in the index that are not found in this document have been removed at the request of the issuing agency. They contain material which supplement, but adds no further applicable information to the content of the document. All supplemental material is, however, contained in the administrative record for this site.

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REPORT DOCUMENTATION PAGE	1. REPORT NO. EPA/ROD/R02-92/194	2.	3. Recipient's Accession No.
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			14.

15. Supplementary Notes

PB93-963819

16. Abstract (Limit: 200 words)

The Dover Municipal Well 4 (DMW-4) site is located within the 500-year floodplain of the Rockaway River, in the Town of Dover, Morris County, New Jersey. Surrounding land use is mixed residential and commercial/light industrial. Ground water in the area is classified as Class II-A, a current source of drinking water. In the portion of the valley close to DMW-4, two silt layers separate permeable sands into a "shallow aquifer," an "intermediate aquifer," and a "deep aquifer," all of which are connected hydraulically. Drilled in 1962, Dover Municipal Well 4 commenced pumping in 1965, as one of the Town's primary water supply wells. In 1980, sampling and analysis of ground water from DMW-4 identified the presence of VOCs—specifically, chlorinated solvents—above federal and state drinking water standards. Subsequently, DMW-4 was voluntarily removed from service by the Town, and standby Well 3 was activated as a potable water production well. The sources of VOC contamination have been traced to the Howmet Turbine Components Corporation (Dover Casting Division) and the New Jersey Natural Gas Company, both of which are under state administrative consent orders to remediate their

(See Attached Page)

17. Document Analysis a. Descriptors

Record of Decision - Dover Municipal Well 4, NJ
First Remedial Action - Subsequent to follow
Contaminated Medium: gw
Key Contaminants: VOCs (benzene, PCE, TCE), metals (lead)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 48
	20. Security Class (This Page) None	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

Abstract (Continued)

individual properties. This ROD addresses remediation of the contaminated ground water in the shallow, intermediate, and deep aquifers at the DMW-4 site, as OU1. Future RODs will address any additional ground water contamination onsite and the potential source(s) of contamination. The primary contaminants of concern affecting the ground water are VOCs, including benzene, PCE and TCE, and, metals including lead.

The selected remedial action for this site includes onsite pumping and treatment of contaminated ground water from both the intermediate and deep aquifers using air stripping to remove VOCs; discharging the treated water offsite to the public water supply system to be used for potable water, with reinjection of surplus quantities; performing a preliminary assessment of air stripper emissions and discharge requirements to determine if vapor phase treatment using activated carbon will be necessary, and if so, disposing of or recycling the spent carbon offsite; monitoring air emissions; and monitoring ground water to ensure effectiveness of the treatment system and to determine if pretreatment for inorganics is necessary. The estimated present worth cost for this remedial action is $1,985,000, which includes an annual O&M cost of $106,000 for 21 years.

PERFORMANCE STANDARDS OR GOALS:

Chemical-specific ground water clean-up goals are based on federal and state MCLs, including PCE 1 ug/l (state); TCE 1 ug/l (state); toluene 1,000 ug/l (federal); 1,1,1-TCA 26 ug/l (state); and lead 15 ug/l (federal). Ground water will be treated to meet all applicable drinking water standards prior to offsite discharge to the public water supply. Any regulated equipment used in the selected remedy will be designed, constructed, and operated to meet state Air Pollution Control and Noise Pollution Control Act requirements.

ROD FACT SHEET

SITE

Name:	Dover Municipal Well No. 4
Location/State:	Dover, Morris Co., New Jersey
EPA Region:	II
HRS Score (date):	28.9 (December 1982)

ROD

Date Signed: September 30, 1992

Selected Remedy

Groundwater: Extraction of contaminated groundwater for treatment via air stripping. Treated groundwater will be conveyed to the municipal water supply system to the extent practicable, with reinjection of any surplus quantity. Appropriate environmental monitoring to ensure the effectiveness of the remedy.

Capital Cost:	$ 496,000
O & M:	$ 106,000
Present Worth:	$ 1,985,000

LEAD

Agency	Federal Remedial Lead
Primary Contact (phone):	Courtney McEnery (212) 264-1251
Secondary Contact (phone):	Robert McKnight (212) 264-7509

WASTE

Type: Groundwater - Elevated levels of VOCs, primarily PCE.

Medium: Groundwater.

Origin: Unknown at this time. An additional operable unit is planned to address contaminant sources.

DECLARATION STATEMENT

RECORD OF DECISION

DOVER MUNICIPAL WELL NO. 4

Site Name and Location

Dover Municipal Well No. 4
Dover, Morris County, New Jersey

Statement of Basis and Purpose

This decision document presents the selected remedial action for groundwater contamination at the Dover Municipal Well No. 4 site. The remedial action was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan. This decision is based on the administrative record for the site.

The New Jersey Department of Environmental Protection and Energy concurs with the selected remedy.

Assessment of the Site

Actual or threatened releases of hazardous substances from the Dover Municipal Well No. 4 site, if not addressed by implementing the response action selected in this Record of Decision, may present an imminent and substantial endangerment to public health, welfare, or the environment.

Description of the Selected Remedy

The remedy presented in this document addresses the current and future threats to human health and the environment associated with contaminated groundwater at the Dover Municipal Well No. 4 site. This Record of Decision provides for the restoration of the contaminated groundwater to drinking water standards. Additional studies will be necessary to investigate contaminant sources and other areas of potential groundwater contamination. A subsequent decision document is planned to evaluate the need for further remediation of the groundwater and remediation of the contaminant sources.

The major components of the selected remedy include:

- Extraction of contaminated groundwater and restoration of the groundwater to drinking water standards;

- Treatment of extracted groundwater to levels attaining drinking water standards;

- Discharge of treated groundwater to the public water supply system to the extent practicable, with reinjection of any surplus quantity; and

- Appropriate environmental monitoring to ensure the effectiveness of the remedy.

Statutory Determinations

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element. Subsequent actions may be necessary to address additional groundwater contamination and the contaminant sources at the site.

Constantine Sidamon-Eristoff
Regional Administrator

9/30/92
Date

State of New Jersey
Department of Environmental Protection and Energy
Office of the Commissioner
CN 402
Trenton, NJ 08625-0402
Tel. # 609-292-2885
Fax. # 609-984-3962

Scott A. Weiner
Commissioner

SEP 30 1992

Mr. Constantine Sidamon-Eristoff
Administrator
U.S. Environmental Protection Agency
Region II
Jacob K. Javits Federal Building
New York, New York 10278

Dear Mr. Eristoff:

The Department of Environmental Protection and Energy has evaluated and concurs with the selected remedy for the Dover Municipal Well No. 4 Superfund site as stated below:

"The remedy presented in this document addresses the current and future threats to human health and the environment associated with contaminated ground water at the Dover Municipal Well No. 4 site. This Record of Decision provides for the restoration of the contaminated ground water to drinking water standards. Additional studies will be necessary to investigate contaminant sources and other areas of potential ground water contamination. A subsequent decision document is planned to evaluate the need for further remediation of the ground water and remediation of the contaminant sources".

The major components of the selected remedy include:

- Extraction of contaminated ground water and restoration of the ground water to drinking water standards;
- Treatment of extracted ground water to levels attaining drinking water standards;
- Discharge of treated ground water to the public water supply system to the extent practicable, with reinjection of any surplus quantities; and
- Appropriate environmental monitoring to ensure the effectiveness of the remedy.

The State of New Jersey appreciates the opportunity to participate in this decision making process and looks forward to future cooperation with the USEPA.

Sincerely,

Scott A. Weiner
Commissioner

dfh

DECISION SUMMARY

RECORD OF DECISION

DOVER MUNICIPAL WELL NO. 4

SITE NAME, LOCATION, AND DESCRIPTION

Dover Municipal Well No. 4 (DMW-4) is situated on Lot 15, Block 2314, approximately 450 feet north of the Rockaway River in the Town of Dover, Morris County, in central northern New Jersey (Figure 1).

Although most of Dover is residential, DMW-4 is located in a commercial/industrial section of the town. DMW-4 is located approximately 1.5 miles east of three production wells (#1, #3, and #5) which serve a community of approximately 22,000 people. The Dover Water Commission owns and operates this municipal well field. Groundwater in the area is classified as Class II-A, a current source of drinking water.

The Town of Dover is located in the New England physiographic province known locally as the New Jersey Highlands. The Highlands consist of several broad, flat, or round-topped ridges separated from each other by deep and generally narrow valleys. Ridge lines are generally 1,000 feet above sea level and relief is approximately 300 to 400 feet above sea level. The ridges generally trend northeast to southwest. The Rockaway River valley runs transverse to this trend in the vicinity of the DMW-4 site.

Within the Rockaway River valley, stratified sands, silts, gravels and clays (glacial outwash deposits) are typically over 100 feet thick and are emplaced on top of bedrock. An interpretation of subsurface information shows the valley sediments are composed primarily of stratified glacial outwash materials which can be characterized into four layers. These layers, in descending order, include: (1) an upper unit of medium to course sand with gravel and cobbles; (2) a unit of finer-grained deposits, typically consisting of two silt layers bracketing a layer of fine sand; (3) a unit of fine to medium sand; and (4) a deposit of medium to course sand, gravel, and cobbles. This layer is the basal unit which lies directly above the bedrock.

Two or more aquifers are present in the unconsolidated sediments which fill the Rockaway River valley. Fine sand and silt layers act as confining units between the more permeable sands above and below them. In the portion of the valley close to DMW-4, two silt layers separate the sands into three aquifers: an upper water-table aquifer (shallow aquifer) and two underlying semi-confined aquifers, labelled as intermediate and deep. The subsurface investigations conducted as part of the remedial investigation (RI) confirmed that, under non-pumping conditions, groundwater in the lower aquifers in the vicinity of DMW-4 flows with the regional topographic gradient (i.e., to the east). Groundwater in the shallow aquifer flows toward the Rockaway River, with a slight down-valley (eastern) component.

The Town of Dover overlies two designated Sole Source Aquifer areas. The United States Environmental Protection Agency (EPA) designates areas as Sole Source Aquifers under the Safe Drinking Water Act to protect principle drinking water sources.

SITE HISTORY AND ENFORCEMENT ACTIVITIES

Drilled in 1962, Dover Municipal Well #4 commenced pumping in June 1965, and was one of the town's primary water supply wells with an average pumping rate of 1,100 gallons per minute (gpm). In March 1980, sampling and analysis of groundwater from DMW-4 by the Town of Dover identified the presence of volatile organic compounds (VOCs), specifically chlorinated solvents in excess of 250 parts per billion (ppb). Additional sampling conducted by the New Jersey Department of Environmental Protection and Energy (NJDEPE) in July and September 1980 revealed the presence of trichloroethene (TCE). Based on these analyses, DMW-4 was voluntarily removed from service by the Town of Dover in September 1980. Since that time, standby well #3 has been used in place of DMW-4 as a potable water production well.

