GROUNDWATER OPERABLE UNIT
REMEDIAL INVESTIGATION REPORT
MIDDLESEX SAMPLING PLANT
MIDDLESEX, NEW JERSEY

VOLUME 1 OF 2 – TEXT AND TABLES

PREPARED FOR
U.S. ARMY CORPS OF ENGINEERS

MAY 2005

CONTRACT NO. DACW41-99-9012
URS PROJECT NO. 19577-079-149

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLES

TABLE OF CONTENTS

TABLES (continued)

TABLE OF CONTENTS

TABLES (continued)

TABLE OF CONTENTS

TABLES (continued)

TABLE OF CONTENTS

TABLES (continued)

TABLE OF CONTENTS

FIGURES – Located in Volume II

TABLE OF CONTENTS

FIGURES (Continued)

TABLE OF CONTENTS

APPENDICES – Located in Volume II

ACRONYMS, ABBREVIATIONS, and SYMBOLS

μg/g	Micrograms per gram
μg/kg	Micrograms per kilogram
μg/L	Micrograms per liter
AEC	U.S. Atomic Energy Commission
ALARA	As Low As is Reasonably Achievable
ARARs	Applicable, Relevant and Appropriate Requirements
ASTM	American Society of Testing Materials
ATSDR	Agency For Toxic Substances and Disease Registry
BCF	Bioconcentration Factor
BHHRA	Baseline Human Health Risk Assessment
BNI	Bechtel National, Inc.
Bq	Becquerel
BWA	Bureau of Water Allocation
°C	Degrees Celsius
CENWK	U.S. Army Corps of Engineers Northwest Division Kansas City District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
cm	Centimeter
cm/sec	Centimeter per Second
cm^2	Square centimeters
CMP	Corrugated Metal Pipe
COCs	Contaminants of Concern
COPCs	Contaminants of Potential Concern
COPEC	Contaminants of Potential Ecological Concern
cpm	Counts per Minute
CQCP	Contractor Quality Control Plan
CRDL	Contract Required Detection Limit
CTA	Central Tendency Analysis
CTET	Carbon Tetrachloride
CV	Comparison Value
CY	Calendar Year
DIPE	Diisopropyl Ether
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DOE	U.S. Department of Energy
ED	Exposure Duration
EFH	Exposure Factors Handbook
Eh	Redox Potential
EML	Environmental Measurements Laboratory
EPA	U.S. Environmental Protection Agency

ACRONYMS, ABBREVIATIONS and SYMBOLS (cont.)

EPC	Exposure Point Concentration
EPDM	Ethylene Propylene Diene Monomer
ERA	Ecological Risk Assessment
ES	Environmental Surveillance
ESA	Ellington Variant-Urban Land Complex
ESV	Ecological Screening Value
°F	Degrees Fahrenheit
fbg	Feet Below Grade
FeO_2	Hematite
F_{OC}	Fraction Organic Carbon
FS	Feasibility Study
ft	Feet or Foot
ft/day	Feet per Day
ft^2	Square Feet
FUSRAP	Formerly Utilized Sites Remedial Action Program
g/kg	Gram per Kilogram
GAC	Granular Activated Carbon
GI	Gastrointestinal
gpm	Gallons Per Minutes
ha	Hectare
HEAST	Health Effects Assessment Summary Table
HI	Hazard Index
IDW	Investigation Derived Waste
in	Inch
IRIS	Integrated Risk Information System
K	Hydraulic Conductivity
K_2O	Potassium Oxide
K_d	Soil-Water Partioning Coefficient
kg	Kilogram
kg/d	Kilogram Per Day
K_h	Henry’s Law Constant (Vapor/Water Partitioning Coefficient)
km	Kilometer
K_{OC}	Organic Carbon Partitioning Coefficient
K_{OW}	Octanol-Water Partitioning Coefficient
kph	Klometers per Hour
L	Liter
L/kg	Liters per Kilogram
L/m	Liters Per Minute
LMAS	Leaky Multiunit Aquifer System
LNAPL	Light Non-Aqueous Phase Liquid
LOAEL	Lowest Observed Adverse Effects Level

ACRONYMS, ABBREVIATIONS, and SYMBOLS (cont.)

m	Meter
m^2	Square Meters
m^3	Cubic Meters
mbg	Meters Below Grade
MCL	Maximum Contaminant Level
MED	Manhattan Engineer District
mg	Milligram
mg/kg	Milligrams per kilogram
mg/L	Milligrams per Liter
mi	Mile
mm	Millimeter
MML	Middlesex Municipal Landfill
mph	Miles per hour
mrem/yr	Millirem per year
MS	Matrix Spike
mS/cm	Millisiemens per centimeter
MSD	Matrix Spike Duplicate
MSP	Middlesex Sampling Plant
MTBE	Methyl Tertiary Butyl Ether
NaI	Sodium Iodide
NaO_2	Sodium Oxide
NAPL	Non-Aqueous Phase Liquid
NCEA	National Center for Environmental Assessments
ND	Non Detect
NJAC	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NLO	National Lead of Ohio
NOAEL	No Observed Adverse Effects Level
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NTU	Nephalometric Turbidity Unit
NWS	National Weather Station
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PAHs	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PCB	Polychlorinated Biphenyl
pCi/g	PicoCuries per gram
pCi/L	PicoCuries per liter
pH	Log of the concentration of [H+] ions
PRGs	Preliminary Remediation Goals

ACRONYMS, ABBREVIATIONS, and SYMBOLS (cont.)

PVC	Polyvinyl Chloride
Q1	First Quarter
Q2	Second Quarter
Q3	Third Quarter
Q4	Fourth Quarter
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
Ra	Radium
Rad/d	Rad/Day
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
SAIC	Science Application International Corporation
SARA	Superfund Amendments and Reauthorization Act
SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act
sec	Second
SERA	Screening-Level Ecological Risk Assessment
SF	Slope Factor
SMDPs	Scientific/Management Decision Points
SOP	Standard Operating Procedure
SRCs	Site-Related Contaminants
Sv	Sievert
SVOC	Semi-Volatile Organic Compound
TAL	Target Analyte List
TBA	Tertiary Butyl Alcohol
TBC	To Be Considered
TC	Toxicity Characteristic
TCE	Trichloroethylene or Trichloroethene
TCL	Target Compound List
TDS	Total Dissolved Solids
TETLDs	Tissue-equivalent Thermoluminescent Dosimeters
Th	Thorium
TLDs	Thermoluminescent Dosimeters
TOC	Total Organic Carbon
TOX	Total Organic Halides
TPH	Total Petroleum Hydrocarbons
TSP	Total Suspended Particulates
TSS	Total Suspended Solids

ACRONYMS, ABBREVIATIONS, and SYMBOLS (cont.)

U	Uranium
UCL	Upper Confidence Limit
URS	URS Corporation
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTL	Upper Threshold Level
VOC	Volatile Organic Compound
VP	Vicinity Property
yd^3	Cubic Yards
yr	Year

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE) is implementing a remediation program at the former Middlesex Sampling Plant (MSP or Site) in Middlesex, New Jersey. The Site includes buildings, building slabs, soils, sediment, surface water, and groundwater impacted or potentially impacted by radioactive and/or chemical materials. The purpose of this Remedial Investigation (RI) is to define the nature and extent of the contamination in the groundwater, surface water, and sediment at MSP. It also presents an evaluation of the fate and transport of the containments in these media and an assessment of the potential risk they posed on human health and the environment. The MSP Soils OU, which includes site soils, building slabs, and portions of the site storm water control system, is addressed in a separate RI. The buildings are not included in either of these OUs as they are to be demolished and removed under a separate administrative order prior to the implementation of remedial actions to address these OUs. The majority of data on which this RI report is based was generated by field activities conducted between August 2000 and September 2002.

MSP was established in 1943 as part of the Manhattan Engineering District (MED) to sample, store, test, and transfer ores containing uranium, thorium, and beryllium. Over the years that MSP was operational, the buildings, grounds, and nearby land parcels became contaminated predominantly with radium and uranium. The plant site is no longer operational and is being addressed under USACE's Formerly Utilized Sites Remedial Action Program (FUSRAP).

AEC, a predecessor of DOE, established the Formerly Utilized Sites Remedial Action Program (FUSRAP) in 1974 to identify, cleanup, or otherwise control sites contaminated with residual radioactivity resulting from activities of MED and early operations of AEC. In 1999, MSP was added to the National Priorities List (NPL). The remedial activities remaining for MSP will be conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA). NPL sites must undergo a two-part study called a Remedial Investigation/Feasibility Study (RI/FS).

Of the seven buildings (process building, administration building, thaw house, ore dump station, boiler shop, equipment storage building, and garage) that existed during AEC operations at the Site, only the administration building and garage remained by 1996. The other buildings were demolished after decontamination, however concrete foundation slabs remain in place for the process building and boiler building. Currently, the majority of the site is paved, except for a grassy area around the administration building and east of the garage. Access is via a locked gate and a 2.1 m [7 foot (ft)] chain link fence surrounds the site. Land use within a 0.8 km (0.5 mi) radius of MSP is a mix of residential, commercial and industrial property, and undeveloped land. About 1,150 people live within 0.8 km (0.5 mi) of the site. There are no ecologically sensitive areas within the fenced borders of MSP. However, the areas south of the site and along the drainage ditch have been identified as successional forested to shrub-scrub habitat with wetlands.

Surface water runoff at MSP was diverted into a below grade drainage system that flows to a settling basin and eventually discharges through a headwall to a drainage ditch at the southern end of the site. The below grade drainage system has been expanded, modified and re-routed several times over the years, then finally plugged to accommodate historic operational needs at the site, manage runoff from the VP and MML piles, and divert run-on from areas surrounding MSP. Backfill around the pipes of this below grade drainage system were identified as a preferential flow pathway for migration of contaminated groundwater and in 1996 an *in situ* carbon filter was installed at the southern end of the site behind the drainage ditch headwall. It is assumed that the purpose of the insitu carbon filter was to help reduce off-site migration of radionuclides via groundwater seepage from backfill material around the on site below grade drainage system.

The first soil sampling effort at MSP was done in 1976 by Oak Ridge National Laboratory. Since then, evaluation of soil or groundwater quality conditions have been carried out by DOE through their contractors Roy F. Weston in 1980, and Bechtel National, Inc., in 1983, 1991 and 1996. The Agency for Toxic Substances Disease Registry performed a study between 2000 and 2002. In addition, DOE or USACE contractors have performed ongoing environmental surveillance sampling (air, groundwater, surface water and stream sediment) at MSP since 1985. Data from these studies indicate that residual amounts of radioactivity are present in soil and groundwater at MSP. Other non-radiological contaminants, primarily metals and synthetic organic compounds, are also present, but at low levels.

Groundwater

Bedrock at MSP is highly fractured mudstone, siltsone and sandstone (Passaic Formation) of the Brunswick Group. The frequency of fractures decreases with depth. Soils are silty to sandy loams ranging in thickness from 0.45 to 2.4 m (1.5 to 7 ft.). Site stratigraphy (in descending order) consists of asphalt, shallow fill (crushed stone, historic fill materials, sand and silt), some native soils (clayey fine sand to silty sand), and weathered bedrock.

At MSP groundwater characterization efforts have been focused on the overburden and the shallow fractured bedrock. Depth to water in the overburden is generally within 0.58 m (2 ft) of the surface. Overburden groundwater flow in the southern two-thirds of the site is generally to the south-southeast and in the northern one-third of the site; overburden groundwater flow is to the north-northeast. Overburden groundwater flow to the north is also likely to discharge to a drainage ditch, which runs in a deep [6 m (±18 ft) below the grade of MSP] railroad right-of-way. Within the shallow bedrock, groundwater occurs at about 3 to 4.6 m (10 to 15 ft) below the surface and flows generally to the north-northeast in the northern one-third of the site. Groundwater in the shallow bedrock over the southern two thirds of the site flows eastward.

Groundwater from wells completed in deeper portions of the Passaic Formation [32 to 122 m (105 to 400 ft) below grade] is used as domestic, municipal and industrial water supplies in Middlesex County and surrounding counties. Groundwater withdrawals for potable or commercial purposes from overburden (i.e., unconsolidated soils) in the area of MSP have not been identified.

Although groundwater at MSP is not used as a source of potable water, the most stringent of: (a) EPA National Primary Drinking Water Standard Maximum Contaminant Levels (MCLs), (b) NJ State Safe Drinking Water Act MCLs, or (c) NJ Class IIA Ground Water Quality Standards (collectively called the comparison criteria) have been used for evaluating the presence of potential contamination. Because of the sporadic occurrence of detected compounds, contaminant plumes have not been identified in either the overburden or bedrock groundwater at MSP.

Methyl Tertiary Butyl Ether (MTBE) was the only volatile organic compound (VOC) reported in groundwater samples from overburden monitoring wells at concentrations in excess of the comparison criteria. MTBE is a gasoline additive and may be migrating onto MSP from an off-site source. Bis(2-ethylhexyl)phthalate (BEHP) and 1,2,4 trichlorobenzene were the only semi volatile organic compounds (SVOCs) reported in groundwater samples from overburden monitoring wells in excess of the comparison criterion. BEHP was also detected in the off-site (background) monitoring well and is a common laboratory contaminant. Elevated concentrations of aluminum, iron and manganese are regularly detected in groundwater samples collected from the overburden monitoring wells installed at MSP due to turbidity. These are naturally occurring metals and their presence is most likely reflective of overall groundwater quality in the vicinity of MSP. No other metals are detected at a frequency or concentration that would indicate the presence of an on-site source. Exceedences of radiological comparison criteria [total uranium, net alpha and radium (sum of Ra-226 and Ra-228)] are regularly reported in groundwater samples from nine on-site overburden monitoring wells. Concentrations of these radionuclides in excess of comparison criteria are not found in groundwater samples from off-site monitoring wells south (downgradient) of MSP.