Between January 1982 and March 1985, initial hydrogeologic investigations were performed for the Dover Water Commission. Separate subsurface studies were also conducted at two industrial facilities located in the river valley east of DMW-4. A hydrogeologic study of the Howmet Turbine Components Corporation Dover Casting Division (Howmet) property in 1982 indicated the presence of VOC contamination in the groundwater. Investigations completed for the New Jersey Natural Gas (NJNG) Company property in 1983 also indicated the presence of VOC contamination in the groundwater. In June 1986, Howmet and NJNG were issued directives from NJDEPE to pay for a remedial investigation and feasibility study (RI/FS) at the DMW-4 site. To date, Howmet and NJNG have not complied with the directives. However, both Howmet and NJNG are under separate New Jersey Administrative Consent Orders (ACOs) for remediation of their individual properties.

HIGHLIGHTS OF COMMUNITY PARTICIPATION

A Community Relations Plan (CRP) was developed to ensure the public opportunities for involvement in site-related decisions, including site analysis and characterization, alternatives analysis, and remedy selection. In addition, the CRP was used by NJDEPE and EPA to determine, based on community interviews, activities to ensure public involvement and to provide opportunities for the community to learn about the site.

A meeting was held in April 1987 to provide residents and local officials with an update on past activities and to inform the public of current and future activities planned for the site.

The RI and FS reports, which addressed the groundwater contamination, were released to the public in August 1992. A Proposed Plan, that identified EPA's and NJDEPE's preferred remedial alternative, was released on August 7, 1992. The documents were made available to the public at information repositories maintained at the Dover Free Public Library and the Dover Municipal Building. The administrative record for the site is located at the Dover Free Public Library. A public comment period was held from August 7 through September 15, 1992. A public meeting was held on August 19, 1992, to present the findings of the RI/FS and the Proposed Plan, and to solicit public input. The issues raised at the public meeting and during the public comment period are addressed in the Responsiveness Summary, which is part of this Record of Decision (ROD).

This ROD presents the selected remedial action for the Dover Municipal Well #4 site, chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The selection of the remedy described in this ROD is based upon the administrative record.

SCOPE AND ROLE OF ACTION

This document addresses remediation of the contaminated groundwater at the DMW-4 site. It includes remedial alternatives which address contaminated groundwater and focuses on the protection of human health and the environment. The remediation of the DMW-4 site will consist of at least two operable units: one which will address the identified groundwater contamination (the subject of this ROD) and one or more which will address additional groundwater contamination at the site and the potential source(s) of the contamination. This operable unit will initiate remediation of the deep, intermediate, and shallow aquifers. If further investigations define source areas of contamination or additional areas of groundwater contamination, remediation of these areas will accelerate cleanup of the shallow and intermediate aquifers as separate operable units.

SUMMARY OF SITE CHARACTERISTICS

An RI was conducted at the DMW-4 site to define the site geology and hydrology, define the nature and extent of groundwater contamination, examine potential migration routes by which contamination could reach DMW-4, and to identify potential sources of contamination. The investigation also provided a basis for defining the zone of capture for DMW-4. The zone of capture is the area over which groundwater flow is directed toward the pumping well. The RI included geophysical surveys, drilling of pilot borings and sampling of subsurface soils, installation of clustered groundwater monitoring wells, a nine-day pump test, and sampling of wells distributed around the DMW-4 site.

Subsurface soil samples obtained during the drilling of the monitoring wells were analyzed during the RI. The only detected soil contaminants were metals, which were found at concentrations consistent with New Jersey background levels. A soil gas survey was then performed as an addendum to the RI to attempt to provide an identification of potential sources of subsurface contamination. The soil gas survey technique utilized on-site gas chromatography to detect and quantify trace levels of VOCs present within the interstitial pore spaces of soil. Under suitable site conditions, VOCs will diffuse upwards from the underlying soil and groundwater and can be evaluated by soil gas methodology. Of the 22 suspected source areas sampled under the soil gas investigation, five areas exhibited VOC contamination equal to or greater than 1 ppb, with one area as high as 3,700 ppb. While this study identified elevated VOC concentrations in these areas, further investigation will be required to conclusively identify source areas.

Since the RI did not sufficiently identify contaminant source area(s), remedial action objectives were developed only for known groundwater contamination at this time. This initial phase of remedial action is referred to as Operable Unit 1 (OU-1). Further study will be required to identify contaminant source areas.

The RI concluded that in the portion of the valley close to DMW-4, two silt layers separate permeable sands into a "shallow aquifer", an "intermediate aquifer", and a "deep aquifer". The RI also demonstrated a hydraulic connection between the aquifers, which indicates that the semi-confining layers do not act as effective barriers to vertical contaminant movement. Under non-pumping conditions, groundwater in the intermediate and deep aquifers flows toward the east. Groundwater in the shallow aquifer flows toward the Rockaway River.

A variety of chlorinated hydrocarbons were detected in groundwater samples from various monitoring wells at concentrations exceeding the promulgated federal and state Maximum Contaminant Levels (MCLs) which have been developed to protect drinking water. Contaminant concentrations and their associated MCLs are shown in Tables 1 through 4. To the north and west of DMW-4, tetrachloroethene (PCE) was detected in shallow, intermediate, and deep wells at levels exceeding the MCL of 1 ppb. During the RI, the highest levels of PCE contamination detected were identified in the intermediate aquifer. PCE was detected at concentrations as high as 1,200 ppb in a portion of the intermediate aquifer located northeast of DMW-4. PCE was also detected in the shallow aquifer at concentrations up to 81 ppb and in the deep aquifer up to 48 ppb.

TCE was detected in the shallow aquifer as high as 17 ppb, in the intermediate aquifer at up to 3 ppb, and in the deep aquifer up to 7 ppb. All of these levels exceed the MCL of 1 ppb.

1,1,1-trichloroethane (1,1,1-TCA) was detected in a deep well southeast of DMW-4 at 49 ppb which exceeds the MCL of 26 ppb. 1,2, dichloroethene (36 ppb) was found in a shallow well south of DMW-4 exceeding the MCL of 10 ppb. Carbon tetrachloride was also detected south of DMW-4 at an estimated concentration of 7 ppb.

Analytes other than chlorinated hydrocarbons detected in wells (excluding the wells located on the NJNG property) include bis(2-ethylhexyl)phthalate and lead.

While phthalates were detected in each of the aquifers, they were also routinely detected in field, trip and/or method blanks, and are typically a laboratory contaminant. Therefore, their actual presence in the groundwater is questionable and requires verification. Similarly, lead was present in a shallow well (24.5 ppb) and deep well (12.3 ppb). However, lead was also detected in the laboratory blank.

Contamination detected at the NJNG property included arsenic, lead, benzene, xylene, benzidine and naphthalene. As previously stated, NJNG is presently under a separate ACO from NJDEPE for the cleanup of its property.

Although groundwater in the vicinity of DMW-4 was found to be contaminated with VOCs, the overall extent of the contamination was not fully determined. However, as previously discussed, a relatively high contaminated portion of the intermediate aquifer was detected in the area northeast of DMW-4. Further investigation is necessary to determine the extent of groundwater contamination in the three aquifers.

SUMMARY OF SITE RISKS

Based upon the results of the RI, a baseline risk assessment was conducted to estimate the risks associated with current and future site conditions. The baseline risk assessment estimates the human health and ecological risk which could result from the contamination at the site if no remedial action were taken.

Human Health Risks

For the human health risk assessment, a reasonable maximum human exposure was evaluated. A four-step process was utilized for assessing site-related human health risks for a reasonable maximum exposure scenario: Hazard Identification--identified the contaminants of concern at the site based on several factors such as toxicity, frequency of occurrence, and concentration; Exposure Assessment--estimated the magnitude of actual and/or potential human exposures, the frequency and duration of these exposures, and the pathways (e.g., ingesting contaminated soil) by which humans are potentially exposed; Toxicity Assessment--determined the types of adverse health effects associated with chemical exposures, and the relationship between magnitude of exposure (dose) and severity of adverse effects (response); and Risk Characterization--summarized and combined outputs of the exposure and toxicity assessments to provide a quantitative (e.g., one-in-a-million excess cancer risk) assessment of site-related risks.

Groundwater monitoring data obtained during the RI indicate that chemicals have been released to and are being transported in the groundwater. The baseline risk assessment began with selecting contaminants which are likely to pose the most significant risks to human health and the environment (chemicals of potential concern). These contaminants include, but are not limited to, PCE, TCE, TCA, arsenic, benzene and bis(2-ethylhexyl) phthalate. These "chemicals of potential concern" and their concentrations in groundwater are shown in Table 5. Of the above-indicated contaminants, all but TCA are known to cause cancer in laboratory animals and are suspected to be human carcinogens.

The baseline risk assessment identified several potential exposure pathways by which the public could be exposed to contaminant releases from the DMW-4 site. The baseline risk assessment evaluated the health effects which could result from exposure to contamination through inhalation, dermal contact and ingestion pathways, and considered both current and future land use scenarios.

Under current EPA guidelines, the likelihood of carcinogenic (cancer causing) and noncarcinogenic effects due to exposure to site chemicals are considered separately. It was assumed that the toxic effects of the site-related chemicals would be additive. Thus, carcinogenic and noncarcinogenic risks associated with exposures to individual indicator compounds were summed to indicate the potential risks associated with mixtures of potential carcinogens and noncarcinogens, respectively. The health effects criteria for the chemicals of potential concern are presented in Tables 6 and 7.

Noncarcinogenic risks were assessed using a Hazard Index approach, based on a comparison of expected contaminant intakes and safe levels of intake (Reference Doses). Reference Doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects. RfDs, which are expressed in units of milligrams per kilogram per day (mg/kg-day), are estimates of daily exposure levels for humans which are thought to be safe over a lifetime (including sensitive individuals). Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) are compared with the RfD to derive the hazard quotient for the contaminant in the particular media. The hazard index is obtained by adding the hazard quotients for all compounds across all media. A hazard index greater than 1.0 indicates that the potential exists for noncarcinogenic health effects to occur as a result of site-related exposures. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media.

Potential carcinogenic risks were evaluated using the cancer potency factors developed by EPA for the indicator compounds. Cancer potency factors (CPFs) have been developed by EPA's Carcinogenic Risk Assessment Verification Endeavor for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CPFs, which are expressed in units of $(mg/kg\text{-}day)^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to generate an upper-bound estimate of the excess lifetime cancer risk associated with exposure to the compound at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the CPFs. Use of this approach makes underestimation of the risk highly unlikely.

For known or suspected carcinogens, EPA considers excess upper-bound individual lifetime cancer risks of between 1×10^{-4} to 1×10^{-6} to be acceptable. This level indicates that an individual has no greater than a one in ten thousand to one in a million chance of developing cancer as a result of exposure to site conditions over a 30-year period.

The Hazard Indices and cancer risks associated with the potential exposure pathways at the DMW-4 site are presented in Table 8.