Groundwater from bedrock monitoring wells contained four VOCs in excess of comparison criteria: carbon tetrachloride, chloroform, MTBE and trichloroethene. One SVOC (bis(2-ethylhexyl)phthalate) was also reported in excess of the comparison criterion in a groundwater sample from one bedrock monitoring well. Iron and manganese were the only metals found to exceed comparison criteria in filtered groundwater samples from bedrock wells. This is likely due to naturally occurring concentrations of these metals in Passaic Formation groundwater. Net alpha concentrations exceeded the comparison criteria in groundwater from one bedrock well during one sampling event. Radium (sum of Ra-226 and Ra-228) was found slightly above the comparison criterion in groundwater samples from two wells during one sampling event. Other radionuclides were not reported at values above comparison criteria.

Sediment

Sediment samples were collected and analyzed for metals and radionuclides. To obtain an initial qualitative understanding of the results, prior to the evaluating the significance of any contamination in the risk assessment, metals concentrations were compared to the sediment quality guidance from New Jersey Department of Environmental Protection (NJDEP 1998) and from the EPA (EPA 2000), or background (upstream) levels. Radionuclide concentrations in the sediments are compared to the clean-up criteria developed for soils in the MSP Soils Operable Unit Feasibility Study and the background results. A complete evaluation of risk posed by each contaminant in the sediment is presented in the risk assessment discussed in Chapters 7 and 8.

All of the downstream sediment sample locations contained a least a few samples with detected elevated levels of these metals as compared to the criteria (except silver). For radionuclides, several results for Ra-226, U-235, and U-238 were above the Derived Concentration Guideline Levels (DCGLs) developed for MSP soils in the Soils Operable Unit Feasibility Study. Levels detected in sediment samples were greater at the headwall discharge (outfall) sampling location, when compared to downstream locations.

Surface Water

Surface water does not contain organic compounds in excess of comparison criteria. The highest concentrations of metals detected in surface water (aluminum, iron, lead, manganese and sodium) were from the upstream sampling location. Concentrations of net alpha in surface water exceeded comparison criteria in samples just downstream of the MSP outfall.

Fate and Transport

In order to evaluate the potential distribution and concentration of the various contaminants that may occur down gradient of the site if no soil remedial action is taken, a simple one-dimensional fate and transport model was developed for the site. Modeling indicated that if remedial actions were not implemented on the groundwater at MSP, radionuclides and VOCs would eventually migrate off site. The time frame estimated by the model for impacted groundwater to move more than 0.4 km (0.25 mi) beyond the site boundary (10+ years) is well beyond the 2005 anticipated cleanup schedule for MSP.

Human Health and Environmental Risk

The baseline human health risk assessment concluded that potential health risks associated with uranium (chemical and radiological), manganese, and carbon tetrachloride for a residential scenario are unacceptable. Further evaluation of remedial alternatives is therefore necessary. The screening level ecological assessment found that radiological risks (i.e., doses) to aquatic and benthic organisms were acceptable. However, contaminants of potential ecological concern were identified that need to be considered during the remedial planning process. These remedial efforts will address contaminant source and greatly reduce the likelihood of off-site migration.

Recommendations

The data generated during these RI activates is adequate for remedial planning and the evaluation of potential remedial alternatives in the FS. However, Further delineation of groundwater quality conditions to the north and east of MSP is recommended. Groundwater in the overburden, under the northern portion of the site, flows beyond the property boundary to the north-northeast. Similarly, shallow groundwater in the southern portion of the site flows beyond the property boundary to the east-southeast. Sampling data indicate that groundwater on the MSP site contains concentrations of radionuclides in excess of comparison criteria. While the need to identify the ultimate distribution of groundwater potentially impacted by MSP is required under CERCLA, sufficient information has been gathered to adequately characterize the site for the purpose of developing and evaluating effective remedial alternatives. Furthermore, additional data collected to augment the RI will not affect the ultimate remedial outcome for MSP.

1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE) is implementing a remediation program at the former Middlesex Sampling Plant (MSP or site) in Middlesex, New Jersey. This Remedial Investigation (RI) report addresses the Groundwater Operable Unit (OU) for the site and includes groundwater in overburden materials and the bedrock, as well as surface water and sediment in drainage ditches and swales south of the site. The MSP Soils OU, which includes surface soil, subsurface soil and on-site buildings was addressed in a separate RI report (USACE, 2003).

The MSP facility was established in 1943 as part of the Manhattan Engineer District (MED) to sample, store, test, and transfer ores containing uranium, thorium, and beryllium in support of the United States development of the atomic bomb during World War II. Over the years MSP was operational, the buildings, grounds, and nearby land parcels became contaminated with radium, uranium, thorium, and their daughter products. The plant site is no longer operational and is currently being addressed under USACE's Formerly Utilized Sites Remedial Action Program (FUSRAP). Under this program and specifically under the guidance of the Kansas City and New York Districts of the USACE, groundwater, surface water, sediment, and air monitoring activities are conducted quarterly by URS Corporation (URS) as part of an on-going Environmental Surveillance program. URS also conducts site maintenance, which includes grounds keeping (i.e., lawn mowing and snow removal) activities throughout the year.

The U.S. Atomic Energy Commission (AEC), a predecessor of the U.S. Department of Energy (DOE), established FUSRAP in 1974 to identify, cleanup, or otherwise control sites contaminated with residual radioactivity resulting from activities of the MED and early operations of the AEC. In 1997, FUSRAP was transferred from DOE to USACE by the 1998 Energy and Water Development Appropriations Act. MSP is one of 46 FUSRAP sites identified for remedial action under this program. On February 18, 1999, MSP was added to the National Priorities List (NPL) under the Federal Facilities Section. Remedial activities at the site will be conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA). NPL sites must undergo a two-part study called a Remedial Investigation/Feasibility Study (RI/FS). The objective of the RI is to assess potential impacts to health and the environment and to gather data needed to evaluate remedial alternatives. That information is then used in the FS to evaluate remedial action alternatives.

This RI report describes the activities and documents the results of investigations conducted at MSP over a period of years by DOE and USACE in cooperation with and oversight by the

U.S. Environmental Protection Agency (EPA) Region II and the New Jersey Department of Environmental Protection (NJDEP).

This introductory section presents a site description, the purpose and scope of the report, and a reader's guide to the organization and content of subsequent sections in the RI.

1.1 SITE DESCRIPTION

The former MSP site is at 239 Mountain Avenue, in the Borough of Middlesex, Middlesex County, New Jersey, approximately 29 kilometers (km) [18 miles (mi)] southwest of Newark, New Jersey (Figure 1-1). The 3.9 hectare (ha) [9.6 acre] site is surrounded by a 2.1 meter (m) [7 foot (ft)] high chain link fence. Figure 1-2 illustrates the present layout of the site. There are no current commercial or industrial activities at the MSP site. The two existing buildings in the northern portion of the site were previously used as an administration office and garage. There are also two building slabs remaining from the demolition of a Boiler House and Process Building. The majority of the site is paved, except for a grassy area around the Administration Building and east of the garage.

Other site features include two asphalt pads, which cover the southern two-thirds of the site. These pads were formerly used for the interim storage of soil removed from the Middlesex Municipal Landfill (MML) and the vicinity property (VP). These stockpiles of soil were identified as MML soil pile and the VP soil pile. The material placed in these interim storage piles was the result of DOE cleanup actions conducted in 1981 through 1986. The MML and VP soil piles were removed and disposed off site in 1998 and 1999, respectively.

The site surface slopes toward the south at approximately a one-percent grade and is underlain by three abandoned subsurface stormwater drainage lines. The two eastern-most drainage lines, constructed of 0.45 m (18-inch [in]) diameter corrugated metal pipe (CMP), drained the northern one-third of the site and a stormwater catch basin on Wood Avenue. The western-most subsurface drainage line constructed of 0.30 m (12 in.) diameter polyvinyl chloride (PVC) pipe, received surface water runoff from the remaining portion of the northern end of the site. Although currently disconnected from the storm drainage lines, a sump in the former Process Building also discharged water to the subsurface stormwater drainage system (Figure 1-2). Due to concerns about radionuclide migration, the stormwater drainage system was plugged with concrete and abandoned in 1996, and the drainage line associated with the Wood Avenue catch basin was rerouted along the eastern perimeter of the site.

A settling basin near the southern site boundary, approximately 2.6 m (8.6 ft) deep, receives stormwater runoff from the current surface water collection system that surrounds the two asphalt pads, which once contained the MML and VP soil piles. Water in the settling basin discharges to a drainage ditch, referred to as the South Drainage Ditch, through a concrete headwall on the south site boundary (Figure 1-2). The South Drainage Ditch is approximately 350 m (1,150 ft) in length, and flows through an unoccupied field to a larger drainage feature referred to as Main Stream. Main Stream then flows in a southwesterly direction for approximately 640 m (2,100 ft) through a wooded area and discharges into Ambrose Brook (Figure 1-3). An *in situ* granular activated carbon filter was installed on the subject property behind the drainage ditch headwall in 1996 to reduce the likelihood of potential off-site migration of radionuclides into the ditch from discharging groundwater (Figure 1-2). The filter consists of activated carbon granules within a wooden frame. The filter is not currently being maintained, and there is no available documentation of maintenance activities that were completed after its initial installation.

The east side of MSP borders residential homes, small businesses, and fields (Figure 1-3). The west side borders an industrial vehicle salvage facility (Absolute Auto Body). This property encompasses approximately 6 ha (15 acres) and is occupied with hundreds of inoperable cars, trucks and industrial equipment. The property to the south includes the South Drainage Ditch and consists of marshy land and fields. The property south of the site is currently under development with the construction of condominiums on the south side of Main Stream. Partial land clearing north of Main Stream has occurred for future construction. The main entrance to the facility (Mountain Avenue) is on the north side, which also borders the Lehigh Valley Railroad.

1.2 PURPOSE AND SCOPE

The purpose of this RI is to define the nature and extent of radiological and chemical contamination in the Groundwater OU at the Middlesex site, evaluate the fate and transport of contaminants, and assess potential human health and ecological risk. This information will then be used in the FS to identify potential remedial action alternatives and evaluate applicable or relevant and appropriate requirements (ARARs). Data collected during field investigations between 1976 and August 2002 have been used to achieve the goals of this RI. While some data gaps may exist (e.g., extent of groundwater contamination between various data points), the information currently available for groundwater sufficiently characterizes the site for the identification and evaluation of remedial action alternatives in the FS.

Groundwater at MSP is also currently being monitored as part of an Environmental Surveillance Program (USACE, 2000a). This ongoing monitoring program provides data to assess trends and changes (if any) in the groundwater flow system and the nature and extent of contamination.

1.3 REPORT ORGANIZATION

This RI report is organized in a format similar to the outline suggested in the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1989a) and the *New Jersey Technical Requirements for Site Remediation* (NJAC 7:26E, 1997). As previously mentioned, Section 1.0 provides a site description, the purpose and scope of the report and a guide to the organization and content of the RI. Section 2.0 summarizes the operational history, site features, and previous removal actions and previous investigations performed to characterize the site. Section 3.0 characterizes the environmental setting relevant to evaluating site contamination. A summary of field investigation and sampling activities is provided in Section 4.0. Results of the field investigations done to assess the nature and extent of groundwater contamination are presented in Section 5.0. The fate and transport of contaminants are described in Section 6.0. Section 7.0 presents the Baseline Human Health Risk Assessment and discusses the risks to human health from exposure to contaminants in the groundwater. Section 8.0 is the Screening Level Ecological Risk Assessment and focuses on the impacts of MSP groundwater contamination on the environment if MSP is not remediated. Section 9.0 summarizes the RI findings and presents recommendations. Section 10.0 includes a list of the references. Figures and tables are presented in their respective sections following the text, before the appendices.

Nineteen appendices supplement this report:

Appendix A	2002 Focused Soil Investigation
Appendix B	Data Quality Assessment and Validation
Appendix C	Boring Logs
Appendix D	Geochemistry
Appendix E	Ecology
Appendix F	Monitoring Well Installation Form A
Appendix G	Monitoring Well Survey Form B
Appendix H	Monitoring Well Completion Diagrams
Appendix I	Grain Size Analysis
Appendix J	Monitoring Well Development Forms
Appendix K	Borehole Geophysical Data
Appendix L	Slug Test Calculations
Appendix M	SOP – Groundwater Sampling
Appendix N	Low-Flow Groundwater Sampling Guidelines
Appendix O	Groundwater Field Sampling Data Sheets
Appendix P	Shower Model
Appendix Q	Statistics
Appendix R	Glossary of Terms
Appendix S	Alternative Risk Analysis for TCE

1.4 UNCERTAINTIES

There are three areas within this RI report where uncertainties may be found:

- **Between sampling points –** For practical purposes, not all groundwater can be sampled at every point on the property. Therefore, reasonable assumptions have been made regarding the occurrence and distribution of site related constituents in groundwater. These assumptions have been developed using generally accepted standard hydrogeologic procedures and are described in the text of the report.

- **Groundwater modeling –** The mathematical simulation of groundwater flow and contaminant transport systems requires that assumptions be made for such factors as flow boundaries, certain soil conditions, contaminant degradation rates, and other input parameters. The values used have been taken from EPA and other generally accepted published guidelines and are appropriately referenced in the report.

- **Risk methodologies –** Human health and ecological risk assessment techniques established by EPA have been used to evaluate potential impacts to both on-site and off-site receptors.

None of the uncertainties identified are significant enough to affect the overall findings of the RI or to prevent the use of those findings in the FS.

2.0 SITE HISTORY AND SUMMARY OF PREVIOUS INVESTIGATIONS

This section of the RI describes the background and operational history of MSP. It also summarizes previous soil and groundwater characterization activities that have been conducted at the site, including remedial investigation activities and the environmental surveillance program.

2.1 SITE BACKGROUND

The subject site has been used for industrial activities since the early 1900s. A timeline of the operational history between 1913 and the present is shown on Figure 2-1. A description of historic uses and an overview of key site features are provided below.

2.1.1 Background and Operational History

The industrial operations at the Middlesex site began in 1910 with the construction of a plant for the manufacture of asphalt paint. At this time the plant included a brick warehouse, a boiler house, a garage, an Administration Building, a dye warehouse, and four smaller buildings (DOE, 1997). The original company, (name unknown), was purchased in 1913 by the American Marietta Company, with products sold under the American Asphalt Company label.

In October 1943, AEC leased the brick warehouse from American Marietta Corporation and converted it into the former Process Building for the MED. AEC established MSP to sample, store, test, and transfer ores containing uranium, thorium, and beryllium (as well as a chemical precipitate, magnesium di-uranate, supplied by African Metals Corporation beginning in 1950). Between 1943 and 1955, uranium assay analysis was the primary operation, which was conducted by the United Lead Company (ULC) under contract with the AEC.

The earliest processing and sampling methods used at MSP were manual. The ore arrived in burlap or paper bags and was thawed in the thaw house if necessary. The ore was then conveyed to framed screens in the Process Building, manually worked through the screens, and allowed to collect on the floor below the screens. Eventually the ore was blended by repeated shoveling of the accumulated material, and a grab sample of this mixed material was collected and processed for analyses.

Sampling was later accomplished by the use of cascades. Ore was dumped on riffles, which extended from the second to the first floor of the Process Building, and worked through by hand. Once on the first floor of the Process Building, a grab sample was collected for analysis and the remaining material drummed for shipment.

Pipe sampling later replaced the cascade method. A portion of each lot was passed through a vibrating screen. The oversized lumps were passed through a grinding mill and recycled to the screen. The material was drummed, and three pipe samples taken from each drum. The sample was then successively dried, ground in a bell grinder, riffled, pulverized, composited, and blended overnight in a ball mill. This composited material was then dried and packaged for distribution.

Ore was originally dried by a series of propane burners mounted over a conveyor belt that carried the ore from the dumping station to the processing equipment. This proved unsatisfactory since the rubber belts melted and the woven belts became caked with wet ore. This system was later replaced with an oil-fired rotary kiln dryer. Eventually, the process became mechanized and consisted of a series of conveyors, rotary driers, crushers, bucket elevators, vibrating screens, cone grinders, and samplers.

The processing of magnesium di-uranate precipitate and beryllium ore was generally similar to the uranium ore. However, magnesium di-uranate processing was primarily mechanical due to exposure concerns. The magnesium di-uranate was received in drums instead of burlap or paper sacks. The drum lids were cut off and the drums emptied by a mechanical drum dumper into a bucket elevator that carried the material to a lump breaker. The lump-free magnesium di-uranate was fed through a hopper into a Vezin sampler unit where a 10 percent cut was taken for a sample. The remaining 90 percent was fed through a screw conveyor into drums. This final step was completed under a magnesium di-uranate dust collection system (Cahalane, 1958). Magnesium di-uranate dust collected by the dust collection system was first discharged to a dust-tight screw conveyor that in turn discharged to a drum. The beryllium ore did not need to be thawed or dried. The same equipment used to process the uranium ore was used to process the beryllium ore.

It is presumed that some, if not all, of the first uranium ores processed at the MSP site originated from the Skinkolobwe Mine in the former Belgian Congo, Africa. This mine was discovered in 1915, and the pitchblende (the chief ore of uranium) was of higher grade than found elsewhere in the world (Nininger, 1956). A stockpile of Skinkolobwe ore was transported to a warehouse in New York at the end of 1940 and provided the initial supply of uranium for the Manhattan Project. The ore-bearing rocks at Skinkolobwe are from veins in metamorphic beds. In addition to pitchblende, the ore contained significant quantities of cobalt, copper, molybdenum, iron sulfides, tungsten, gold, platinum, and palladium. The mineralogy of the deposit includes 30 minerals of uranium (uranoxides, urano-silicates, urano-phosphates, urano-carbonates, and urano-molybdenite) (Derrks and Vaes, reference date unknown).

In 1946, MED was deactivated and MSP operations were continued under the direction of AEC. The leased facility was purchased through condemnation by AEC from American Marietta Corporation, and various new buildings were constructed (DOE, 1997). These new structures included a replacement for the Administration Building, a replacement garage, a thaw house, and a storage house. A chain link fence was installed around the site and approximately 3.2 of the 3.9 ha (9.6 acre) were paved with asphalt for use as a drum storage area.

Throughout the late 1940s and early 1950s, the site received and shipped various research and decontamination wastes. In addition, low-level combustible waste was incinerated on the Site. The incinerated ashes and noncombustible scrap were reportedly placed in drums and transported off site for disposal. MSP was also used to prepare contaminated wastes for shipment and disposal at sea.

During 1951 and 1952, MSP became the intermediate point for the shipment of uranium bars from Lake Ontario Ordnance Works in Niagara Falls, New York, to American Machine and Foundry Company in Brooklyn, New York, where the bars were experimentally machined into slugs. Scraps from this operation were then returned to MSP for shipment to a uranium recovery processor. Before operations ceased, they also included assaying beryllium ore for shipment to Brush Beryllium in Luckey, Ohio.

Over the years that MSP was operational, the buildings, grounds, and nearby land parcels became contaminated with radium and uranium. It is unlikely the magnesium di-uranate processing had significantly impacted the ground surface or adjacent properties due to the more controlled handling of the material. The handling of uranium ore sacks likely resulted in spillage, and subsequent migration mechanisms caused localized radiological contamination, both on and off site. It should be noted, however, that the facility management practices used were standard industry techniques that were considered appropriate at the time.

AEC terminated primary operations at MSP in 1955. However, it continued to be used for storage and limited sampling of thorium residues. AEC activities at the Site ended in September 1967, after decontamination of the structures and certification of the Site for unrestricted release was complete. Decontamination activities included sandblasting, vacuuming, detergent and acid washing, concrete chipping, and equipment removal. In cases of severe contamination, parts of buildings were removed. In addition, a portion of the paved yard and underlying gravel and soil were transported by rail to the Nuclear Fuel Services licensed burial site at West Valley, New York (Ford, Bacon, & Davis, 1979a). In 1968, AEC returned the MSP property to the General Services Administration, which transferred the site to the U.S. Department of the Navy. The site served as a U.S. Marine Corps reserve training center from 1969 to 1979 before being placed back into the custody of DOE in 1980.

2.1.2 Early Cleanup Actions

During 1976, the MSP site was re-evaluated for residual radioactive contamination due to changes in radiological standards and release guidelines (ORNL, 1977). The Site was placed back into USDOE custody in 1980 after contamination above current guidelines was found to be present on the MSP site, and surrounding Vicinity Properties (VP) that included residential and commercial properties as well as portions of the drainage area to the south. Residual contamination above the current guidelines that originated from the MSP was also identified at the Middlesex Municipal Landfill (MML). This contaminated landfill material resulted from construction activities in 1948 when excess soil from grading operations at MSP containing small amounts of pitchblende ore (high-grade uranium ore) was taken to the MML. The contaminated material subsequently was covered to varying depths during landfill operations.

Clean up of the VP and the MML was initiated by the DOE in 1981 and completed in 1986 (BNI, 1985a; BNI, 1985b). The excavated materials generated from these actions were temporarily stored on specially constructed pads at the MSP site in two piles, the VP and MML interim storage piles. As their names imply, the VP pile contained the excavated materials from the clean up of the VP (a total of 26,900 cubic meters [m^3]; 35,200 cubic yards [cy]), and the MML pile contained the excavated materials from the clean up of the MML (a total of 23,800 m^3 31,200 cy). The piles were subsequently removed to a permitted commercial disposal facility in 1998 and 1999 (USACE, 1997; USACE, 1999a).

2.1.3 Site Features

This section presents a summary of the existing and former features at the MSP site. They include the buildings and pads (i.e., building structures, building and structure foundation slabs, and storage pile pads), the storm water discharge system (termed the Pipe Chases) that includes the underground site storm water control system, and the South Drainage Ditch that accepts the storm water discharge from the site.

2.1.3.1 Buildings and Pads

The six site buildings that existed during AEC's operations were the Process Building, Administration Building, thaw house, boiler house, equipment storage building, and garage (Figure 2-2). The only buildings that remain at MSP are the administrative building and the garage. The Process Building was a brick warehouse in which sampling and assay of uranium ore was conducted. The thaw house was a concrete block building used to store ore that needed to be thawed prior to processing. The boiler for heating the Process Building was in the boiler house. The concrete block Administration Building contained offices, a laundry, shower, lunchroom, two locker rooms, a health and safety dispensary, and a waste disposal unit (solid waste incinerator). The equipment storage building was a Quonset hut made of steel and corrugated metal. The garage was a wood frame building covered with corrugated metal. During site operations, a seventh structure of concrete block was used as a dumping station for uranium ore onto the conveyor for transport to the assay equipment in the Process Building (Cahalane, 1958).

The thaw house was demolished and buried on site prior to construction of the MML pile asphalt pad, and the equipment storage building was demolished in the early 1980s. A series of underground fuel tanks and surface pumps (Figure 2-2) were near the center of the Site (Ford, Bacon, and Davis, 1979a). These tanks and pumps were removed during construction activities in 1980. The Process Building and boiler house were demolished in 1996 (DOE, 1996).

During Site operations, a sump in the ore Process Building floor was used for the disposal of wastewater. The sump was 3.7 m long, 1.8 m wide, and 3 m deep (12 ft by 6 ft by 10 ft) and extended into the water table. As part of Process Building demolition in 1996, the sump was drained and plugged with concrete.

In 2000, preliminary activities related to the demolition of the Administration Building were initiated. During these preparation activities, low levels of radiological contamination were found on the building’s roof. Demolition activities have since been postponed, and the building remains at MSP. Other than box trailers used for general storage of USACE field equipment the only other standing building presently on site is the garage.

2.1.3.2 <u>Pipe Chases (Subsurface Storm Water Drainage System)</u>

Surface storm water runoff (rainfall, snowmelt, etc.) at MSP was diverted into a subsurface storm drainage system which then directed it to the South Drainage Ditch. As is typical of subsurface drain systems, the pipes are surrounded by non-native bedding backfill material. This backfill is usually granular in nature and more porous than the surrounding soil. The USACE historically identifies this subsurface pipe and backfill feature on the Site as the “Pipe Chase”. This RI continues to refer to the "Pipe Chase" to be consistent with historical descriptions of this area.

Prior to 1980, the site storm water system consisted of a 0.30 to 0.35 m (12 to 14 in) diameter below grade line (hereafter called the Main Line) that extended through the approximate center of the Site from the Administration Building southward to the southern property boundary. This Main Line received roof runoff from the Administration Building and garage as well as runoff collected by a sump in the former ore Process Building. The sump in the ore Process Building was connected to the Main Line by a 0.2 m (8 in) diameter feeder line. A second 0.2 m (8 in) diameter feeder line joined the Main Line just north of the southern site boundary. This feeder line drained the area on the west side of the property, south of the former thaw house. A series of catch basins were also located at turns and bends along the feeder and Main lines. Water collected by this system was subsequently discharged through a concrete headwall into the South Drainage Ditch. Figure 2-3 illustrates the locations of the subsurface drainage lines before 1980.

In support of the VP and MML clean up actions a portion of the above lines (Main and feeder lines) were plugged and abandoned with concrete at both ends in 1980. The remainder of the site system was plugged in 1996. The former Process Building sump and most of the catch basins were also plugged and abandoned with concrete at that time. Replacement of the below-grade drainage lines in 1980 consisted of the installation of a surface trench drain system around the areas of the former VP and MML piles, and a settling basin and granular activated carbon filtration system were installed in the southern portion of the site.

Figure 1-2 shows these changes to the storm water system as well as the resultant changes to the site surface.

2.1.3.3 <u>South Drainage Ditch</u>

On-site surface water at MSP is conveyed via surface (and subsurface prior to its closure and sealing) drainage systems to a shallow ditch (South Drainage Ditch) at the southern site boundary. ULC, USDOE's FUSRAP Program Management Contractor at that time, conducted a remediation effort, involving the excavation and removal of contaminated materials (soil) from this ditch in September and October of 1981. However, phased investigations of the drainage ditch conducted between 1990 and 1996 (BNI, 1993a; BNI, 1996a) showed that radioactive contaminants were once again present in the ditch. In 1996, a second remediation effort was initiated and approximately 54 m^3 (70 yd^3) of radioactive soil from the South Drainage Ditch were excavated and added to the VP pile. An *in situ* granular activated carbon (GAC) filter was installed on the site behind the drainage ditch headwall to help reduce further off-site migration of radionuclides via groundwater seepage into the ditch. During emplacement of the filter, 120 m^3 (160 yd^3) of radioactive material were excavated from the MSP property; this material was also added to the VP pile. The Wood Avenue portion of the storm water drainage system was rerouted in 1996 to avoid re-contamination of the drainage ditch. The unused portion of the storm water system was sealed. Storm water entering the re-routed Wood Avenue drainage system is not contaminated and currently discharges to an area east of the South Drainage Ditch.

The extent and nature of contamination in the South Drainage Ditch is addressed as part of this Groundwater OU RI report (Section 5.5).

2.2 REVIEW OF PREVIOUS INVESTIGATIONS

The nature and extent of soil and groundwater contamination at the MSP site, as delineated by previous investigations, is described in the following sections. Prior to 1991, the analytical data collected at the MSP was focused on radiological contamination, and only later was sampling for both radiological and chemical constituents performed. The nature of radiological contamination in MSP soil and groundwater is well documented with the primary contaminants being uranium and radium. Chemical contamination in soil by SVOCs have also been identified, as has elevated levels of select metals.

Prior to the groundwater and soil RIs conducted in 2000, there have been six significant historical investigations of the site to evaluate the nature and extent of the contamination. These historical investigations have included building material, air, soil, sediment, groundwater, and surface water sampling and analysis, and they provide information used as a basis for conducting the RIs. However, due to uncertainty of sample locations and/or validity of the data, not all of the data generated were combined with the RI data to assess the nature and extent of the soil and groundwater contamination. The following table lists these investigations by date and states if the data were used in combination with the data generated by the RIs in the groundwater contamination assessment for the Site.