The "current use" cancer risk associated with residences located within the zone of capture of DMW-4 is estimated to be 3×10^{-5} (three in a hundred thousand). The route of exposure for carcinogenic effects of most concern for current use is inhalation of VOCs present in groundwater. The chemical of primary concern via the inhalation pathway is benzene (2×10^{-5}). The cancer risks for adults and children associated with future residential use of groundwater within the capture zone of DMW-4 is 9 x 10^{-5} for adults and 4 x 10^{-5} for children, respectively.

At the Dover site, the Hazard Index associated with current use is .003. The Hazard Index associated with future residential use of groundwater within the capture zone of DMW-4 is 0.7 for adults and 2.0 for children. Current federal guidelines for acceptable exposures are a maximum Hazard Index equal to 1.0 and an individual lifetime excess carcinogenic risk in the range of 10^{-4} and 10^{-6} (one in ten thousand to one in a million).

The estimate of carcinogenic risk is within the range of acceptable exposure and the Hazard Index exceeds one only for children under a future residential land use scenario. However, cleanup is warranted because, as discussed earlier, groundwater contaminants are present at concentrations exceeding MCLs in each of the three aquifers. Further, high concentrations of PCE are present in the intermediate aquifer. These concentrations of PCE and other contaminants in the shallow and intermediate aquifers can migrate into the deeper aquifer because the confining layers between the aquifers are not impermeable.

As in any risk assessment, the estimates of the risk for the DMW-4 site may have many uncertainties. As a result of the uncertainties, the risk assessment should not be construed as presenting an absolute estimate of risks to human or environmental populations. Rather, it is a conservative analysis intended to indicate the potential for adverse impacts to occur.

Environmental Evaluation

The environmental evaluation provides a qualitative assessment of the potential impacts involving the groundwater contamination associated with DMW-4. The primary objectives of an environmental evaluation are to identify the ecosystems, habitats and populations likely to be found at the site and to characterize the contaminants, exposure routes and potential impacts to the identified environmental components. The only media that will be discussed in this environmental assessment will be the three contaminated aquifers within the zone of capture of DMW-4 and the potential impact on the Rockaway River ecosystem. Possible effects of surface soil contamination cannot be evaluated because contaminant sources were not identified.

The environmental assessment considered potential impacts to the Rockaway River associated with the site. There were no federally endangered species within the area of investigation. There is some indication that the potential exists for elevated inorganics in groundwater to produce adverse environmental effects. Further evaluation of this possibility would be required.

<u>Conclusion</u>

Actual or threatened releases of hazardous substances from the Dover site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare or the environment.

REMEDIAL ACTION OBJECTIVES

Only the remediation of groundwater contamination is addressed in this ROD for Operable Unit 1. Specific remedial objectives are as follows:

- Continue to prevent exposure, due to groundwater ingestion and inhalation, to contaminants at levels exceeding MCLs;
- Minimize further contamination of DMW-4 and prevent contamination of additional existing wells by minimizing the migration of contaminants; and
- Restore contaminated groundwater for future use.

The goal for the restoration of contaminated groundwater is to achieve promulgated federal and state MCLs which have been developed to protect drinking water. MCLs are enforceable standards based on health risks associated with an individual's consumption of two liters of water per day over a 70-year period.

SUMMARY OF REMEDIAL ALTERNATIVES

CERCLA, as amended, requires that each selected site remedy be protective of human health and the environment, be cost effective, comply with other statutory laws, and utilize permanent solutions and alternative treatment technologies and resource recovery alternatives to the maximum extent practical. In addition, the statute includes a preference for the use of treatment as a principal element for the reduction of toxicity, mobility, or volume of the hazardous substances.

The RI identified the groundwater itself as the principal environmental medium affected by contamination. The sources of this groundwater contamination are not addressed by this ROD.

The FS evaluated, in detail, three main alternatives for remediating groundwater. Under Alternative 3, there are two extraction options, three treatment options and three discharge options evaluated. In addition to the alternatives evaluated in the FS, the Proposed Plan discussed an additional alternative to remediate the DMW-4 site, consisting of a modified Alternative 3, Extraction Option E1 (Wellhead Extraction). Since the three components of Alternative 3 (Extraction/Treatment/Discharge) are evaluated separately, to determine the total cost for Alternative 3, the selected options must be added. The estimated capital cost, operation and maintenance (O&M) cost, and net present worth cost for each alternative discussed below are provided for comparison.

An estimated implementation timeframe is given for each remedial alternative described below. It refers to the time required to implement the alternative, including construction and operation and maintenance.

<u>Alternative 1 - NO ACTION</u>

Estimated Capital Cost:	-0-
Estimated Annual O&M Cost:	-0-
Estimated Present Worth Cost:	$ 79,000
Estimated Implementation Timeframe:	None

CERCLA requires that a "No Action" alternative be considered as a baseline for comparison with other alternatives. The No Action alternative would not involve any remedial action to reduce the toxicity, mobility or volume of groundwater contamination at the DMW-4 site. The site would remain in its present condition. Additionally, the potential for off-site migration of contaminants in groundwater would not be prevented under this alternative. Because contamination would remain at the site, a review of the No Action remedy would be conducted after five years to determine the need for response measures at that time. No other action is proposed under this alternative. The only costs associated with the No Action alternative would be the cost of the five-year review of the remedy.

<u>Alternative 2 - Groundwater MONITORING WITH Groundwater USE RESTRICTIONS</u>

Estimated Capital Cost:	-0-
Estimated Annual O&M Cost:	$ 20,000
Estimated Present Worth Cost:	$360,000
Estimated Implementation Timeframe:	30 Years

Alternative 2 consists of the institution of groundwater use restrictions and continued groundwater monitoring. Groundwater use restrictions would include restrictions on the installation of process or potable wells. Groundwater monitoring involves annual monitoring for 30 years. As with the No Action alternative, a review of this alternative would need to be performed after five years. The estimated implementation timeframe noted above is associated with the long-term monitoring program.

Alternative 3 - Groundwater EXTRACTION/TREATMENT/DISCHARGE

Alternative 3 involves groundwater extraction, treatment, and discharge, all of which are broken down further into separate options. Extraction options include E1 (Wellhead Extraction) and E2 (Multi-Well Extraction). Treatment options include T3 (Air Stripping), T4 (Carbon Adsorption), and T5 (UV Oxidation). Discharge options include D1 (Discharge to Groundwater), D2 (Discharge to Surface Water), and D4 (Discharge to Water Supply); all of which are described below. Options T1 (Off-Site Treatment), T2 (Biological Treatment) and D3 (Discharge to Sanitary Sewer System) were discussed in the FS report, but are not discussed in this ROD. T1 and D3 were not retained for further consideration on the basis of limited effectiveness and implementability constraints. Insufficient information concerning T2 was available to thoroughly evaluate the option against the nine evaluation criteria which are described later in this document.

Implementation would include groundwater monitoring. Monitoring would be conducted during the treatment period and for 5 years subsequent to achievement of groundwater remediation goals. The following summarizes the extraction, treatment and discharge options of Alternative 3 which were evaluated in the FS and Proposed Plan. Since the time period for remediation varies with the extraction option (16 years for E-1 and 6 years for E-2), each treatment and discharge option contains two sets of present worth costs.

EXTRACTION

Alternative 3 - Groundwater Extraction Option E1- Wellhead Extraction

Estimated Capital Cost:	$ 2,000
Estimated Annual O&M Cost:	$ 48,000
Estimated Present Worth Cost:	$730,000
Estimated Implementation Timeframe:	16 Years
Groundwater Monitoring:	21 Years

Option E1 consists of groundwater extraction using DMW-4 only. It is anticipated that DMW-4 would be pumped at approximately 1,000 gpm to ensure containment of contaminated groundwater within the capture zone. This flow rate would be refined during the remedial design. The extracted groundwater would be treated and discharged using a combination of treatment/discharge technology options. Based on modeling of the groundwater system and the assumption that sources of contamination will be eliminated, it is estimated that a 16-year extraction period would be required to extract six aquifer volumes from the shallow aquifer and twelve aquifer volumes from the deep and intermediate aquifers. The actual time required to meet remedial goals could vary based on the effectiveness of the technology and success in controlling the sources of contamination.

Alternative 3 - Groundwater Extraction Option E2 - Multi-Well Extraction

Estimated Capital Cost:	$590,000
Estimated Annual O&M Cost:	$ 66,000
Estimated Present Worth Cost:	$1,260,000
Estimated Implementation Timeframe:	6 Years
Groundwater Monitoring:	11 Years

Option E2 consists of extraction of contaminated groundwater via the installation and pumping of an estimated eight extraction wells. The specific number and extraction well locations would be defined during the design phase. Groundwater would be extracted from the shallow, intermediate and deep aquifers at an estimated average total rate of about 915 gpm. This system would provide extraction of contaminated groundwater from the capture zone of DMW-4, while also extracting contaminated groundwater nearer to the potential source area(s) or from areas of concentrated groundwater contamination. Based on groundwater modeling and the assumption that sources of contamination will be eliminated, it is estimated that extraction would occur over a six-year period. Like option E1, this extraction option would be combined with a groundwater treatment option and discharge option.

Alternative 3 - Modified Groundwater Extraction Option E1 - Wellhead Extraction with Additional Extraction Wells

Estimated Capital Cost:	$150,000
Estimated Annual O&M Cost:	$ 65,000
Estimated Present Worth Cost:	$1,045,000
Estimated Implementation Timeframe:	16 Years
Groundwater Monitoring:	21 Years

This option is a modification of Extraction Option E1, Wellhead Extraction, which includes extraction of contaminated groundwater from both the intermediate and deep aquifers. Contaminated groundwater would be extracted from the deep aquifer through pumping DMW-4 and from the more highly contaminated portion of the intermediate aquifer through an estimated two new extraction wells. The extraction system would be designed to minimize the migration of the more highly contaminated groundwater from the intermediate aquifer into the deep aquifer.

Like the two options above, the extracted groundwater would be treated and discharged using a combination of treatment/discharge technology options.

TREATMENT

Alternative 3 - Groundwater Treatment Option T3 - Air Stripping

		Wellhead	Multi-well
Estimated Capital Cost:	$260,000		
Estimated Annual O&M Cost:	$ 41,000		
Estimated Present Worth Cost:		$840,000	$560,000
Estimated Implementation Timeframe:		16 Years	6 Years

Option T3 consists of on-site treatment of contaminated groundwater using an air stripping system. Air strippers would transfer volatile groundwater contaminants from the extracted groundwater to the gas phase. An air emission monitoring program would be implemented during the operation of the treatment system. Although a preliminary assessment of air stripper emissions and discharge requirements indicate that vapor phase treatment of effluent gases may not be required, a further detailed assessment of vapor phase treatment would be necessary prior to implementation of the air stripping system. If vapor phase treatment were determined necessary, spent carbon would require off-site regeneration or disposal. The cost associated with this treatment is presented under the Supplemental Treatment Costs section below.