Year	Site Investigation Title	Used in Nature and Extent Assessment	Justification for Exclusion/Inclusion
1976	Radiological Survey of the Middlesex Sampling Plant, (ORNL, 1977)	No	Sample locations can not be accurately determined (Site was regraded in 1980)
1980	Hydrology of the Former Middlesex Sampling Plant, (Weston, 1980)	No	Sample locations can not be accurately determined, and the integrity of the wells was questionable
1983	Radiological Survey of the Former Middlesex Sampling Plant (BNI, 1985c)	Yes – Soil No - GW	Soil data was used for assessment of soil contamination. Groundwater data was in question due to problems with well integrity
1991	Subsurface Soils Chemical Characterization, (BNI, 1993e)	Yes – Soil No - GW	Soil data was used for assessment of soil contamination. However no groundwater data was generated

Year	Site Investigation Title	Used in Nature and Extent Assessment	Justification for Exclusion/Inclusion
1996	Shallow Groundwater Investigation and Drainage Ditch Assessment, (BNI, 1996c)	Yes – Soil No - GW	Soil data was used for assessment of soil contamination. Data from seven of the groundwater wells that are part of the ES program are considered, but not combined with RI data for the assessment
2000	Public Health Assessment for Middlesex Sampling Plant, (ATSDR, 2002)	No - GW	Data from the groundwater evaluation are considered, but not combined with RI data for the assessment

As previously mentioned, due to a lack of documentation of the radiological status of the property after its release by AEC in 1967 the site was resurveyed in 1976 by Oak Ridge National Laboratory (ORNL, 1977). The results of this study identified contamination above then current guidelines both on MSP property and properties in the vicinity. In support of the ensuing remediation of select VP, the site was re-graded and paved in 1980 to accommodate an interim storage pile generated from the cleanup. As such, the point of reference for the elevation of soil samples collected in 1976 changed. Due to the uncertainties associated with the location of the 1976 samples, these data were not used in the Soils OU RI report for identification of site-related contaminants (SRCs).

In May 1980, Roy F. Weston, Inc. (Weston) conducted a radiological study on MSP soils in conjunction with a groundwater investigation (Weston, 1980). The elevation of the soil samples collected for this study could not be determined from the drill logs included in the Weston report, and therefore, these analytical results were not used in assessing the nature and extent of potential contamination in the Soils OU RI.

Weston also initiated a groundwater monitoring program with the installation of 20 monitoring wells. Six additional monitoring wells were later installed in July 1981 as part of the environmental surveillance program. Heavy truck traffic during the 1980 remedial action activities resulted in silting and partial collapse of some of those wells. The locations of monitoring wells installed during 1980 and 1981 are presented in Figure 2-4. Apparently, the monitoring wells installed in 1980 and 1981 did not have grout between the casing and formation (NLO, 1981). In addition, three of the bedrock monitoring wells installed in 1980 had casing set at an undocumented elevation in the bedrock with open-hole completions set to

15.2 m (50 ft). For these reasons, the groundwater data generated from these wells, including the environmental surveillance data obtained prior to 1994 may not be representative of current site groundwater conditions. Due to the well construction methods and the uncertainty associated with the data from these wells, several of the monitoring wells were replaced in 1994, and all but one (MSP-12) of the remaining 1980/81 monitoring wells were abandoned (sealed).

The 1991 study provided the most complete evaluation of chemical contamination at the site. It was limited to soil and didn't include the groundwater. The sample locations are shown on Figure 2-6.

Seven new monitoring wells were installed in 1994 (B18W24S through B18W30S). Well MSP-12 was left in place to monitor water-level elevations in the shallow groundwater flow system. However, a comparison of the groundwater elevation data from this well to the groundwater elevations in the other new (1994) wells found that the elevations in MSP-12 fluctuated in a manner that was inconsistent with the other adjacent newly installed wells. Because the other wells installed in 1980/81 were of questionable integrity, it was suspected that MSP-12 was not providing reliable data. The inconsistent fluctuations may also be due to the presence of fill material or surface water infiltration causing water levels in this well that are not representative of the groundwater levels in this portion of the Site. Therefore, groundwater elevation data from MSP-12 were not included in this RI. The monitoring wells that were installed in 1994 now comprise the groundwater-monitoring network that has been sampled as part of recent environmental surveillance activities.

Additional wells and borings/piezometers were installed in 1996 during the shallow groundwater investigation to obtain localized groundwater data for installation of the *in situ* granular activated carbon filter (BNI, 1997b). These wells and piezometers have not been sampled as part of the environmental surveillance program. The locations of the borings are shown on Figure 2-7 and the wells and peizometers are shown on Figure 2-8.

In total, there remain 13 groundwater monitoring wells and 4 piezometers at the MSP site that were installed through 1996. With the exception of the seven wells installed in 1994, which are currently used as part of the environmental surveillance program, none of the remaining wells/piezometers have provided sample analytical data used in site characterization efforts. The data from these remaining wells was collected prior to the 2000 RI activities, and was not included in the RI because the respective sampling methodologies and validation protocols are not available. Comparing data collected by others without knowledge or confirmation of the protocols to the 2000 RI data could result in inaccurate comparisons.

Table 2-1 presents a summary of the significant results generated from these historical investigations. As concluded in the Public Health Assessment (ATSDR, 2002), which is a summary and evaluation of the historical data available through 2000, the results of the investigations indicate that the groundwater beneath MSP is contaminated with radium, uranium, metals (e.g., arsenic, chromium, and lead), and VOCs (e.g., benzene and MTBE). It also concluded that no exposures to contaminated groundwater immediately beneath the site are occurring or are expected to occur in the future.

2.2.1 2000 Investigation of Surface and Subsurface Site and Background Soils

In 2000, USACE's contractor, URS drilled and sampled 50 boreholes on site as part of the Soils OU Investigation for the USACE. The borehole locations were distributed throughout six different areas of concern (AOC): the Process Building slab, boiler building slab, Administration Building, Pipe Chases, and former MML and VP piles. The soil borings were drilled to depths ranging from 1.8 to 3.3 m (6 to 11 ft). Boring locations are shown on Figure 2-9. The data from this investigation has been incorporated with the historic data from past investigations to evaluate site conditions at MSP. This data can be found in the Remedial Investigation Report for the Soils Operable Unit (USACE, 2003).

The primary findings of the Soils RI are that slightly elevated levels of metals, SVOCs and radionuclides have been identified on site, and in most cases, the elevated levels are with in an order of magnitude of the screening criteria. A summary of the significant results is as follows:

2.2.1.1 Volatile Organic Compounds

Soil RI sampling data indicate that VOCs are not present at MSP in concentrations that represent a significant impact to on-site soil quality. The following is discussion of the results.

- Ten volatile organic compounds have been detected in soil underlying the asphalt pad of the Former VP pile. Acetone, a laboratory and/or field artifact detected in the laboratory method, rinsate and/or trip blanks, was identified in numerous samples. Several compounds were detected in a single soil sample collected from the Former VP Pile area. These include 1,4-Dichlorobenzene, Chlorobenzene, Ethylbenzene, p,m-xylene, and o-xylene. The concentrations detected in these samples were also the highest on-site.

- Five soil samples collected during the soil investigation program contained trace concentrations of methyl tertiary butyl ether (MTBE) and its breakdown product, tertiary butyl alcohol (TBA) below detection limits. These compounds are octane boosters that were introduced as gasoline additives in 1979. Their presence likely is not related to MSP activities which ceased prior to 1979.

- Three volatile organic compounds were detected in soil underlying the asphalt pad of the former MML pile. Carbon disulfide was found at seven locations at the Former MML Pile. Acetone was reported in twelve samples, however, acetone was also detected in rinsate, laboratory method, and/or trip blanks. The highest detected concentrations of benzene and carbon disulfide are 2 micrograms per kilogram (μg/kg) and 17 μg/kg, respectively.

- Nine VOCs were detected in soil underlying Pipe Chases. Carbon disulfide was detected in one soil sample. Four of the VOCs detected in this AOC were found only once (cis-1,2 dichlorethene, o-xylene, toluene, and trichloroethene). In addition, two of the detected VOCs are common laboratory and/or field artifacts (acetone and methylene chloride). Both of these compounds were detected in the laboratory method, rinsate and/or trip blanks.

- Six VOCs have been detected in soil underlying the building pads and open areas on the northern side of MSP. Two of the detected VOCs are common Laboratory and/or field artifacts (acetone and methylene chloride). Both of these compounds were detected in the laboratory method, rinsate and/or trip blanks and all VOCs with the exception of 1,1,2-tricholorethane (4,960 μg/kg) and acetone (150 μg/kg) were detected below a concentration of 30 μg/kg. The 1,1,2-trichloroethane hit is in a sample from beneath the former boiler building floor pad.

2.2.1.2 <u>Semivolatile Organic Compounds</u>

SVOCs have been detected in both surface and subsurface soils at MSP. Twenty-two SVOCs were detected in surface soils at MSP. Eleven of the twenty-two SVOCs were detected in ten or more samples of the 47 total surface soil samples collected at MSP. These frequently detected SVOCs include:

1. Anthracene
2. Benzo(a)anthracene
3. Benzo(a)pyrene
4. Benzo(b)fluoranthene
5. Benzo(k)fluoranthene
6. Benzo(g,h,i)perylene
7. Chrysene
8. Fluoranthene
9. Indeno(1,2,3-cd)pyrene
10. Phenanthrene
11. Pyrene

The data indicate that with the exception of two sample locations, surface soil north of the former VP pile does not contain significant concentrations of SVOCs. South of the former MML pile, elevated SVOC concentrations in surface soil occur most frequently in samples collected within the Pipe Chases and from beneath the northern half of the former VP pile.

Five of the 11 most often detected SVOCs [benzo(k)fluoranthene, benzo(b)fluoranthene, benzo(a)pyrene, benzo(a)anthracene and indeno(1,2,3-cd) pyrene] have reported concentrations within ranges listed in NJDEP 7:26E-4.6 Table 4-2 as representative of Historical Fill. The presence of these SVOCs is probably related to burial of asphalt, cinders or slag. Other SVOCs [chrysene, dibenzo(a,h)anthracene and phenanthrene] concentrations occur in samples from across the site, but are also usually associated with the Historical Fill SVOC constituents [benzo(k)fluoranthene, benzo(a)pyrene, benzo(a)anthracene and indeno(1,2,3-c,d)pyrene].

Twenty-two different SVOCs have been found in subsurface soils at MSP and for the most part, the concentration of SVOCs detected in the surface samples are greater than their respective concentration in the subsurface samples. This is not unexpected, as the majority of SVOCs found are most often associated with asphalt, cinders and slag entrained in the near-surface fill material.

The data indicate that subsurface soil north of the former VP pile does not contain high concentrations of SVOCs. This finding is consistent with results of surface soil sampling for this same area. South of the former MML pile, elevated SVOC concentrations in soil occur most frequently in samples collected from areas across the northern half of the former VP pile. SVOC concentrations found in surface soils at eight locations were not detected in deeper samples from these same locations.

The most commonly detected SVOCs (greater than or equal to 10 hits out of 60 samples) within the subsurface samples at the MSP include the following:

1. Anthracene
2. Benzo(a)anthracene
3. Benzo(a)pyrene
4. Benzo(b)fluoranthene
5. Benzo(g,h,i)perylene
6. Benzo(k)fluoranthene
7. Chrysene
8. Dibenzo(a,h)anthracene
9. Fluoranthene
10. Indeno(1,2,3-cd)pyrene
11. Phenanthrene
12. Pyrene

Five of the 12 most often detected SVOCs [benzo(k)fluoranthene, benzo(b)fluoranthene, benzo(a)pyrene, benzo(a)anthracene and indeno(1,2,3-cd)pyrene] have reported concentrations within ranges listed in NJDEP 7:26E-4.6 Table 4-2 as representative of Historical Fill. Their presence is probably related to asphalt, cinders or slag entrained in soil. Other SVOCs with elevated concentrations occur in samples from across the site, but are typically associated with the Historical Fill SVOCs identified earlier.

Soils data indicate that SVOCs are widely present throughout the southern half of MSP. However, the lack of a pattern to their occurrence indicates that the SVOCs detected cannot be related to specific mechanical separation or waste management practices at the site.

2.2.1.3 Metals in MSP Soils

Soil samples from MSP were tested for the presence of priority pollutant metals in 2000. Twenty-three metals have been detected in the soil samples. Of these metals; aluminum, calcium, copper, iron, manganese, potassium, silver, and zinc are common, naturally occurring metals that did not show specific trends in distribution or concentrations across the site. Also, from the sample information shown, it can be seen that no specific trends in concentrations were observed in antimony, beryllium, cobalt, magnesium, mercury, nickel, selenium and vanadium.

Results on over 100 surface and subsurface soil samples collected by URS have been used for the characterization of MSP soils. Both surface and subsurface data indicate that metals are widely present throughout MSP. However, no clear pattern of their occurrence is discernible from the data. It is therefore difficult to relate the metals detected above applicable background criteria to specific MSP operations or waste management practices.

2.2.1.4 Radionuclides

Data indicate that radioactive material is present above background levels across most of the site. This is particularly the case for radionuclides: U-238, Ra-226, and Th-232, in both the surface and subsurface soil layers. U-238 was detected in 99 soil samples with activity ranging between 0.243 and 399 pCi/g. Ra-226 was detected in 101 soil samples with activity ranging between 0.314 and 222 pCi/g. Th-232 was detected in 97 soil samples with activity ranging between 0.204 and 11.5 pCi/g.

Ra-226 is the most dispersed at concentrations of concern, though all three radionuclides are present at concentrations well above background. Elevated concentrations also are present in the areas of the former VP and MML piles. The areas around the former Process Building pad and the Administration Building show less contamination than the former VP and MML areas. The soils around the Pipe Chases also indicate radiological contamination. Finally, the areas east of the Process Building pad shows levels above background, though not as high as in the other AOC.