Alternative 3 - Groundwater Treatment Option T4 - Carbon Adsorption

		Wellhead	Multi-well
Estimated Capital Cost:	$520,000		
Estimated Annual O&M Cost:	$370,000		
Estimated Present Worth Cost:		$5,400,000	$2,900,000
Estimated Implementation Time frame:		16 Years	6 Years

Option T4 consists of on-site treatment of contaminated groundwater using a carbon adsorption treatment system. In carbon adsorption, organic contaminants are adsorbed to the carbon particles within a carbon filtration system. Carbon adsorption treatment would require off-site regeneration or disposal of the spent carbon. An air emission monitoring program would be implemented during the operation of the treatment system.

Alternative 3 - Groundwater Treatment Option T5 - UV Oxidation

Estimated Capital Cost:	$ 800,000		
Estimated Annual O&M Cost:	$1,400,000		
		Wellhead	Multi-well
Estimated Present Worth Cost:		$19,000,000	$9,500,000
Estimated Implementation Timeframe:		16 Years	6 years

Option T5 consists of on-site treatment of contaminated groundwater using an ultraviolet (UV) oxidation system. UV oxidation destroys chlorinated hydrocarbons by oxidation using a combination of ultraviolet light, hydrogen peroxide, ozone, and/or catalysts. The technology provides complete destruction of most chlorinated contaminants without the creation of air emissions or residual waste streams.

SUPPLEMENTAL TREATMENT COSTS

Continued monitoring of the extracted groundwater during design and implementation of the extraction/treatment system would be required to determine if supplemental treatment is necessary to remediate the low levels of phthalate, NJNG contaminants, or lead found during the RI (e.g., chemical precipitation, carbon polishing, etc.). Monitoring of the extraction/treatment system would also be required to determine if pretreatment of the inorganics is necessary to prevent fouling of the organic treatment process. The estimated present worth costs for treatment of inorganics, assuming a treatment rate of 1,000 gpm, would range from $2,000,000 for 6 years of treatment to $5,000,000 for 16 years. The estimated present worth cost of carbon polishing for phthalates or NJNG contaminants would be $2,000,000 for 6 years of treatment to $3,000,000 for 16 years of treatment.

Although a preliminary assessment of air stripper emissions and discharge requirements indicates that vapor phase treatment may not be required, a further detailed assessment of vapor phase treatment would be necessary prior to implementation of the air stripping operation. The estimated present worth costs associated with vapor phase treatment, if it is required, would be $800,000 for 6 years of treatment to $1,200,000 for 16 years of treatment.

DISCHARGE

Alternative 3 - Discharge Option D1 - Discharge to Groundwater

Estimated Capital Cost:	$1,100,000	
Estimated Annual O&M Cost:	$ 59,000	
	Wellhead	Multi-well
Estimated Present Worth Cost:	$2,100,000	$1,700,000
Estimated Implementation Timeframe:	16 years	6 Years

Option D1 consists of discharge of the treated groundwater back to the aquifer using infiltration galleries, reinjection wells or a combination of the two. Due to the proposed high groundwater extraction and treatment rate, combined reinjection of treated groundwater to the shallow, intermediate, and deep aquifers is assumed for the purposes of this evaluation. It is estimated that reinjection would require the installation of a minimum of 19 reinjection wells. Under this option, groundwater would be treated to MCLs prior to reinjection.

Alternative 3 - Discharge Option D2 - Discharge to Surface Water

Estimated Capital Cost:	$56,000	
Estimated Annual O&M Cost:	negligible	
	Wellhead	Multi-well
Estimated Present Worth Cost:	$67,000	$67,000
Estimated Implementation Timeframe:	16 years	6 Years

Option D2 consists of discharge of the treated groundwater to surface water (the Rockaway River), using direct discharge via a dedicated pipe or discharge to a storm sewer. Prior to discharge, groundwater would be treated to levels which attain New Jersey surface water discharge limitation requirements. The major costs associated with this option are the capital costs associated with the installation of the discharge piping. Because costs for pumping are included in the treatment options, O&M costs are estimated to be negligible for this discharge option. A storm sewer located adjacent to DMW-4 which leads to the Rockaway River was used for discharge of the treated pump test water during the Phase I RI.

Alternative 3 - Discharge Option D4 - Discharge to Public Water Supply System

Estimated Capital Cost:	$86,000	
Estimated Annual O&M Cost:	negligible	
	Wellhead	Multi-well
Estimated Present Worth Cost:	$100,000	$100,000
Estimated Implementation Timeframe:	16 Years	6 Years

Option D4 consists of discharge to the public water supply system, whereby the treated groundwater would be used for potable water supply. This alternative would require strict compliance with potable water requirements (i.e., MCLs) to ensure protection of public health. The major costs associated with this option are the capital costs associated with permitting and the installation of the discharge piping. Because costs for pumping are included in the treatment options, O&M costs are estimated to be negligible for this discharge option. This alternative could also be combined with another discharge alternative and used on an emergency basis.

SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

Evaluation Criteria

The alternatives noted above were evaluated using criteria derived from the NCP and CERCLA, as amended by SARA. These criteria relate directly to factors mandated by CERCLA, as amended, in Section 121, including Section 121(b)(1)(A-G). The criteria are as follows:

Threshold Criteria

1. Overall protection of human health and the environment addresses whether or not a remedy provides adequate protection and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

2. Compliance with ARARs addresses whether or not a remedy would meet all of the applicable or relevant and appropriate requirements of Federal and State environmental statutes and requirements and/or provide grounds for invoking a waiver.

Primary Balancing Criteria

3. Long-term effectiveness and permanence refers to the magnitude of residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once remedial objectives have been met.

4. Reduction of toxicity, mobility or volume through treatment addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility or volume of the hazardous substances as a principal element.

5. Short-term effectiveness addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the

construction and implementation period, until the remedial objectives are achieved.

6. Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular alternative.

7. Cost includes estimated capital and operation and maintenance costs, and the present worth costs.

Modifying Criteria

8. State acceptance indicates whether, based on its review of the RI/FS and the Proposed Plan, the State supports, opposes, and/or has identified any reservations regarding the preferred alternative.

9. Community acceptance refers to the community's comment on the alternatives described in the Proposed Plan, and the RI and FS reports. Responses to public comments are addressed in the Responsiveness Summary of this ROD.

Comparisons

A comparative discussion of the major components of the alternatives, using the evaluation criteria, follows. Where differences exist among the various treatment and discharge options for Alternative 3, those differences are noted and discussed. In addition to the alternatives evaluated in the FS, the Proposed Plan presented an additional alternative to remediate the DMW-4 site for Operable Unit 1, consisting of a modified Alternative 3, Extraction Option E1 (Wellhead Extraction). After evaluating the two extraction options presented in the FS report, it was determined that a combination of the two extraction options might be more appropriate. Due to the presence of relatively high levels of PCE contamination in a portion of the intermediate aquifer, extraction wells in this area in combination with wellhead extraction would be more effective in remediating groundwater.

Overall Protection of Human Health and the Environment

Overall protection of human health and the environment is the central mandate of CERCLA, as amended. Protection is achieved by reducing health and environmental threats and by taking appropriate action to ensure that, in the future, there would be no unacceptable risks to human health and the environment through any exposure pathway.

The "No Action" alternative is not considered protective because the risks associated with the DMW-4 site would persist for the foreseeable future. Additionally, the potential for downgradient migration of contaminants in groundwater would continue to exist. Therefore, the "No Action" alternative will not be considered further in the analysis of options for the site.

Alternative 2 provides some protection of human health through the implementation of groundwater use restrictions, but does not provide actual treatment to reduce groundwater contamination, prevent further degradation of the aquifers, or restore the aquifers.

Alternative 3 provides overall protection of human health and the environment through active measures to restore the contaminated groundwater. The modified Alternative 3(E1) provides a significant degree of protection of human health and the environment by initiating the restoration of the deep aquifer and by preventing the further migration of the highest contaminated portion of the intermediate aquifer.

Compliance with ARARs

Section 121(d) of CERCLA, as amended, requires that remedies for Superfund sites comply with federal and state laws that are applicable and legally enforceable. Remedies must also comply with the requirements of laws and regulations that are not applicable, but are relevant and appropriate. Applicable requirements are defined as cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, remedial action, location, or other circumstance at a Superfund site. Relevant and appropriate requirements are defined as substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or circumstance at a Superfund site, address problems or situations sufficiently similar to those encountered at the Superfund site that their use is well suited to the particular site. EPA has also developed another category of requirements, known as "to be considered" (TBCs), that includes nonpromulgated criteria, advisories, guidance, and proposed standards issued by federal or state governments. TBCs are not potential ARARs because they are neither promulgated nor enforceable. It may be necessary to consult TBCs to interpret ARARs, or to determine preliminary remediation goals when ARARs do not exist for particular contaminants. However, identification and compliance with TBCs is not mandatory in the same way that it is for ARARs.

MCLs are applicable drinking water standards and are, therefore, ARARs for aquifer restoration, discharge to the potable water supply, and reinjection to the groundwater. Other ARARs for the site include the promulgated New Jersey Surface Water Quality Standards, Clean Water Act Ambient Water Quality Criteria, Occupational Safety and Health Administration Standards, the Resource Conservation and Recovery Act, and the Clean Air Act. New Jersey's Air Pollution Control Regulations for VOC and toxic emissions and OSWER Directive 9355.0-28, Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites are also ARARs for the DMW-4 site.

EPA has divided ARARs into three categories to facilitate their identification:

> Action-Specific ARARs are usually technology- or activity-based requirements or limitations on actions or conditions involving specific substances.
>
> Chemical-specific ARARs are usually health- or risk-based numerical values or methodologies used to determine acceptable concentrations of chemicals that may be found in or discharged to the environment.
>
> Location-specific ARARs restrict actions or contaminant concentrations in certain environmentally sensitive areas. Examples of areas regulated under various federal laws include floodplains, wetlands, and locations where endangered species or historically significant cultural resources are present.

The goal for the cleanup of groundwater contamination at the DMW-4 site is to restore the groundwater to the more stringent of the federal or state promulgated MCLs which have been devised to protect drinking water.

Alternative 2, Groundwater Monitoring with Groundwater Use Restrictions, would not achieve ARARs because contaminants would remain on site above MCLs. Alternative 3 and the modified alternative are intended to meet MCLs in the aquifer under certain assumptions. The modified alternative will improve the effectiveness of Alternative 3 by reducing the contamination in the intermediate aquifer. Pumping the relatively high contamination in the intermediate aquifer by the use of additional extraction wells is intended to significantly reduce contamination and enhance the remedial action.

The groundwater treatment options of Alternative 3, Options T3 and T4, Air Stripping and Carbon Adsorption, are both expected to achieve ARARs. Option T5, UV Oxidation, is expected to meet chemical-specific ARARs for most contaminants, although achievement of the ARARs for TCA may require supplemental treatment prior to discharge.