In January 2001, a background soils investigation involving the sampling of eight boreholes at six different locations was completed (Figure 2-10). Six public parks were chosen to be representative of local settings and indicative of land use in the area. The boreholes were completed to a depth of 0.9 m (36 in) below grade and sampled at depths of 0 to 15 cm (0 to 6 in) and 60 to 90 cm (24 to 36 in). The 16 soil samples were analyzed for VOC, SVOC, TAL metals, isotopic uranium, isotopic radium, isotopic thorium, and total uranium. This data can be found in the Remedial Investigation Report for the Soils Operable Unit (USACE, 2003).

2.3 ENVIRONMENTAL SURVEILLANCE PROGRAM

The Environmental Surveillance (ES) program for MSP includes sampling and analysis of air, water (groundwater and surface water) and streambed sediment. This program is designed to aid in the evaluation of potential effects on off-site populations posed by the presence and possible migration of radioactive constituents and other residuals from the property. The main elements of the current (2000 to 2002) ES program include:

- Monitoring of radon gas and external gamma radiation on a quarterly, semi-annual and annual basis.

- Sampling of surface water and streambed sediment on a quarterly basis with analysis for isotopic uranium, isotopic thorium, and isotopic radium (referred to collectively as radioactive constituents), and metals. Surface water is additionally analyzed for SVOCs and gamma emitters (i.e., gamma scan).

- Quarterly sampling and analysis of groundwater for isotopic uranium, isotopic thorium, isotopic radium; gamma emitters; VOCs including MTBE, tertiary butyl alcohol (TBA), and diisopropyl ether (DIPE); SVOCs and metals. Additional analyses are performed for settleable solids, total dissolved solids (TDS), alkalinity, carbonate and bicarbonate as well as total phosphorous, chloride and sulfate.

ES sampling locations are shown on Figures 2-11 and 2-12.

2.3.1 Analytical Methods

Under the current MSP ES Program, analytical methods approved and published by EPA and the American Society for Testing and Materials (ASTM) are used for chemical (i.e., non-radiological) analyses. The laboratories conducting the radiological analyses adhere to EPA-approved methods and procedures developed by the Environmental Measurements Laboratory (EML) and ASTM. Laboratories analyzing the chemical and radiological samples are also certified by NJDEP and validated by USACE. A listing of the specific procedures and the data quality objectives for the surveillance program is provided in the *Environmental Surveillance Work Plan* (USACE, 2000a). This plan was prepared by URS under the direction of USACE and was approved by EPA and NJDEP.

2.3.2 Evaluation Criteria

The criteria for evaluating calculated doses from external gamma radiation and inhalation of radioactive particles, and measured concentrations of radon gas are as follows:

- Title 10 Code of Federal Regulations (CFR) Part 20, Subpart D.

- Title 40 CFR Part 61, Subparts H and Q

- EPA Action Levels for Radon Concentration.

Criteria for evaluating the measured concentrations of radionuclides in sediment, surface water, and groundwater are:

- Title 10 CFR Part 20, Subpart D.

- Title 40 CFR Part 192, Subparts A and D.

- Safe Drinking Water Act (SDWA).

For the annual ES monitoring reports only, the unpromulgated New Jersey Residential Direct Contact Soil Criteria established February 3, 1992 were used in evaluating the detected concentrations of chemical parameters in sediment. The following Federal standards for drinking water and State primary drinking water standards are used as a conservative basis for comparison of chemical analytical results:

- Safe Drinking Water Act MCL.

- Safe Drinking Water Act – Health Advisories.

- EPA Region 9 Preliminary Remediation Goals (PRGs).

- New Jersey Safe Drinking Water Act Standards.

- New Jersey Class IIA Groundwater Quality Standards.

- New Jersey Surface Water Standards

2.3.3 Sampling Locations and Rationales

The ES program at MSP has been developed in order to provide information about potential exposures to the public. Figures 2-10 and 2-11 illustrate sampling locations and media being sampled for the ES program at MSP.

Surface water and streambed sediment sampling is conducted upstream of the property in order to provide baseline information, at an outfall point where most of the site's drainage is discharged, and at two locations downstream along a stream that receives runoff from the site (Main Stream). These sampling locations are shown on Figure 2-11.

A system of seven wells installed in 1994 provides information regarding on-site and downgradient groundwater quality conditions (Figure 2-10). Groundwater monitoring includes analysis for radioactive constituents, metals, VOCs, SVOCs and the other parameters described in Section 2.3.

Measurement of external gamma radiation and radon gas is conducted at off-site (background) and fence line locations at the MSP (Figure 2-10). This is being done to assess exposures to both the public and site workers.

2.3.4 Historic Environmental Surveillance Results

ES has been ongoing at MSP since 1986. Prior to 2000, ES field sampling efforts and reporting were performed primarily by Bechtel National, Inc. (BNI) under a contract with DOE. More recently, ES activities have been performed by USACE. The ES scope of work at MSP has been refined throughout the years based on evaluation of the reported data and changing site conditions. The current sampling and analysis program is considered appropriate for the MSP site at this time, and is essentially the same as the program accomplished in prior years.

Environmental Surveillance Monitoring Reports and various technical memoranda (interim reports) have been compiled for the MSP site since initiation of environmental surveillance activities in 1986. BNI performed the sampling and analysis of the various media, and submitted the Environmental Surveillance Monitoring Reports on an annual basis. Evaluation of the data from the earlier reports indicate the radiological contamination at the MSP site is relatively low, with only a small number of sediment and groundwater samples exhibiting activity levels in excess of regulatory guidelines. Airborne radiological constituents have not shown dosage rates or activity levels above regulatory guidelines since inception of the surveillance period. A summary of the BNI conclusions from the data collected in the 1997 and 1998 ES programs is presented to illustrate the prior environmental quality conditions at MSP. A more detailed discussion of the ES results for the groundwater, sediment and surface water in included in Section 5.0.

2.3.4.1 <u>1997 ES Findings</u>

- No air monitoring (radon or external gamma) parameters exceeded regulatory standards during 1997.

- For radiological parameters in groundwater, exceedances occurred in two of the seven wells sampled. The downgradient monitoring well, B18W30S, contained a total uranium activity level of 42.57 pCi/L. The “upgradient” monitoring well (as originally designated in the early ES program), B18W24S, contained a total uranium activity level of 275.68 pCi/L.

- Dissolved metals in groundwater data, as compared to the New Jersey Class II-A Groundwater Standard, show consistent, slightly elevated concentrations of arsenic and manganese in each of the groundwater monitoring wells in the ES program. Sporadic elevated concentrations of other metals including aluminum, antimony, iron, thallium, and chromium appear as well. Only one organic constituent slightly exceeded a regulatory standard, dichloromethane, in monitoring well B18W29S.

- Surface water exceedances in relation to the New Jersey Surface Water Standards included slightly elevated concentrations of arsenic and lead in the three downstream surface water sampling locations. In addition, a slightly elevated arsenic concentration was detected in the background surface water sampling location (SWSD004).

- Sediment sampling and analysis results did not display concentrations above applicable guidelines for radioactive or chemical constituents in 1997.

2.3.4.2 1998 ES Findings

- No air monitoring (radon or external gamma) parameters exceeded regulatory standards during 1998.

- For radiological parameters in groundwater, four of the seven wells sampled exceeded total uranium activity levels. The downgradient monitoring well B18W30S, contained a total uranium activity level of 72.09 pCi/L. This value was higher than the 1997 analytical results of 42.57 pCi/L.

- Monitoring well B18W24S contained a total uranium activity level of 206.23 pCi/L. This value was slightly less than the 1997 analytical results of 275.68 pCi/L.

- The monitoring well adjacent to the western property boundary, B18W25S, contained a total uranium activity level of 121.01 pCi/L in 1998, which was significantly higher than the previous activity levels reported for this well.

- The monitoring well in the south central portion of the site, adjacent to the plant outfall, contained a total uranium activity level of 32.7 pCi/L in the 1998 sampling event. This activity was significantly higher than historic activity levels in this well, which ranged from 1.64 to 8.47 pCi/L, since 1994.

- Dissolved metals in groundwater data, as compared to the New Jersey Class II-A Groundwater Standard, again showed consistent, slightly elevated concentrations of arsenic and manganese in each of the groundwater monitoring wells in the ES program. Sporadic elevated concentrations of other metals including aluminum, antimony, iron, chromium, and nickel appeared as well. The data indicate sporadic results that may be significantly influenced by the previous sampling techniques producing turbid samples. Only one organic constituent, chlorobenzene, slightly exceeded a regulatory standard in monitoring well B18W27S.

- Elevated dissolved metals concentrations in relation to the New Jersey Surface Water Standards included slightly elevated concentrations of arsenic in the three downstream surface water sampling locations (1.9 to 3.4 µg/L). In addition, a slightly elevated arsenic concentration was detected in the background surface water sampling location SWSD004 (1.4 µg/L).

- Sediment sampling and analysis results displayed slightly elevated concentrations of metals in two locations; SWSD004 (background) and SWSD006. The metals detected included cadmium, beryllium, and arsenic.

2.3.4.3 <u>1999 ES Findings</u>

- No ES program activities were conducted.

2.3.4.4 <u>2000 ES Findings</u>

- External gamma radiation dose rates measured by tissue-equivalent thermoluminescent dosimeters (TETLDs) in place at MSP did not exceed the NRC Federal Standard of 100 millirem per year (mrem/yr) for the quarterly or semi-annual exposure periods. No radon concentrations for on-site monitoring locations exceed the 4 pCi/L EPA action levels for radon concentrations and on-site locations were equal to the off-site (background) concentrations (0.2 pCi/L), with the exception of Stations 1 (behind the Administration Building) and 18 (near the settling basin) (both at 0.3 pCi/L).

- Sporadic exceedances of manganese and iron were detected at both upstream and downstream surface water sampling locations. Aluminum concentrations exceeded the regulatory criteria at two locations during all three surface water monitoring events and antimony exceeded standards at one location during the second quarter monitoring event. However, these metals are not contaminants that have been historically significant at MSP. Uranium concentrations in surface water samples near the site outfall exceeded standards and the gross alpha concentrations at this same location were about double the upstream values. Gross alpha exceeded the regulatory criteria of 15 pCi/L at location 004 during Q2 and Q3 sampling events.

- Concentrations of metals detected in sediment samples were below NJDEP residential and non-residential soil cleanup criteria. However, arsenic, cadmium, chromium, lead, manganese and zinc values at the outfall location were much higher (ranging between two and twenty times) than the upstream sample. The sediment sample collected during the Q2 sampling event near the MSP outfall contained a thorium concentration above Federal standards (6.68 pCi/g vs. 5 pCi/g) as well as an elevated uranium level. However, all sediment samples collected during the Q3 and Q4 ES sampling events were below Federal Standards.

- Low concentrations of acetone and bis(2-ethylhexyl)phthalate were detected in a few groundwater samples collected during the 2000 ES monitoring events. The aforementioned compounds are common laboratory contaminants and were found at concentrations below the regulatory criteria. Concentrations of inorganic constituents (chlorides, TDS, etc.) were not found in excess of regulatory limits.

- Manganese and iron exceeded regulatory limits in groundwater in numerous samples collected during the 2000 ES sampling events. The presence of these compounds is likely related to naturally occurring or ambient conditions and not historic site activities. Exceedances of chromium in groundwater samples were observed during three quarterly sampling events. Exceedances of Ra-228 and total uranium were observed at numerous groundwater monitoring wells. There was one exceedance of gross alpha during Q3 at well B18W28S. However, specific trends in concentration could not be developed.

The data collected during the 2000 ES sampling events indicates that residual amounts of radioactive and non-radioactive constituents (primarily metals) continue to be detected in the surface water, sediment and groundwater on and around MSP.

2.3.4.5 <u>2001 ES Findings</u>

- External gamma radiation dose rates measured by TETLDs in place at MSP did not exceed the Nuclear Regulatory Commission (NRC) Federal Standard of 100 mrem/yr for the quarterly or semi-annual exposure periods. It should be noted that the USACE request to change the surveillance schedule for MSP from quarterly to semi-annually was partially granted by NJDEP and USEPA. A one-time suspension of quarterly surveillance was granted for the second quarter of 2001and sampling activities were suspended.

- No radon concentrations for on-site monitoring locations exceed the 4 pCi/L EPA action levels for radon.

- Exceedances of aluminum, iron, and manganese were detected at the outfall, upstream, and downstream surface water sampling locations. However, these metals are not contaminants that have been historically significant at MSP.

- Uranium concentrations in surface water samples near the site outfall (SWSD001) exceeded standards for all four sampling events. Gross alpha exceeded the regulatory criteria of 15 pCi/L at Location 004 during the Q2 and Q4 sampling events. This is consistent with historic sampling data. Ra-226 and Ra-228 were detected at concentrations exceeding standards during Q3 only at the downstream surface water location (SWSD003).

- Concentrations of metals detected in sediment samples were below NJDEP residential and non-residential soil cleanup criteria.

- Concentrations of bis(2-ethylhexyl)phthalate were detected in three groundwater samples collected during the 2001 ES monitoring events at levels exceeding both the EPA Region 9 PRGs and the NJDEP Groundwater Quality Criteria. However, the aforementioned compound is a common laboratory contaminant that may contribute to the slightly elevated results.

- Concentrations of MTBE exceeding the NJDEP Standards were detected in a number of groundwater samples. MTBE was detected primarily in the monitoring wells along the west side and the southern portion of the property that is sidegradient and downgradient of the adjacent auto salvage yard.

- Concentrations of inorganic constituents (chlorides, TDS, etc.) were found in excess of regulatory limits in two of the seven monitoring wells sampled. Total Dissolved Solids were detected in groundwater from B18W29S and B18W29SR during all four quarterly sampling events at levels slightly above the SDWA standard of 500 milligrams per liter (mg/L). Chloride was also found at concentrations exceeding the SDWA in groundwater from B18W29S and B18W29SR during Q1 and Q3 respectively.