Options D1 and D2, Discharge to Groundwater and Surface Water, respectively, would have to be designed with floodplain and historic preservation requirements under consideration. All discharge options would be required to meet associated action-specific requirements. Promulgated surface water quality standards would apply to surface discharge of treated groundwater, and promulgated Federal and State MCLs would apply to discharge to the aquifer or the potable water supply.

Long-Term Effectiveness

This evaluation criterion refers to the ability of the remedy to maintain reliable protection of human health and the environment over time.

Alternative 3 is considered to provide more long-term effectiveness and permanence than Alternative 2 since, under Alternative 2, no groundwater treatment is provided and contaminated groundwater migration is not prevented. Under extraction Option E1, Wellhead Extraction, the higher level of contaminated groundwater in the intermediate aquifer would be drawn into the less contaminated deep aquifer before being extracted, thereby negatively impacting long-term effectiveness. The modified alternative would increase the long-term effectiveness of Option E1 by preventing the further migration of the relatively highly contaminated portion of the intermediate aquifer and would provide long-term effectiveness for the deep aquifer by initiating restoration.

The effectiveness of Option E2, Multi-Well Extraction, would depend on the ability to identify the extent of contamination of the three aquifers. Alternative 2 would provide long-term effectiveness to the extent that the institutional controls remain effective. This would require continued monitoring and enforcement efforts over the long term.

Groundwater treatment option, T4 - Carbon Adsorption, is expected to have the greatest long-term effectiveness because it treats both chlorinated and aromatic organic compounds and results in destruction of these compounds through spent carbon regeneration. Option T3, Air Stripping, is also expected to be effective in the long term for the contaminants of concern.

The discharge option of Alternative 3, D2 - Discharge to Surface Water, has the greatest long-term effectiveness due to relative ease of maintenance. This is followed by Discharge Options D4, Discharge to Public Water Supply, and D1, Discharge to Groundwater, which are also easily operated and maintained, although closer monitoring of the performance of these systems would be required. Under D1, however, additional potential operational problems associated with the reinjection system, such as clogging of reinjection wells, might need to be addressed.

Reduction of Toxicity, Mobility, and Volume

This evaluation criterion relates to the performance of a technology or remedial alternative in terms of eliminating or controlling risks posed by the toxicity, mobility, or volume of hazardous substances.

In comparison to Alternative 2, Alternative 3 provides a greater reduction of toxicity, mobility, and volume through treatment because it provides active treatment of contaminated groundwater. Alternative 2 does not provide any reduction in toxicity, mobility, or volume of contamination. The modified alternative reduces the toxicity, mobility, and volume of contaminants in the aquifers, provides reduction for the intermediate aquifer through the removal of the relatively highly contaminated portion of that aquifer, and prevents the migration of the intermediate aquifer into the deep aquifer.

Groundwater extraction option E2, Multi-Well Extraction, would provide the most timely reduction of mobility and volume by extracting the contaminated groundwater closer to the potential contaminated source areas, if the source areas were known. At this time, source areas and other potential highly contaminated areas have not been fully identified. Extraction Option E1, Wellhead Extraction, requires that the contaminated groundwater be drawn through the aquifers to the extraction well in the deep aquifer. This would result in higher concentrations of contaminants being drawn into the deeper aquifer. The modified alternative provides for the removal of the higher level of contaminated groundwater from the intermediate aquifer in addition to the restoration of the aquifers.

Treatment option T4, Carbon Adsorption, provides the greatest reduction of contaminant toxicity through off-site thermal carbon regeneration. Option T3, Air Stripping, is second for reduction of contaminant toxicity. Option T5, UV Oxidation, is next since it is not effective in the treatment of certain chemicals of concern.

Except for Option D1, Discharge to Groundwater, which could have a beneficial effect, the discharge options have no effect on the toxicity, mobility, or volume of contaminated groundwater. If properly located, reinjection can enhance contaminant mobility to augment extraction.

Short-Term Effectiveness

This criterion considers the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved.

Alternative 2 would be the quickest to implement, since the only action needed would be to institute groundwater restrictions, and would have no short-term impacts. Groundwater extraction option, E1 - Wellhead Extraction, provides the least short-term impact of the active remediation alternatives since it requires no well installation activities. The modified alternative would require the installation of several extraction wells in the intermediate aquifer and would take slightly longer to implement than Option E1 alone. However, the modified alternative would provide a greater degree of short-term effectiveness than would only the wellhead extraction under E1, since the highest level of contaminants present in the intermediate aquifer would begin to be extracted sooner. Option E2, Multi-well Extraction, requires the installation of a more extensive extraction well system than either Option E1 or the modification to Alternative 3(E1), and would, therefore, require a longer implementation period.

None of the options under Alternative 3 would create any significant short-term, health-related concerns for the public beyond those associated with normal construction activities. Increased traffic during construction and transportation of treatment residuals would be expected.

Implementability

This criterion examines the technical and administrative feasibility of a remedy, including availability of materials and services needed to implement the chosen solution.

Alternative 2 is relatively easy to implement as it only involves a groundwater monitoring program and groundwater use restrictions. Alternative 3 and the modified alternative are also relatively easy to implement and rely on technically feasible and reliable technologies to actively restore groundwater quality. Alternative 3 has few associated administrative difficulties which could delay implementation. The treatment technologies have been used successfully to address similar contaminants at other Superfund sites. Skilled workers needed to implement the remedies are readily available in the area, and the treatment units can be easily operated and maintained.

The groundwater extraction option of Alternative 3, E1 - Wellhead Extraction, is the easiest to implement since it involves utilizing only the existing well. Option E2, Multi-Well Extraction, entails the installation of extraction wells which would increase the operation and maintenance requirements and administrative requirements for the acquisition of easements and rights of way necessary for the extensive piping network to transport the extracted groundwater to the treatment system. Because the sources and extent of groundwater contamination have not been fully identified, selecting locations for the extraction wells for Option E2 would be difficult. The modified alternative would be easily implemented since it would rely on the use of DMW-4 and the installation of extraction wells in the portion of the intermediate aquifer that exhibited the highest level of contamination.

The groundwater treatment options of Alternative 3, T3 - Air Stripping and T4 - Carbon Adsorption, are expected to be easily implemented because they are readily available and easily set up. However, Option T4, Carbon Adsorption, may have additional operation and maintenance requirements due to the need for disposal or regeneration of spent carbon. Option T5, UV Oxidation, is next based on its limited availability and more intensive operation and maintenance requirements.

Implementation of Alternative 3 may also require the provision of an inorganic pretreatment system. While inorganic contaminant levels in the groundwater were not found in concentrations above MCLs, pretreatment for inorganics may be required to prevent fouling of the organic treatment system. The need for inorganic pretreatment will be determined during the design phase.

Installation of the extraction and injection wells and their associated piping may have to take place on private properties and may be expected to require some administrative and legal efforts.

Option D4, Discharge to Public Water Supply, is the easiest to implement due to existing connections to the public water supply system. Options D2, Discharge to Surface Water, and D1, Discharge to Groundwater, are also implementable. Under D1, however, potential operational problems associated with the reinjection system, such as clogging of reinjection wells, might need to be addressed.

Cost

Costs are evaluated in terms of remedial action capital costs, operation and maintenance costs, and present worth.

Long-Term Groundwater Monitoring with Water Use Restrictions has an estimated present worth of $360,000, which is associated primarily with the long-term groundwater monitoring program. Alternative 3 consists of a combination of extraction, treatment, and discharge technologies. The groundwater extraction options, which include groundwater monitoring for five years beyond achieving remedial levels, are Wellhead Extraction (Option E1) with a present worth of $730,000, Multi-Well Extraction (Option E2) at $1,260,000, and the modification to Alternative 3(E1) with a present worth of $1,045,000.

The groundwater treatment options, based on 16 years (Wellhead Extraction) and 6 years (Multi-Well Extraction) of treatment, respectively, are $840,000 and $560,000 for Option T3, Air Stripping; $5,400,000 and $2,900,000 for Option T4, Carbon Adsorption; and $19,000,000 and $9,500,000 for Option T5, UV Oxidation.

The three groundwater discharge options evaluated are Option D1, Discharge to Groundwater, at $1,800,000 for 16 years and $1,600,000 for 6 years; Option D2, Discharge to Surface Water, at $67,000; and Option D4, Discharge to the Public Water Supply System, at $100,000.

State Acceptance

The State Acceptance factor addressed whether the State of New Jersey supports, opposes, and/or has identified any reservations with the preferred alternative.

The State of New Jersey agrees with and supports the selected alternative presented in this Record of Decision.

Community Acceptance

This evaluation factor addresses public reaction to the remedial alternatives which were considered, and the preferred alternative.

Issues raised during the public comment period and at the public meeting held on August 19, 1992, are addressed in the Responsiveness Summary section of this ROD. Comments received during the public comment period indicated that the local residents were generally satisfied with the preferred alternative for the cleanup of contaminated groundwater. Upon review of these comments, EPA and NJDEPE have determined that no significant changes to the remedy, as it was originally identified in the Proposed Plan, were necessary.

THE SELECTED REMEDY

Section 121(b) of CERCLA, as amended, requires EPA to select remedial actions which utilize permanent solutions and alternative treatment technologies or resource recovery options to the maximum extent practicable. In addition, EPA prefers remedial actions that permanently and significantly reduce the toxicity, mobility, and volume of hazardous substances found at the site.

After careful consideration of the remedial alternatives, EPA has selected an alternative believed to provide the best balance among alternatives with respect to the evaluation criteria for groundwater remediation for Operable Unit 1. The RI/FS reports should be consulted for more information on the remedial alternatives.

The selected alternative to remediate the DMW-4 site is a modified Alternative 3 with Extraction Option E1 (Wellhead Extraction), Treatment Option T3 (Air Stripping), and Discharge Option D4 (Discharge to Public Water Supply System). Because the presence of relatively high levels of contamination in the intermediate aquifer could adversely impact the effectiveness of the wellhead extraction system by drawing contamination into the deeper aquifer, it has been determined that these high contaminant levels in the intermediate aquifer must be removed. Therefore, the selected remedy includes extraction of contaminated groundwater from both the intermediate and deep aquifers. Contaminated groundwater would be extracted from the deep aquifer through pumping DMW-4 and from the more highly contaminated portion of the intermediate aquifer through an estimated two new extraction wells. The extraction system would be designed to minimize the migration of contaminants from the intermediate aquifer into the deep aquifer.

The input received during the public comment period, consisting primarily of questions and statements submitted at the public meeting held on August 19, 1992, and written comments, is presented in the attached Responsiveness Summary. Public comments encompassed a range of issues, but did not necessitate any major changes in the preferred alternative for the site. Accordingly, the preferred alternative has been selected by EPA and NJDEPE as the remedial solution for the site.

This operable unit will initiate remediation of contamination present in the deep, intermediate, and shallow aquifers. However, if further investigations define source areas of contamination or additional areas of groundwater contamination, remediation of these areas may accelerate cleanup of the shallow and intermediate aquifers as additional operable units.

The estimated present worth cost of this modified alternative is $1,985,000. This cost is based on extraction of groundwater from the deep aquifer using DMW-4, extraction of the high level of contaminants found in the intermediate aquifer using an estimated two new extraction wells, treatment through air stripping, and discharge to the potable water supply system over a period of approximately 16 years.

Groundwater contamination at New Jersey Natural Gas is being addressed through NJDEPE administrative actions. Other potential contaminant sources will be further investigated and a subsequent remedial decision made. Any additional cleanup work determined to be necessary will be performed as a second operable unit action.

If it is determined during design or implementation that the entire volume of remediated groundwater cannot be discharged to a public water supply system, the surplus quantity would be reinjected into the groundwater. The goal of the remedial action is to restore the groundwater to MCLs. Based on information obtained during the remedial investigation and on a careful analysis of the remedial alternatives, it is anticipated that the selected remedy will achieve this goal. However, studies suggest that groundwater extraction and treatment remedies are not always completely successful in reducing contaminants to health-based levels in an aquifer. Actual operation of the remedial system may indicate the technical impracticability of reaching health-based water quality standards using this approach.

Promulgated federal and state MCLs and New Jersey Ground Water Quality Standards promulgated under state law are the groundwater cleanup goals for the remedy selected in this ROD. EPA recognizes NJDEPE's request that groundwater at the site be remediated to the levels specified in the proposed "Cleanup Standards for Contaminated Sites" which NJDEPE distributed to the public for comments earlier this year. EPA has not identified these proposed state regulations as ARARs since they have not been promulgated by the state at this time. Therefore, any additional actions which might be required (beyond the remedy selected in this ROD) to remediate groundwater at the site to the levels specified in the proposed state regulations are not required by CERCLA, nor are they eligible for federal funding under CERCLA. Any such additional actions may be undertaken if they are not inconsistent with the remedy selected in this ROD, and if they are performed with NJDEPE funding.

In summary, the selected alternative is believed to provide the best balance of trade-offs among the alternatives with respect to the criteria used to evaluate alternatives. Therefore, based on information available at this time, EPA and the State of New Jersey believe that the selected alternative would provide overall protection of human health and the environment, would comply with ARARs, and would be cost effective. This action would utilize permanent solutions and alternative treatment technologies to the maximum extent practicable, given the scope of the action.

The selected remedy will include groundwater extraction for an estimated period of 16 years, during which time the remedial system's performance will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation.

Some additional activities will be performed during the remedial design and remedial action phases for the site. These activities are described below.

The aquifers will be periodically monitored during the remedial design and remedial action phases, as well as following the completion of the remedial action. During the remedial design, studies will be undertaken to further delineate the extent of contamination and groundwater flow patterns, and to determine if the remediation of the groundwater contamination can be accelerated by optimizing the extraction system.

An analysis will be made during the remedial design to ensure that any adverse impacts to any wetland areas will be mitigated. If appropriate, some of the treated groundwater could be discharged to wetland areas to help offset any dewatering effects created by the groundwater extraction.

Since the remedial action will occur within the 500-year floodplain of the Rockaway River, a floodplain assessment will be conducted during the remedial design.

A Cultural Resources survey will be prepared to ensure compliance with the National Historic Preservation Act.

STATUTORY DETERMINATIONS

Superfund remedy selection is based on CERCLA, as amended, and the regulations contained in the NCP. EPA's primary responsibility at Superfund sites is to undertake remedial actions that achieve adequate protection of human health and the environment. Additionally, several other statutory requirements and preferences have been established. These specify that, when complete, the selected remedy must comply with ARARs, unless a statutory waiver is justified. The remedy must also be cost effective and utilize permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable. Finally, there is a preference for remedies which employ treatment that permanently and significantly reduce the toxicity, mobility, or volume of hazardous wastes as their principal element. The following sections discuss how the remedy selected for the DMW-4 site meets these requirements and preferences.

Protection of Human Health and the Environment

The selected remedy protects human health and the environment through the extraction and treatment of contaminated groundwater.

The extraction and treatment of the contaminated groundwater will significantly reduce the threat of potential exposure to contaminated groundwater.

There are no short-term adverse impacts associated with the selected remedy which cannot be readily controlled. While no cross-media impacts are expected from the remedy, any environmental impacts associated with site-related contaminants or remedial activities will be addressed in the remedial design.

Compliance with Applicable or Relevant and Appropriate Requirements

The selected remedy will comply with all applicable or relevant and appropriate action-, contaminant-, and location-specific requirements. The ARARs are presented below.

Action-Specific

The selected remedy will be in compliance with all federal and state ARARs. The cleanup goals for the remediation of the groundwater are the more stringent of the promulgated state and federal MCLs which are standards for drinking water.

Emissions from the treatment unit would conform with the provisions of the Clean Air Act. This will be accomplished through the installation of appropriate air pollution control equipment if necessary. Occupational Safety and Health Administration requirements would be complied with during the implementation of the remedy.

With respect to state action-specific ARARs, the air stripper and any other regulated equipment will be designed, constructed, and operated to meet the Air Pollution Control and the Noise Pollution Control Act requirements and regulations.

Chemical-Specific

The more stringent of the state and federal MCLs will be used as cleanup goals for the groundwater remediation.

Location-Specific

The site is not within the coastal zone as defined by the State of New Jersey. Additionally, there are no federally designated wild and scenic rivers and there are no significant agricultural lands in the vicinity of the site. The project area may be sensitive for the discovery of cultural resources. Therefore, as discussed earlier, a cultural resources survey will be prepared during remedial design. Additionally, a wetlands delineation will be performed at that time to determine the presence of and potential impacts on wetland areas. Since the remedial action will take place in a floodplain, a floodplain assessment will be conducted during the design phase.

Utilization of Permanent Solutions and Alternative Treatment or Resource Recovery Technologies to the Maximum Extent Practicable

EPA and the State of New Jersey have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner for the DMW-4 site. Of the alternatives that are protective of human health and the environment, and comply with ARARs, EPA and the State of New Jersey have determined that the selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, cost, and State and community acceptance.

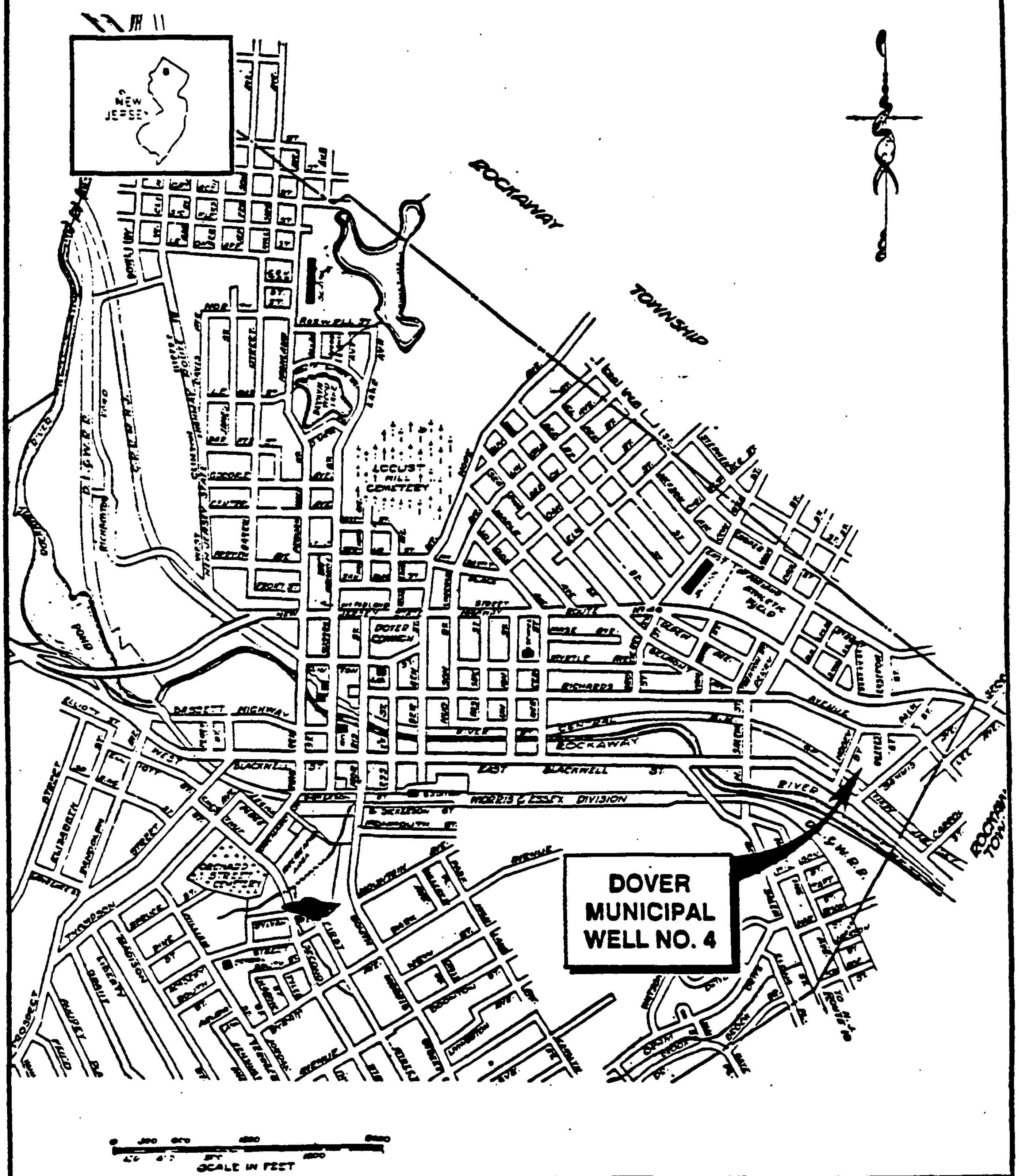
The selected alternative reduces toxicity, mobility, and volume of contaminants in the groundwater; complies with ARARs; provides both short-term and long-term effectiveness; and protects human health and the environment. Contaminants in the groundwater will be removed and treated. This will significantly reduce the toxicity, mobility and volume of the contaminants, and offer a permanent solution to the risks posed by the contaminated groundwater.

Cost Effectiveness

The selected alternative is determined to be cost effective because it provides the highest degree of protectiveness among the alternatives evaluated, at reasonable cost.

Preference for Treatment as a Principal Element

By extracting and treating the contaminated groundwater, the selected remedy addresses the threats posed by the site through the use of treatment technologies. Therefore, the statutory preference for remedies that employ treatment as a principal element is satisfied by the selected remedy.