- Aluminum, manganese and iron exceeded regulatory limits in groundwater in 52 samples collected during the 2001 ES sampling events. Nickel, potassium, and sodium also exceeded standards in groundwater from monitoring well B18W29S only. Exceedances of chromium and lead in groundwater samples were observed during Q1 only in monitoring wells B18W28S and B18W29S.

- Exceedances of gross alpha, Ra-226, Ra-228 and total uranium were observed in 15 groundwater samples. However, specific trends in concentration could not be developed.

The data collected during the calendar year (CY) 2001 ES sampling events indicate that residual amounts of radioactive and non-radioactive constituents (primarily metals) continue to be detected in the surface water, sediment and groundwater on and around MSP.

2.3.4.6 <u>2002 ES Findings</u>

- External gamma radiation dose rates measured by TETLDs in place at MSP did not exceed the NRC Federal Standard of 100 mrem/yr. No radon concentrations for onsite monitoring locations exceed the 4 pCi/l EPA action levels for radon.

- Exceedances of aluminum, iron, and manganese were detected in surface water samples from the outfall, upstream, and downstream sampling locations. Surface water was analyzed for radioactive parameters that included isotopes of radium, thorium and uranium as well as total uranium, gross alpha and gross beta. The total uranium sample results are 135 +/- 18.9 μg/L during Q1 and 67.5 +/-10.9 μg/L during Q4, which exceeds the USEPA and NJ Primary Drinking Water Standards of 30 μg/L. Additionally, net alpha results exceeded USEPA and NJ Primary Drinking Water Standards of 15 pCi/L at one location (23.6 pCi/g) in Q1 and at another location in Q3 (50.96 pCi/g).

- Lead in one sediment sample collected during Q1 was found to exceed the New Jersey Residential Direct Contact Soil Cleanup Criteria of 400 mg/kg at 483 mg/kg. Lead exceedances were not detected in subsequent quarters. Arsenic in one sample collected during Q3 and Q4 was detected exceeding the New Jersey Residential and Non-Residential Direct Contact Soil Cleanup Criteria of 20 mg/kg. Arsenic was reported at 30.8 mg/kg in Q3 and 26.6 mg/kg in Q4. There are no radiological limits for radioactive constituents in sediment associated with monitoring programs stated in the New Jersey soil cleanup criteria (residential or non-residential). Sediment data will be compared to remedial criteria developed as part of a site-specific ecological risk assessment as discussed in Section 8.0.

- Concentrations of Bis(2-ethylhexyl)phthalate were detected in two groundwater samples collected during the 2002 ES monitoring events at levels exceeding the USEPA MCL of 6 μg/L. The aforementioned compound is a common laboratory contaminant.

- Total dissolved solids (TDS) was found in the groundwater sample collected from one well during Q1 that was slightly above the NJDEP Class IIA Ground Water Quality Standard of 500 mg/L.

- Aluminum, manganese and iron exceeded regulatory limits for groundwater in 26 groundwater samples collected during the 2002 ES sampling events.

- Net alpha concentrations in three groundwater samples exceeded the USEPA standard of 15 pCi/L in three wells at levels that ranged from 15.89 to 68.80 pCi/L. Total uranium concentrations in groundwater exceeded the USEPA standard of 30 pCi/L in the same three wells at levels that ranged from 52.8 to 396 pCi/L.

The data collected during the calendar year (CY) 2002 ES sampling events indicate that residual amounts of radioactive and non-radioactive constituents (primarily metals) continue to be detected in the surface water, sediment and groundwater on and around MSP.

2.3.5 Analysis of Airborne Releases

To measure the annual effective dose from airborne emissions of radioactive particulates potentially released from MSP during 2000, 2001, and 2002 wind erosion and fugitive dust generation due to drying were considered. Airborne particulate release rates are calculated using historical data for site soil contamination and a limited reservoir surface wind erosion model. Contributions from radon gas, which is not a particulate, are not considered in this calculation.

The estimated dose to the potential maximally exposed individual for 2000, 2001, and 2002 was less than the 10 mrem/y limit set in 40 CFR 61. This indicated that the population in the immediate vicinity of the site (i.e., 75 meters or 246 feet) was not adversely affected by the airborne emissions of radioactive particulate from the MSP property. Therefore, no additional engineering controls are required to curtail the concentrations of particulate released from the site.

2.4 QUALITY ASSURANCE

Field work, laboratory analysis and report preparation activities for this RI have been performed under procedures and guidelines described in the MSP Quality Assurance Project Plan (QAPP), dated August, 2000 (USACE, 2000b). This plan, which was reviewed and approved by EPA and NJDEP, is supplemented with the Contractor Quality Control Plan (CQCP) (USACE, 2000d).

Groundwater RI quality assurance (QA) activities can be divided into two broad categories: field sampling and data validation (chemical and radiological). Each of these QA components is described in Appendix B with additional details available in the QAPP and CQCP.

3.0 CHARACTERIZATION OF THE ENVIRONMENTAL SETTING

This section describes the environmental characteristics of the site that are relevant to identifying and evaluating potential transport pathways, mechanisms, and receptors. The information presented in this section provides a framework for discussions on the nature and extent of groundwater contamination in Section 5.0.

3.1 CLIMATE, METEOROLOGY AND AIR QUALITY

Meteorological data presented in this report were obtained from the National Weather Service (NWS) station at Newark International Airport in Newark, New Jersey (NOAA, 2002).

The regional climate in the vicinity of MSP is humid with a mean annual precipitation of 1.1 m (43.04 in) and an average temperature of 12.3 degrees Celsius (°C) [54.1 degrees Fahrenheit (°F)]. The most precipitation occurs between March and May and also between July and September due to summer thunderstorms. The average annual maximum temperature for the Middlesex area is 17.0°C (62.7°F), and the average annual minimum temperature is 7.6°C (45.7°F). A monthly summary is presented in Table 3-1.

The annual average relative humidity recorded over the past 30 years was 64 percent, with the average minimum occurring in April (58 percent) and average maximum in September (68 percent). During the last 26 years, the annual average barometric pressure observed in the surrounding area was 0.76 m (30.01 in) of mercury.

Winds are predominantly from the northwest with an average speed of 14.3 to 22.7 kilometers per hour (kph) [8.9 to 14.1 miles per hour (mph)]. Middlesex County is currently in attainment with federal and state air quality standards for all parameters with the exception of ozone.

3.2 AREA DEMOGRAPHICS AND LAND USE

The population of New Jersey as estimated by the U.S. Census Bureau on April 1, 2001, is 8,414,350 with approximately 750,162 people residing in Middlesex County. The population of Middlesex County has steadily increased over the past 30 years with an overall growth of about 21 percent. Population projections for Middlesex County over the next 20 years indicate an increase of approximately 13 percent (Bureau of Census 1998 / Middlesex County Planning Department). Approximately 96 percent of the county is urban or suburban in character. The area within 0.8 km (0.5 mi) of MSP is a mixture of residential homes, commercial and industrial properties, and undeveloped land. The residential population within 0.8 km (0.5 mi) of MSP is approximately 1,150 people. The preceding demographic data have been derived from the US Census Bureau Population Estimates.

3.3 TOPOGRAPHY, SOILS AND GEOLOGY

3.3.1 Topographic Setting

The MSP study area is in the Newark Basin portion of the Piedmont Physiographic Province. Most of this province is a maturely dissected peneplain, sloping gently toward the coast. The regional topography is hilly to rolling terrain with a few high ridges. In central New Jersey, the province is crossed southwest to northeast by the Newark Basin, a broad, structural basin that forms a lowland plain. Drainage is dendritic; fluvial erosion, transportation and deposition, and mass wasting are the primary geomorphic processes operating in this basin (USDA, 1999). The elevation in Middlesex County ranges from nearly sea level to a maximum of approximately 73 m (240 ft) above mean sea level.

Located in northwest Middlesex County, the 3.9 ha (9.6 acre), predominantly asphalt-paved MSP site slopes from north to south. A site survey conducted by GEOD, Inc. of Newfoundland, New Jersey, in November 2000, indicated that the site elevations range from approximately 18 m (58 ft) above mean sea level at its north end to 15 m (49 ft) above mean sea level along its south end. This translates to an average slope of approximately 1 percent. Figure 3-1 illustrates topographic relief of the property.

3.3.2 Soils and Overburden

The U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS) in Middlesex County has identified soils to be silty to sandy loams of the Ellington Variant-Urban Land Complex in the northern part of the site and the Reaville-Urban Land Complex in the southern part of the site (Figure 3-2). The soil of the Ellington Variant-Urban Land complex is moderately well-drained and the Reaville-Urban Land soils are poorly drained. Both soil types have slopes that range from 0 to 5 percent (USDA SCS, 1987). Due to the urban development of the area, these native soils have also probably been either disturbed, stripped or altered (Ford, Bacon & Davis, 1979b).

As observed in the field during the completion of soil borings as part of the Soil OU RI field activities, non-native fill material in the form of gravel (GP) and historic fill was observed directly beneath the asphalt pads, former building foundations and ground surface. Historic fill material was observed to be clay and fine sand with trace amounts of gravel and concrete debris. Underlying the non-native fill material were the clayey fine sands to silty sands of the native soils. The non-native fill material was observed as deep as 0.15 to 1.4 m below ground surface (mbs) [0.5 to 4.5 feet below ground surface (fbs)]. The native soils underlying MSP were observed to be reddish brown fine to medium sands with trace amounts of silt and coarse sand and some gravel. The thickness of these soils over bedrock ranged from 0.45 to 3.5 m (1.5 to 11 ft). Vertical profiles of the soil types observed at MSP can be found on the soil boring logs in (Appendix C).

3.3.3 Geology

3.3.3.1 Structural Setting

The site is located within the Newark Basin which formed as a result of Triassic and Early Jurassic tectonic activities. Covering over 7000 km^2 (2,700 mi^2), the Newark Basin is the largest in a series of rift basins in eastern North America. It is approximately 190 km (118 mi.) long by 50 km (31 mi) wide and extends southwest from the Hudson River Valley of New York to southeastern Pennsylvania (Figure 3-3). The rift basin is a half graben bounded on the northwest by a series of major faults and is broken into five northwest-tilted fault blocks (Olsen, 1980). Following a series of rifting events, the basin was subsequently filled, at some locations, with over 3,050 m (10,000 ft) of stream and lacustrine deposits. Between 230 million and 187 million years ago, these deposits were intruded and overlain by three distinct basaltic lava flows.

Geologic maps of the northern Newark Basin show the MSP site on the eastern flank of the Watchung Syncline, a major northeast-southwest trending syncline (Parker, 1993; Drake et al. 1996). The geologic maps also indicate that MSP lies in an area of extensional faults that trend essentially north-south, approximately parallel to the axis of the Watchung Syncline. There are several fault features within a 4.8 km (2.9 mi) radius of MSP. Figure 3-4 shows that the beds of the Passaic Formation have a general northeast-southwest strike and a dip of 10 degrees to the northwest. Observations made during BNI's 1994 and 1996 field efforts (SAIC, 1995; BNI, 1997c) concluded that bedrock at the site has an apparent dip of 5 to 10 degrees from horizontal; however, no determination of true strike direction was made.

3.3.3.2 Stratigraphy

The bedrock strata in the Newark Basin make up lithologic units known as the Newark Supergroup. The Newark Supergroup can be divided into Jurassic and Triassic units. Presented in Figure 3-5, the Triassic units are, from older to younger, the Stockton Formation, a mostly buff and red conglomerate, arkose, and mudstone unit; the Lockatong Formation, a mostly gray mudstone unit; and the Passaic Formation. The Passaic Formation of the Brunswick Group is the thickest and most extensive formation in the Newark Basin. Lithologies of the Passaic Formation consist primarily of interlayered dark to reddish brown, gray, green, and purple lacustrine clastics (mudstone, shale, and siltstone) with minor fluvial sandstone.

The Jurassic units of the Brunswick Group consist of three basalt flow units, each made up of two to four individual flows, and three sedimentary rock sequences overlying the basalts. From older to younger, the Jurassic units consists of the Orange Mountain Basalt, the Feltville Formation, a mostly red and buff gray siltstone with minor limestone, shale and sandstone, the Preakness Basalt, the Towaco Formation, a red to buff to gray sandstone and calcareous siltstone, the Hook Mountain Basalt, and the Boonton Formation, a purplish to brownish-red fine sandstone and siltstone. Above the Mesozoic bedrock are often unconsolidated Pleistocene and Recent deposits of varying thickness (Olsen, 1980).

The Jurassic units and the Triassic Passaic Formation of the Brunswick Group, Newark Supergroup, underlie the MSP site. The Passaic sediments consist mostly of reddish-brown feldspathic mudstone and micaceous siltstone with some claystone and fine-grained sandstone.

Stratigraphic units underlying MSP are identified in the following descending order:

- Overburden Materials,
- Weathered Bedrock of the Passaic Formation, and
- Fractured Bedrock of the Passaic Formation.

The classification of overburden material included the gravel base associated with the asphalt pads, the historic fill material, the clayey fine sands to silty sands of the native soils, and the backfill material associated with the sub-grade storm water collection system. The weathered and fractured bedrock of the Passaic Formation was observed in core to be reddish brown to gray mud/siltstone and shale. Overburden materials range from 0.15 to 3.5 m below ground surface (mbs) [0.5 to 11 feet below ground surface (fbs)] across the site. Top of bedrock was observed to be in the range of 1.5 to 3.5 mbs (5 to 11 fbs) across the site. Boring logs can be found in Appendix C.

In order to illustrate the site geology and assist in the interpretation of hydrogeologic conditions, a series of cross sections were constructed. The locations of the cross sections are shown in Figure 3-6 while the three cross sections are illustrated in Figures 3-7 through 3-9. A fence diagram, Figure 3-10, presents the three cross sections in three dimensions. Boring logs used to construct the following cross sections can be found in Appendix A of the Soils OU RI Report (USACE, 2003).