FROM: TOWN OF DOVER MAP PREPARED BY RAYMOND SHARP, LICENSED ENGINEER & SURVEYOR, 1961

DOVER MUNICIPAL WELL NO. 4

FIGURE 1

SITE LOCATION MAP

TABLE 1

COMPARISON OF DETECTED SHALLOW GROUND WATER CONTAMINANTS TO APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

PARAMETER	MAXIMUM CONCENTRATION DETECTED IN SHALLOW GROUND WATER AQUIFER			FEDERAL ARARs		NJ ARARs
	Round 1 9/87	Round 2 10/87	Round 3 5/89	MCL[1] (ppb)	MCLG[2] (ppb)	NJMCL (ppb)
** VOAs (ppb) **						
trans-1,2-Dichloroethene	1		36(T)	100	100	10
Tetrachloroethene	2		81	5	0	1
1,1,1-Trichloroethane	9(R)	11		200	200	26
Trichloroethene			17	5	0	1
BNAs (ppb)						
Bis(2-ethylhexyl)phthalate			130			
Diethylphthalate			1			
INORGANICS (ppb)	Rej	Rej				
Arsenic			3.43	50		50
Chromium			10.8	100	100	100
Copper			21.8	1300*		
Lead			24.5	15*		
Mercury			0.4	2	2	2
Selenium			3.82	50	50	50
Zinc			471			
** General Parameters**						
pH	4.8-7.8	5.9-8.0	5.3-7.2			
Total Dissolved Solids (mg/l)	422	1462	721			

1. MCL - Maximum Contaminant Level. National Primary Drinking Water Regulations, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992.
2. MCLG - Maximum Contaminant Level Goal, based on health considerations only, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992.
3. Maximum Contaminant Level for Drinking Water; NJ Safe Drinking Water Act, NJAC 7:10-16.7.

* - Action levels representative of drinking water quality at the tap, U.S. EPA, May 7, 1991.
Rej - Data rejected during data validation.
(R) - Data collected during resampling round (12/87).
(T) - 1,2 - Dichloroethene (Total).

Note: We[redacted]W-2S, and wells MW-H1S and MW-H5M (Howmet wells) are located beyond the DMW #4 capture zone and are not included in this summary. NJNG wells MW-C1M and MW-C3M are not included because remediation of NJNG site-related [illegible]

TABLE 2

COMPARISON OF DETECTED INTERMEDIATE GROUND WATER CONTAMINANTS TO APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

PARAMETER	MAXIMUM CONCENTRATION DETECTED IN INTERMEDIATE GROUND WATER AQUIFER Round 1 9/87	Round 2 10/87	Round 3 5/89	FEDERAL ARARs/ MCL[1] (ppb)	MCLG[2] (ppb)	NJ ARARs NJMCL (ppb)
** VOAs (ppb) **						
Tetrachloroethene	1200	1000		5	0	1
1,1,1-Trichloroethane		18	16	200	200	26
BNAs (ppb)						
Butylbenzylphthalate			5			
Diethylphthalate			2			
Di-n-octylphthalate			35			
Bis(2-ethylhexyl)phthalate			170			
INORGANICS (ppb)	Rej	Rej				
Arsenic			3	50		50
Copper			8.5	1300*		
Mercury			0.33	2	2	2
Zinc			167			
General Parameters						
pH	6.9-9.2	6.6-9.6	6.3-7.8			
Total Dissolved Solids (mg/l)	309	355	493.0			

1. MCL – Maximum Contaminant Level. National Primary Drinking Water Regulations, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992.
2. MCLG – Maximum Contaminant Level Goal, based on health considerations only, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992.
3. Maximum Contaminant Level for Drinking Water; NJ Safe Drinking Water Act, NJAC 7 10-16 7.

* – Action levels representative of drinking water quality at the tap, U.S. EPA, May 7, 1991.
Rej – Data rejected during data validation.

Note: NJNG wells MW-C1D and MW-C3D are not included in this summary because remediation of NJNG site-related contamination is not a prime objective of this study. See Table 3-6.

TABLE 3

COMPARISON OF DETECTED DEEP GROUND WATER CONTAMINANTS TO APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

PARAMETER	MAXIMUM CONCENTRATION DETECTED IN DEEP GROUND WATER AQUIFER Round 1 9/87	Round 2 10/87	Round 3 5/89	FEDERAL ARARs/TBCs MCL[1] (ppb)	MCLG[2] (ppb)	NJ ARARs NJMCL[4] (ppb)
** VOAs (ppb) **						
Carbon Tetrachloride		7				
trans-1,2-Dichloroethene			2(T)	100	100	10
Tetrachloroethene	17	37	48	5	0	1
Toluene		4		1000	1000	
1,1,1-Trichloroethane	11	49	8	200	200	26
Trichloroethene	3(R)	2	7	5	0	1
BNAs (ppb)						
Butylbenzylphthalate			4			
Di-n-octylphthalate			2			
Bis(2-ethylhexyl)phthalate			76			
INORGANICS (ppb)	Rej	Rej				
Copper			31	1300*		
Lead			12.3	15*		
Mercury			0.84	2	2	2
Selenium			5.25			
Zinc			298			
General Parameters						
pH	6.1-8.5	6.4-11.2	6.2-9.3			
Total Dissolved Solids (mg/l)	280	384	389.0			

1. MCL – Maximum Co[illegible]aminant Level. National Primary Drinking Water Regulations, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992.
2. MCLG – Maximum Contaminant Level Goal, based on health considerations only, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992.

* – Action levels representative of drinking water quality at the tap, U.S. EPA, May 7, 1991.
Rej – Dat[illegible]cted during data validation.

3. Maximum Contaminant Level for Drinking Water; NJ Safe Drinking Water Act, NJAC 7:10-16.7.

(R) – Data collected during resampling round (12/87).
(T) – 1,2 – Dichloroethene (Total).

... are located beyond the DMW #4 capture zone and are not included in this

TABLE 4

SUMMARY OF GROUND WATER CONTAMINANTS DETECTED AT DMV #4 TO APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

	CONCENTRATIONS DETECTED IN GROUND WATER AT DMW#4							FEDERAL ARARs/ TBCs		--NJ ARARs--
		PUMP TEST		PUMP TEST		PUMP TEST		1	2	
PARAMETER	9/80	1/82 START	1/82 MAX	4/85 START	5/85 MAX	10/87 START	10/87 MAX	MCL (ppb)	MCLG (ppb)	NJMCL (ppb)
** ORGANICS (ppb) **										
1,2-Dichloroethene	9.4	ND	1.9	ND	1			100	100	10
trans-1,2-Dichloroethene						-	ND	100	100	10
cis-1,2-Dichloroethene								70	70	10
Tetrachloroethene	122	7.6	56.4	15	54	15	36	5	0	1
1,1,1-Trichloroethane	118	0.73	118	1	23	-	ND	200	200	26
Trichloroethene	2	ND	0.45	-	-	-	ND	5	0	1

1. MCL - Maximum Contaminant Level. National Primary Drinking Water Regulations, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992.
2. MCLG - Maximum Contaminant Level Goal, based on health considerations only, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992.
3. Maximum Contaminant Level for Drinking Water; NJ Safe Drinking Water Act, NJAC 7:10-16.7.

ND - Not Detected

Note: The January 1982 pump test was performed by Alfred Crews Consulting Engineers.
The April-May 1985 pump test was performed by Alfred Crews Consulting Engineers.
The October 1987 pump test was performed by TRC Environmental Consultants, Inc.

TABLE 5

SUMMARY OF MONITORING WELL DATA (CONTAMINANTS OF CONCERN)

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (ug/L)	RANGE OF DETECTION (ug/L)	ARITHMETIC 95% UCL FOR SCENARIO 1 (a) (ug/L)	ARITHMETIC 95% UCL FOR SCENARIO 2 (b) (ug/L)
INORGANICS					
ARSENIC	4/20	3	3-7.06	NA	2.53
COPPER	10/20	7	7.1-31	NA	10.70
CYANIDE	10/44	2.5-5	2.5-33	NA	4.88
LEAD	6/18	3	7.91-24.5	NA	9.68
MERCURY	6/19	0.2	0.24-0.84	NA	0.26
SELENIUM	3/20	2	2.06-5.25	NA	1.83
ZINC	19/20	4	10.1-471	NA	140.57
VOLATILE ORGANICS					
1,1,1-TRICHLOROETHANE	9/53	5	2-49	4.62	6.10
1,2-DICHLOROETHENE (trans)	3/53	5	1-36	8.05	4.14
BENZENE	4/52	5	4-460	111.97	36.46
TETRACHLOROETHENE	9/53	5	2-1200	15.67	95.67
TOLUENE	5/53	5	3-101	11.44	8.96
TRICHLOROETHENE	5/53	5	2-17	4.94	3.32
BASE NEUTRAL / ACIDS					
bis(2-ETHYLHEXYL)PHTHALATE	5/17	10	43-170	NA	61.66
BUTYLBENZYLPHTHALATE	4/20	10	1-5	NA	5.00 @
DIETHYL PHTHALATE	3/20	10	1-2	NA	2.00 @
DI-N-OCTYL PHTHALATE	5/20	10	2-35	NA	10.20

(a) : The 95% UCL is calculated based on data from the shallow aquifer and three sampling rounds
(b) : The 95% UCL is calculated based on data from three aquifers and three sampling rounds
(@) : Highest detected value used in place of 95% UCL
NA : Not Applicable

TABLE 6

SUMMARY OF TOXICITY VALUES ASSOCIATED WITH CARCINOGENIC EFFECTS

INHALATION

COMPOUND NAME	SLOPE FACTOR INHALATION (MG/KG/DAY)-1	WEIGHT-OF-EVIDENCE CLASSIFICATION	TYPE OF CANCER	SF BASIS/ SOURCE
INORGANICS				
Arsenic	5E+01	A	Respiratory Tract	Occupational/HEAST
Copper	NA	D		NA/IRIS,HEAST
Cyanide	NA	D		NA/IRIS,HEAST
Lead	NA	B2		NA/IRIS,HEAST
Mercury	NA	D		NA/IRIS,HEAST
Selenium	NA	D		NA/IRIS,HEAST
Zinc	NA	D		NA/IRIS,HEAST
VOLATILES				
1,1,1-Trichloroethane	NA	D		NA/IRIS,HEAST
1,2-Dichloroethene	NA			NA/IRIS,HEAST
Benzene	2.9E-02	A	Leukemia	Occupational/IRIS
Tetrachloroethene	1.8E-03	B2	Leukemia, liver	HEAST
Toluene	NA	D		NA/IRIS,HEAST
Trichloroethene	1.7E-02	B2	Lung	HEAST
SEMIVOLATILES				
Bis(2-ethylhexyl)phthalate	NA	B2		NA/IRIS,HEAST
Butylbenzylphthalate	NA	C		NA/IRIS,HEAST
Diethylphthalate	NA	D		NA/IRIS,HEAST
Di-n-octylphthalate	NA			NA/IRIS,HEAST

NA: Not Applicable

TABLE 6 (continued)

SUMMARY OF TOXICITY VALUES ASSOCIATED WITH CARCINOGENIC EFFECTS

ORAL

COMPOUND NAME	SLOPE FACTOR (SF) ORAL (mg/kg/day)-1	WEIGHT-OF EVIDENCE CLASS	TYPE OF CANCER	SF BASIS/ SOURCE
INORGANICS				
Arsenic	NA	A	Skin	NA/IRIS,HEAST
Copper	NA	D		NA/IRIS,HEAST
Cyanide	NA	D		NA/IRIS,HEAST
Lead	NA	B2	Renal tumors	Oral/IRIS
Mercury	NA	D		NA/IRIS,HEAST
Selenium	NA	D		NA/IRIS,HEAST
Zinc	NA	D		NA/IRIS,HEAST
VOLATILES				
1,1,1-Trichloroethane	NA	D		NA/IRIS,HEAST
1,2-Dichloroethene	NA			NA/IRIS,HEAST
Benzene	2.9E-02	A	Leukemia	Occupational/IRIS
Tetrachloroethene	5.1E-02	B2	Liver	Gavage/HEAST
Toluene	NA	D		NA/IRIS,HEAST
Trichloroethene	1.1E-02	B2	Liver	Gavage/HEAST
SEMIVOLATILES				
Bis(2-ethylhexyl)phthalate	1.4E-2	B2	Liver	IRIS
Butylbenzylphthalate	NA	C	Leukemia	Diet/IRIS
Diethylphthalate	NA	D		NA/IRIS,HEAST
Di-n-octylphthalate	NA			NA/IRIS,HEAST

NA: Not Applicable

TABLE 7

SUMMARY OF TOXICITY VALUES ASSOCIATED WITH NONCARCINOGENIC-CHRONIC EFFECTS

INHALATION

COMPOUND NAME	CHRONIC RFD INHALATION (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	INHALATION RFD BASIS/ SOURCE	UNCERTAINTY AND MODIFYING FACTORS
INORGANICS					
Arsenic	3E-04 a				
Copper	NA			NA/IRIS,HEAST	
Cyanide	2E-02 a		Myelin degeneration		
Lead	NA		CNS effects	NA/IRIS,HEAST	
Mercury	9E-06		Neurotoxicity	Occupational/HEAST	UF=30
Selenium	NA			NA/IRIS,HEAST	
Zinc	2E-01 a				
VOLATILES					
1,1,1-Trichloroethane	3E-01		Hepatotoxicity	HEAST	UF=1000
1,2-Dichloroethene	NA			NA/IRIS,HEAST	
Benzene	NA			NA/IRIS,HEAST	
Tetrachloroethene	NA			NA/IRIS,HEAST	
Toluene	6E-01		CNS effects, eyes and nose irritation	HEAST	UF=100
Trichloroethene	NA			NA/IRIS,HEAST	
SEMIVOLATILES					
Bis(2-ethylhexyl)phthalate	2E-02 a				
Butylbenzylphthalate	2E-01 a				
Diethylphthalate	8E-01 a				
Di-n-octylphthalate	2E-02 a				

a : The oral Rfd was used when an inhalation value was not available

TABLE 7 (continued)

SUMMARY OF TOXICITY VALUES ASSOCIATED WITH NONCARCINOGENIC-CHRONIC EFFECTS

ORAL

COMPOUND NAME	CHRONIC RFD (ORAL) (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	ORAL RFD BASIS/ SOURCE	UNCERTAINTY AND MODIFYING FACTORS
INORGANICS					
Arsenic	3E-04	Medium	Keratosis and hyperpigmentation	Oral/IRIS	UF=1
Copper *	4E-02		Local GI irritation	HEAST	
Cyanide	2E-02	Medium	Weight loss,thyroid effects,myelin degeneration	Diet/IRIS	UF=100;MF=5
Lead	NA		Neurobehavioral effects	NA/IRIS,HEAST	
Mercury	3E-04		Kidney effects	Oral/HEAST	UF=1000
Selenium	5E-03	High	Clinical selenosis	Diet/IRIS	UF=3;MF=1
Zinc	2E-01		Anemia	Therap./HEAST	UF=10
VOLATILES					
1,1,1-Trichloroethane	9E-02		Hepatotoxicity	Inhal./HEAST	UF=1000;MF=1
1,2-Dichloroethene	1E-02		Decreased hematocrit and hemoglobin	Gavage/HEAST	UF=3000
Benzene	NA			NA/IRIS,HEAST	
Tetrachloroethene	1E-02	Medium	Hepatotoxicity,weight gain	Gavage/IRIS	UF=100;MF=1
Toluene	2E-01	Medium	Changes in liver and kidney weights	Gavage/IRIS	UF=1000;MF=1
Trichloroethene	NA			NA/IRIS,HEAST	
SEMIVOLATILES					
Bis(2-ethylhexyl)phthalate	2E-02	Medium	Increased relative liver weight	Diet/IRIS,HEAST	UF=1000;MF=1
Butylbenzylphthalate	2E-01	Low	Effects on body weight gain, testes,liver,kidney	Diet/IRIS,HEAST	UF=1000;MF=1
Diethylphthalate	8E-01	Low	Decreased growth rate,food consumption rate and altered organ weights	Diet/IRIS	UF=1000,MF=1
Di-n-octylphthalate	2E-02		Elevated kidney and weights,increased SGOT,SGPT	Diet/HEAST	UF=1000

: HEAST uses current drinking water standard for RfD – conversion made to mg/kg/day

TABLE 8

SUMMARY OF CANCER RISK ESTIMATES
SCENARIO 1

	INHALATION AVERAGE DAILY DOSE (Life) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	CANCER POTENCY FACTOR (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL CANCER RISK
								2E-05
EXPOSURE PATHWAY: INDOOR VOC INHALATION								
BENZENE	8.5E-04	No	2.9E-02	A	Leukemia	Occupational/IRIS	2E-05	
TETRACHLOROETHENE	5.5E-04	No	1.8E-03	B2	Leukemia, Liver	HEAST	1E-06	
TRICHLOROETHENE	6.1E-05	No	1.7E-02	B2	Liver	Gavage/HEAST	1E-06	

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES
SCENARIO 1

	TOTAL HAZARD INDEX RATIO
EXPOSURE PATHWAY: INDOOR VOC INHALATION	1E-03

TABLE 8 (continued)

SUMMARY OF CANCER RISK ESTIMATES
SCENARIO 2 (ADULTS)

CHEMICAL	CHRONIC DAILY INTAKE (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK	TOTAL CANCER RISK
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN DRINKING WATER								8E-05	9E-05
VOLATILE ORGANICS									
BENZENE	4.3E-04	No	2.9E-02	A	Leukemia	Occupational/IRIS	1E-05		
TETRACHLOROETHENE	1.1E-03	No	5.1E-02	B2	Liver	Gavage/HEAST	6E-05		
BASE NEUTRAL / ACIDS									
bis(2-ETHYLHEXYL)PHTHALATE	7.2E-04	No	1.4E-02	B2	Liver	IRIS	1E-05		
EXPOSURE PATHWAY: INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS								4E-06	
VOLATILE ORGANICS									
BENZENE	1.1E-04	No	2.9E-02	A	Leukemia	Occupational/IRIS	3.0E-06		
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN WATER								5E-06	
VOLATILE ORGANICS									
BENZENE	1.6E-05	No	2.9E-02	A	Leukemia	Occupational/IRIS	5E-07		
TETRACHLOROETHENE	9.8E-05	No	5.1E-02	B2	Liver	Gavage/HEAST	5E-06		

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES
SCENARIO 2 (ADULTS)

	PATHWAY HAZARD INDEX	TOTAL HAZARD INDEX
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN DRINKING WATER	7E-01	7E-01
EXPOSURE PATHWAY: INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS	3E-04	
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN WATER	2E-02	

TABLE 8 (continued)

SUMMARY OF CANCER RISK ESTIMATES
SCENARIO 2 (CHILDREN)

CHEMICAL	CHRONIC DAILY INTAKE (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEM. SPEC. RISK	TOTAL PATHWAY RISK	TOTAL EXPOSURE RISK
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN DRINKING WATER								4E-05	4E-05
VOLATILE ORGANICS									
BENZENE	2.1E-04	No	2.9E-02	A	Leukemia	Occupational/IRIS	6E-06		
TETRACHLOROETHENE	5.4E-04	No	5.1E-02	B2	Liver	Gavage/HEAST	3E-05		
BASE NEUTRAL / ACIDS									
bis(2-ETHYLHEXYL)PHTHALATE	3.5E-04	No	1.4E-02	B2	Liver	IRIS	5E-06		
EXPOSURE PATHWAY: INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS								4E-06	
VOLATILE ORGANICS									
BENZENE	1.0E-04	No	2.9E-02	A	Leukemia	Occupational/IRIS	3E-06		
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN WATER								2E-06	
VOLATILE ORGANICS									
BENZENE	6.9E-06	No	2.9E-02	A	Leukemia	Occupational/IRIS	2E-07		
TETRACHLOROETHENE	4.1E-05	No	5.1E-02	B2	Liver	Gavage/HEAST	2E-06		

SUMMARY OF CHRONIC HAZARD INDEX RATIOS
SCENARIO 2 (CHILDREN)

CHEMICAL	CHRONIC DAILY INTAKE (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD INDEX	PATHWAY HAZARD INDEX	TOTAL HAZARD INDEX
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN DRINKING WATER										2E+00	2E+00
INORGANICS											
ARSENIC	1.7E-04	No	3.0E-04	Medium	Keratosis and hyperpigmentation	Oral/IRIS	UF = 1		6E-01		
COPPER	7.1E-04	No	4.0E-02		Local GI irritation	HEAST			2E-02		
CYANIDE	3.2E-04	No	2.0E-02	Medium	Weight loss,thyroid effects,myelin degeneration	Diet/IRIS	UF = 100	MF = 5	2E-02		
LEAD	6.4E-04	No	NA		Neurobehavioral effects	NA/IRIS,HEAST					
MERCURY	1.6E-05	No	3.0E-04		Kidney effects	Oral/HEAST	UF = 1000		6E-02		
SELENIUM	1.2E-04	No	5.0E-03	High	Clinical selenosis	Diet/IRIS	UF = 3	MF = 1	2E-02		
ZINC	9.3E-03	No	2.0E-01		Anemia	Therap./HEAST	UF = 10		5E-02		
VOLATILE ORGANICS											
1,2-DICHLOROETHENE (trans)	2.7E-04	No	1.0E-02		Decreased hematocrit and hemoglobin	Gavage/HEAST	UF = 3000		3E-02		
TETRACHLOROETHENE	6.3E-04	No	1.0E-02	Medium	Hepatotoxicity,weight gain	Gavage/IRIS	UF = 100	MF = 1	6E-01		
BASE NEUTRAL / ACIDS											
bis(2-ETHYLHEXYL)PHTHALATE	4.1E-03	No	2.0E-02	Medium	Increased relative liver weight	Diet/IRIS,HEAST	UF = 1000	MF = 1	2E-01		
DI-N-OCTYL PHTHALATE	6.7E-04	No	2.0E-02		Elevated kidney and liver weights,increased SGOT,SGPT	Diet/HEAST	UF = 1000		3E-02		
EXPOSURE PATHWAY: INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS										1E-03	
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN WATER										5E-02	