3.3.3.3 <u>Soil Geochemistry</u>

The Passaic Formation is composed primarily of reddish-brown micaceous siltstone and mudstone with some claystone and fine-grained sandstone. The quartz percentage in these rocks ranges from 10 to 30 percent in the mudstone to 50 to 75 percent in the siltstone (Van Houton, 1969). Glauberite molds are commonly filled in by calcite, gypsum or barite. The overburden materials are largely weathered and reworked silts and clays of the Passaic Formation.

The reddish color of the Passaic Formation rock is a result of reworked hematite (Fe_2O_3). Hematite comprises about 5 to 10 percent of the formation (Boch, 1959). Feldspar comprises about 15 percent of the formation. Both sodium feldspar and potassium feldspar are present, although sodium-feldspar typically dominates. Illite is the major clay mineral in the Passaic Formation with subordinate chlorite (Sturm, 1956). Passaic Formation mudstone is generally rich in sodium oxide (Na_2O) with somewhat less potassium oxide (K_2O). Most of the Na_2O is present in detrital feldspar and only a minor amount in authigenic feldspar. Little K_2O is present in feldspar. The K_2O is present primarily in illite and sericite (Van Houten, 1969).

3.4 GROUNDWATER

This section provides an overview of groundwater underlying and in the vicinity of MSP. Additional information on the MSP groundwater flow system is described in Section 3.6.

3.4.1 Hydrogeologic Setting

The Passaic Formation is the major bedrock aquifer throughout a large part of central and northeastern New Jersey occurring throughout the Newark Group. Figure 3-11 shows the regions where the Newark Group aquifers occur. Aquifer conditions generally exist as unconfined to partially confined in the upper 60 m (200 ft) and confined at greater depths. Regionally, the depth range of the Passaic Formation aquifer is 9 to 450 m (30 to 1,500 ft) below existing grade. The common well yield rate of the aquifer is 40 to 1,900 liters per minute (L/m) [10 to 500 gallons per minute (gpm)]. Well yields have been known to exceed 5,700 L/m (1,500 gpm). Water is generally hard and may have high concentrations of iron and sulfate (USGS, 1999).

The Passaic Formation aquifer is used for domestic, municipal, and industrial water supply in Middlesex County and surrounding counties with pumping rates ranging from approximately 10 to 1,200 L/m (2.6 to 317 gpm) (Michalski, 1990). Groundwater flow is controlled by secondary porosity associated with fractures and joints in the formation. Observations made throughout the outcrop area of the Passaic Formation in New Jersey indicate one set of vertical joints that roughly parallels the strike of the beds and a second set oriented generally perpendicular to the strike (Vecchioli and Miller, 1974). Systematic fractures, both near-vertical joints and partings along bedding, are generally believed to provide the principal passages for groundwater flow in the Passaic Formation.

Observed movement of water under pumping conditions, and presumably under natural conditions, is preferentially along strike. Numerous pumping tests of wells completed in the Passaic Formation, where drawdown has been recorded in more than one direction, indicate that the aquifer has anisotropic hydraulic properties. The degree of anisotropy varies, even to the point of approaching isotropy. Where mildly anisotropic conditions exist, draw down is always greatest along strike (Vecchioli et al., 1969).

The Passaic Formation aquifer has been described as consisting of a series of alternating tabular aquifers and aquitards several tens of feet thick. The water-bearing fractures of each tabular aquifer are more or less continuous, but hydraulic connection between individual tabular aquifers has been described as poor. These tabular aquifers extend down-dip for a few hundred feet and are continuous along strike for thousands of feet (Carswell, 1976).

Near surface groundwater at MSP occurs within the shallow overburden material which underlies the site and the weathered and fractured bedrock of the Passaic Formation. The earliest study of the groundwater system at MSP was performed by Roy F. Weston (Weston, 1980). During this study, groundwater velocity was found to be greater in the deeper fractured bedrock than in the shallower overburden material and weathered bedrock. The low hydraulic conductivity and low hydraulic gradient (0.017) were considered to be representative of the weathered shale and silts of the Passaic Formation at an approximate depth of 3 mbg (10 fbg). In weathered bedrock, the calcareous zones and solution cavities that were observed in the core samples, along with changes in drilling characteristics, suggested an increase in transmissivity at the 4.6 to 7.6 m (15 to 25 ft) depth. The deep bedrock zone also showed a steeper groundwater hydraulic gradient (0.11) that, coupled with the higher hydraulic conductivity, resulted in a higher groundwater flow velocity.

In the overburden, a groundwater mound is typically observed in the vicinity of the former Process Building slab. Overburden groundwater flow is generally radial from this area. North of the slab, flow is typically to the north; east of the slab, flow is toward the east; and south of the slab, flow is to the south and southeast. A downward gradient was found to be present at the site. Groundwater elevations in the overburden are generally 12 to 15 feet higher than groundwater elevations in the shallow bedrock. Once groundwater enters the unweathered bedrock, flow patterns at some depth are different from the overlying shallow bedrock, following fractures and bedding planes primarily along strike. In the shallow bedrock, a groundwater mound is also observed near the former Process Building slab, with flow radial from this area. In the southern portion of the site, though, flow is from the southwest corner of the site toward the northeast. A potentiometric low point is typically observed at URSMW11D and bedrock flow is toward this area. The site conceptual model is discussed in further detail in Section 3.6

The conceptual groundwater flow model of the Passaic Formation aquifer in the Newark Basin has evolved over recent years. Recently published scientific articles (Michalski and Britton, 1997; Morin et al., 1997) provide a different model of groundwater flow in the Passaic Formation bedrock at a site approximately 6.4 km (4 mi) along strike from MSP. This model could be applicable to the MSP site and consists of a leaky, multiunit aquifer system (LMAS) overlain by a weathered zone and overburden (Model 5, Figure 3-12). In this model, bedding plane partings or fractures control permeability distribution and groundwater flow direction within discrete aquifer units. A near-vertical set of joints or fractures provides leakage between the discrete aquifer units. Lower permeability and greater storage could exist in the weathered bedrock than in the deeper bedrock (Michalski and Britton, 1997).

3.4.2 Groundwater Geochemistry

Regional groundwater geochemistry is highly dependant upon the minerals that the water comes in contact with as it moves through the aquifer. The Passaic Formation consists primarily of reddish-brown feldspathic mudstone and micaceous siltstone with some claystone and fine-grained sandstone. Groundwater ultimately begins as precipitation, which percolates into the subsurface. As the precipitation percolates through the subsurface, it generally becomes more alkaline, mineralized and reducing through chemical interactions with aquifer materials. This occurs in Newark Group groundwater. In a study of over 90 groundwater samples collected from wells completed in the Brunswick Group, the median pH increased to 7.6, the alkalinity increased to a median of 141 mg/L and conductivity increased to a median of 450 mS/cm. (Sefes, 1994).

Dissolved oxygen in rainwater is typically near saturation (8.5 to 14 mg/L) (American Water Works Association, 1975). As groundwater migrates through the subsurface, dissolved oxygen concentration decreases and the groundwater becomes more reducing. Groundwater in the Newark Group had a median dissolved oxygen concentration of 2.9 mg/L.

In general, groundwater in the Newark Group is slightly alkaline. It has low dissolved solids (median 340 mg/L) and is hard (median hardness of 200 mg/L). The cations present at measurable concentrations include (in order of decreasing median concentration) calcium (50 mg/L), sulfate (44 mg/L), silica (22 mg/L), chloride (18 mg/L), magnesium (16 mg/L), sodium (15 mg/L), and potassium (1.3 mg/L) (Serfes, 1994). Iron and manganese are also commonly detected in waters in the Newark Group. Unlike what would typically be expected, dissolved solids concentrations in the Brunswick Group do not appear to decrease with depth. Cation concentrations and chemical properties show variation within the Newark Group (including the Passaic Formation). These variations are due primarily to heterogeneities in the aquifer materials which the groundwater contacts.

The geochemistry of groundwater at MSP was evaluated through samples collected from monitoring wells. Groundwater geochemistry can affect the fate and transport of contaminants. Changes in groundwater geochemistry may also be indicative of the presence of contaminants. The groundwater anion parameters analyzed include carbonate alkalinity, bicarbonate alkalinity, chloride, phosphorous, sulfate, total suspended solids (TSS), and Total Dissolved Solids (TDS). Groundwater anion data are presented in Tables 3-2 through 3-5. Groundwater quality data have been grouped and are discussed as: overburden wells and bedrock wells. A more detailed discussion on site geochemistry can be found in Appendix D and in Section 5.0.

Overall, the groundwater anion data did not vary significantly between the overburden and bedrock wells. The values from the on site wells are similar to those reported for the Brunswick Group bedrock groundwater (Serfes, 1994). The bicarbonate alkalinity was very similar in most of the overburden and bedrock wells sampled at MSP. Overburden wells completed in the backfill material along the former pipechases had a somewhat lower alkalinity. This could be due to the nature of the Pipe Chase material, which consists of relatively coarse-grained sand and gravel. The overburden and bedrock aquifer materials all consist of similar clay and silt mineralogy. The chloride concentrations in MSP wells are slightly higher than those measured in wells in the Brunswick Group. Elevated chloride levels in the unconsolidated materials may be the result of anthropogenic activity, such as pavement salting. Sulfate concentrations are similar among the overburden and bedrock wells and are within the range of those measured in wells in the Brunswick Group. Phosphorous concentrations are generally low to non-detected in all wells. TSS was only measured in the overburden wells and was only detected in a small percentage of the samples analyzed. On the other hand, TDS was detected in most samples analyzed at similar concentration among the overburden and bedrock wells.

3.4.3 Groundwater Usage

The Passaic Formation beneath MSP is part of an aquifer used for domestic, municipal and industrial water supplies in Middlesex and surrounding counties. As of 1992, approximately 140 private water-supply wells had been identified within 1.6 km (1 mi) of MSP. Most of these wells draw from the deeper parts of the aquifer (ATSDR, 2000). Also, 19 municipal wells were identified within a 6.4 km (4-mi) radius of the site. The nearest public well field is the Elizabethtown Water Company's Sebring's Mills well field, approximately 2 km (1.25 mi) northwest of the site. This well field has not operated since 1978 (SAIC, 1995).

As part of this groundwater RI, a well search was conducted to update domestic, municipal, and industrial wells in the vicinity of MSP. In July 2002, URS requested copies of well completion permits on file with NJDEP Bureau of Water Allocation (BWA) within a 1.6 km (1 mi) radius of MSP. Data provided by BWA indicated the presence of 316 wells within or immediately adjacent to the specified radius. According to permit information on files, these wells are used as follows:

Monitoring Wells	208
Domestic Consumption	81
Extraction (remediation)	9
Gas Vent	8
Recovery	1
Industrial	6
Irrigation	2
Temporary Dewatering	1
Total	**316**

Completion depths of wells used for potable purposes in the vicinity of MSP ranged from 21 to 122 mbg (70 to 400 fbg). In a majority of the water wells, a 16.1 m (50-ft) surficial steel casing was grouted in place and the remainder was left as an open hole.

3.5 ECOLOGY

3.5.1 Flora and Fauna

MSP is in the glaciated area (Tedrow, 1986) of a Mixed Mesophytic Forest (Kricher, 1988) in the Northern Appalachian Piedmont Ecoregion (USDA, 1997). Past and current land use within the region has transformed the landscape by converting most of the forest and open habitats into residential and commercial/industrial uses. Forest corridors, islands and peninsulas characteristic of a Mixed Mesophytic Forest are the dominant habitat type in natural areas, in maturing successional forests and even, in a variant form, on some developed properties.

Two qualitative wildlife species and habitat surveys of MSP and vicinity have been conducted. The first survey was conducted during winter, February 3, 2001. A second survey was conducted during summer, July 10, 2002. Detailed discussions on each of the surveys can be found in Appendix E.

The first qualitative wildlife species and habitat survey of MSP and the area along the South Drainage Ditch, Main Stream and the developed properties to the north and east was conducted on February 3, 2001. This survey found no environmentally sensitive areas as per New Jersey Administrative Code (NJAC) 7:1E-1.8 within the fenced borders of the MSP. The majority of the site was covered by either asphalt, concrete, gravel, buildings or former building foundations/pads. A small lawn was to the north of the existing buildings along Mountain Avenue. The area south of MSP consisted of a successional forested to shrub-scrub habitat with wetlands generally occurring adjacent to the drainage ditch and along Main Stream. These areas mentioned herein would be considered a wetland per NJAC 7:7A-2.4.

The second qualitative wildlife species and habitat survey of the site and surrounding areas was conducted on July 10, 2002. As expected, wildlife and habitat observed during this survey included species not observed during the winter months of the first survey. This survey also found no environmentally sensitive areas within the fenced borders of the MSP as per NJAC 7:1E-1.8. The majority of the site was still covered with either asphalt, concrete, gravel, buildings or former building foundations/pads. The small grass covered area around the existing buildings along Mountain Avenue was also in place at the time of the survey.

3.5.2 Wetlands

Wetlands have been identified on a U.S. Fish and Wildlife Service (USFWS) Map, National Wetlands Inventory Quadrangle; Plainfield, NJ (1979) and a NJDEP Freshwater Wetlands Quarter Quadrangle; Plainfield NW (1991). These documents identify areas likely to have wetlands based on ground surveys, topography, soils information and infrared photography and are delineated on these documents, but have not been verified by the NJDEP and may not coincide with actual wetlands limits on the ground.

The USFWS Map and the NJDEP Freshwater Wetlands Quarter Quadrangle both identify several areas of wetlands to the south of the MSP. Both maps are generally consistent with each other in the extent and classification of the wetlands. These wetlands are identified as Palustrine Forested and Palustrine Scrub/Shrub based on the classification of Cowardin, 1977.

3.6 CONCEPTUAL MODEL

A site conceptual model is a statement of our understanding of site conditions. The current conceptual model of site conditions at MSP is illustrated in Figure 3-13. The hydrogeologic conceptual model for the MSP site was developed using data and information generated during this RI, and to a lesser extent, data from past reports. The model incorporates hydrologic data, site physical characteristics, infiltration/recharge, and surface water drainage patterns. The conceptual model provides a mechanism where observations can be compared and in turn predictions can be made for potential exposure locations. The predictive function of the site conceptual model, of primary importance to contaminant fate and transport analyses, relies on known information and approximated information about the site.

The conceptual model is further illustrated in Figure 3-14 using a schematic depiction of the site. The components of the site conceptual model at MSP are distinguished and explained in the following subsections.

3.6.1 Elements of Model

3.6.1.1 Infiltration and Surface Runoff

Prior to 1946, the majority of the MSP site was bare and/or vegetated and infiltration was a primary mechanism of contaminant transport to the subsurface. Subsequently, the site was paved with asphalt, infiltration was diminished, and surface and subsurface stormwater runoff became the dominant transport mechanism.

Infiltration of rain water through the bare and/or vegetated soil at the site was a mechanism for potential contaminant mobilization and transport during the pre-MED and pre-AEC period of use. Water was introduced to constituents in the soils primarily by vertical infiltration of rainwater. Potential contaminants were then leached from soils and migrated vertically through the vadose zone to the overburden water table. Once in the saturated zone, the contaminants were carried together laterally in solution or in fine particulates or colloids to downgradient locations. Surface runoff, as overland flow, would have occurred when precipitation rates or durations exceeded the capacity of the soils to absorb water. Runoff would eventually be transported to downgradient surface water bodies or stormwater collection systems.

Following the paving of the MSP site in 1946, infiltration as a mechanism of contaminant transport to the subsurface has been reduced. Since 1946, the majority of rainwater has been transported during storm events across the pavement as surface flow and directed to off-site drainage ditches and, after site improvements, to a storm drain system. Today, precipitation infiltrates through the grass-covered areas around the administration building and along the perimeter of the site. Minor amounts of precipitation may also be infiltrating the subsurface through cracks in the asphalt surface. Precipitation infiltrating the subsurface in these areas flows vertically through the vadose zone and into the overburden groundwater system. Surface flow of precipitation within the site is captured by a collection system that discharges into the South Drainage Ditch and Main Stream and eventually into Ambrose Brook as shown on Figure 1-3. No correlation between groundwater and the surface water elevations in the South Drainage Ditch can be performed due to the intermittent nature of the flow in the drainage ditch (flow in the ditch is limited to storm events). Ambrose Brook is a tributary of the Raritan River and represents a major surface drainage stream.

The pipes of the former subsurface stormwater drainage system were plugged and abandoned or rerouted around the site in 1980 and 1996 and therefore, are no longer considered an important pathway at MSP. However, the gravel backfill material around the pipes of this system may continue to serve as a localized preferential flow path for precipitation to reach shallow overburden groundwater. With the abandonment of this stormwater drainage system, sediment transported from MSP by surface flow would not be significant.

3.6.1.2 **<u>Evapotranspiration</u>**

Evapotranspiration is defined as infiltrated water that does not recharge to groundwater. The amount of evapotranspiration depends largely on the extent and type of vegetative cover. Historical photographs indicate vegetative cover existed at the MSP site prior to the 1946 paving of the grounds. It is assumed that evapotranspiration removed a portion of the infiltrated water, although the percentage is unknown. Under current site conditions at MSP, a small percentage of the average annual precipitation is removed by evapotranspiration.

3.6.1.3 **<u>Subsurface Flow System</u>**

The subsurface flow system at MSP is divided into two primary hydrogeologic units; the overburden and the fractured bedrock. For the purposes of this report, the overburden unit consists of native soils, non-native fill material, and extremely weathered bedrock. The fractured bedrock unit is weathered bedrock that is competent enough to sustain an open borehole.

The network of monitoring wells at MSP was initially installed in 1994 and upgraded in 2001. Due to inadequate water yield and excessive turbidity, B18W28S and B18W29S were abandoned and replaced with B18W28SR and B18W28SR. Water level measurements are taken quarterly prior to the collection of groundwater samples. Flow and contaminant transport properties in the overburden and shallow bedrock units are different, and therefore each have been discussed separately, as will the relationship between the two units.

3.6.1.3.1 Overburden Flow System

Soils and unconsolidated materials, which form the overburden aquifer beneath the site are clayey fine sands to silty sands with trace amounts of coarser materials and residual soils, or severely weathered bedrock, with a thickness ranging from 0.6 to 4.6 m (2 to 15 ft). The depth of the water table beneath the site is relatively shallow with seasonal fluctuations of the water table of up to 1 m (3.3 ft).

Flow in the overburden aquifer is controlled largely by stratigraphy and topography. Slug test results (Appendix L) indicate that the hydraulic conductivity in the overburden ranges from 1.1×10^{-6} to 4.2×10^{-3} centimeters per second (cm/sec) (3.0×10^{-3} to 12 feet per day [ft/day]) with an average of 9.6×10^{-4} cm/sec (2.7 ft/day). The hydraulic conductivity of the pipe chase material is slightly lower, averaging 1.9×10^{-4} cm/sec (5.5×10^{-1} ft/day).

Groundwater elevations in 14 existing and newly installed overburden groundwater monitoring wells were measured during six quarterly field events during years 2001 and 2002. Figures 3-15 and 3-16 present the potentiometric surface data collected during those events. Tables 3-7 and 3-8 present overburden groundwater elevations for 2001 and 2002.

Groundwater elevation contour maps indicate that overburden groundwater flow may be influenced in the northern one-third of the site by a railroad right-of-way. Groundwater flow in this vicinity is generally north to northeast, toward the railroad right-of-way, with a typical gradient of 0.008 to 0.016. Groundwater may also be discharging into this right-of-way, which has a flow line 6 m (18 ft) below the grade of MSP. In the southern two-thirds of the site, shallow groundwater flow is generally to the south to southeast, with a gradient of 0.01 to 0.02. Closer to the south site boundary, the overburden groundwater flow may intersect with surface water flow of the South Drainage Ditch, suggesting that some overburden groundwater discharges to this feature.

3.6.1.3.2 Bedrock Flow

The top of the shallow bedrock aquifer zone is observed from 3 to 4.6 m (10 to 15 ft) below the ground surface. The principal component of groundwater flow occurs from secondary porosity, which is a result of fractures present in the Passaic Formation. The thickness of this bedrock unit at the site is not known, but based on MSP well logs, it continues to a depth of 15 m (50 ft) below grade. The hydraulic conductivity and gradient of the shallow bedrock is similar to that of the overburden water-bearing zone. In the shallow bedrock, a groundwater mound is also observed in the vicinity of the former Process Building slab, with flow radial from this area. In the southern portion of the site, though, flow is from the southwest corner of the site toward the northeast. A potentiometric low point is typically observed at URSMW11D and bedrock flow is toward this area. The hydraulic gradient in the shallow bedrock ranges from 0.008 to 0.012 (Figures 3-17 and 3-18). Flow in the shallow bedrock underlying MSP is primarily within bedding plane partings and vertical fractures. Slug test results (Appendix L) indicate that the hydraulic conductivity of the shallow bedrock at MSP averages ranges from 1.8×10^{-6} to 2.1×10^{-4} cm/sec (5.0×10^{-3} to 6.0×10^{-1} ft/day) with an average of 5.2×10^{-5} cm/sec (1.5×10^{-1} ft/day). Tables 3-9 and 3-10 present bedrock groundwater elevations for 2001 and 2002.

The bedding plane fractures control flow through discrete aquifer units in the bedrock based on available literature. These aquifer units range in thickness from a few feet or less to several tens of feet. The discrete aquifer units are part of a leaky system connected by vertical fractures. The shallow bedrock aquifer at MSP is sufficiently fractured to be regarded as an equivalent porous medium. This unit is separated from the deeper bedrock aquifer units by a leaky aquitard. The properties of the hydrogeologic units present at MSP are shown below:

Unit	Description	Thickness	Depth Below Grade	Hydraulic Conductivity	Gradient
Overburden	Residual Soils, Glacial Till, and Extremely Weathered Bedrock	0.6 to 4.6 m (2 to 15 ft)	0.6 to 4.6 m (2 to 15 ft)	9.6 x 10^{-4}cm/sec (2.7 ft/day)	0.01 to 0.02
Shallow Bedrock	Highly fractured bedrock with moderate weathering	At least 10.7m (42 ft)	4.6 to 15 m (15 to 50 ft)	5.2 x 10^{-5}cm/sec (1.6 x 10^{-1} ft/day)	0.008 to 0.016

Groundwater elevations recorded in overburden and shallow bedrock wells installed as couplets at MSP indicate that there is a significant downward gradient between the overburden and bedrock (0.3 to 0.5). This gradient suggests that flow between the overburden and shallow bedrock is limited. Flow between the overburden and shallow bedrock is likely to be greater in areas where the silty residual soils have been removed or reworked during past site activities.

3.6.1.4 <u>Potential Receptors</u>

The majority of potential receptors are south of MSP and would intercept groundwater flow emanating from MSP. These receptors may include streams and other surface water bodies, both natural and man-made, seeps, wells, or other aquifers. Some overburden flow in the southeastern portion of the site is intercepted by the settling basin, which in turn flows to the South Drainage Ditch. Further south of the site (approximately 168 m [550 ft]), the overburden aquifer is intersected by Main Stream, therefore making it likely that groundwater discharges into this stream. Main Stream eventually discharges to Ambrose Brook, which, in turn, flows to the Raritan River, approximately 1.45 km (0.9 mi) from MSP. South of Main Stream, a condominium complex has been built. The overburden material is not utilized for water supply. No supply wells in the overburden were identified downgradient of MSP that could act as potential receptors.

Shallow groundwater in the northern portion of MSP flows to the east and northeast, toward the railroad right-of-way northeast of MSP. The base of the railroad right-of-way is approximately 6 m (18 ft) below the grade of MSP. Bedrock was observed outcropping on the southeast wall of the right-of-way. This indicates that the railroad cut intersects the full thickness of the overburden northeast of the site. Overburden groundwater in the northern portion of the site that does not migrate vertically to the bedrock may discharge to the railroad cut, thus the drainage ditch in the railroad cut is a potential discharge point. Water has not been observed flowing in the railroad cut, but based on local topography and the proximity to Ambrose Brook, water collected in the railroad right-of-way during a storm event likely flows southwest.

The flow in the shallow bedrock is generally toward the north-northeast with minor components flowing south-southeast in the approximate center of the site. Potential receptors identified within 1.6 km (1 mi) of the site are 43 domestic supply wells. These wells are from 32 to 122 mbg (105 to 400 fbg), with an average depth of 56 m (183 ft). Given the aquifer characteristics, it is unlikely that shallow bedrock (4.6 to 15.2 m [(15 to 50 ft]) groundwater at MSP migrates to these well depths so close to the site.

3.7 SUMMARY

The 3.9 ha (9.6 acres) MSP site is on the east coast of the continental United States in an area that receives a mean annual precipitation of 1.1 m (43.04 in) and has an average temperature of 12.3^{o}C (51.4^{o}F). Winds in the vicinity of MSP are predominantly from the northwest. Approximately 750,162 people live in Middlesex County, and projections over the next 20 years indicate population increasing by about 13 percent. Approximately 1,150 people reside within 0.8 km (0.5 mi.) of MSP. Land use within this area is a mixture of residential, commercial and industrial properties, and undeveloped land.

Topography in Middlesex County ranges from nearly sea level to approximately 73 m (240 ft) above sea level. Surface water drainage is dendritic with fluvial erosion, transportation and deposition, and mass wasting acting as the primary geomorphic processes. MSP site elevations range from approximately 18 m (58 ft) above sea level at its northern end to 15 m (49 ft) above sea level along its southern boundary.

Native soils at MSP are clayey fine sands to silty sands, with thickness over bedrock ranging from 0.45 to 2.4 m (1.5 to 7 ft). These soils in the area have been disturbed by urban development. Non-native fill material was also found at MSP as deep as 1.4 mbg (4.5 fbg).

The Passaic Formation is a major aquifer throughout central and northeastern New Jersey. Water from the fractures and joints in this bedrock aquifer is used for domestic, municipal, and industrial purposes in Middlesex and surrounding counties. Pumping rates ranging from 10 to 1,200 L/m (2.6 to 317 gpm) have been reported. The Passaic Formation groundwater system has been described as consisting of a series of alternating tabular aquifers and aquitards several tens of feet thick. The water bearing fractures of each tabular aquifer are more or less continuous, but hydraulic connection between individual tabular aquifers is poor.

Ecologically, past and current land use around MSP has transformed the landscape by converting most of the forest and open habitant into residential and commercial or industrial uses. There are no environmentally sensitive areas within the fenced borders of MSP. The majority of the site is covered by asphalt, concrete, gravel, buildings or the foundations of former buildings.

The conceptual hydrogeological model for MSP indicates that since the site was paved (1946), infiltration of precipitation is not a significant pathway for the mobilization of contaminants. However, storm water drain lines and the coarse soil surrounding those lines (the Pipe Chases) may serve as a localized preferential flow path for precipitation to reach overburden groundwater. Two subsurface flow systems are present at MSP. Groundwater flow in the overburden of the northern one-third of the site is generally north to northeast, toward a railroad right-of-way, with a typical gradient of 0.008 to 0.016. In the southern two-thirds of the site, shallow groundwater flow is generally to the south to southeast, with a gradient of 0.01 to 0.02 and a hydraulic conductivity of 9.6 x 10^{-4} cm/sec (2.7 ft/day).. Closer to the southern boundary of the site, groundwater in the overburden may discharge to the South Drainage Ditch.

Groundwater in the shallow bedrock at MSP occurs about 4.5 to 15 m (15 to 50 ft) below grade and is at least 10.7 m (50 ft) thick. The bedrock unit also has a low hydraulic conductivity, 5.2x10^{-5} cm/sec (1.5x10^{-1} ft/day), and a low hydraulic gradient (0.008 to 0.012). The shallow bedrock is separated from the overburden flow system by the extremely weathered bedrock, which serves as a leaky aquitard, with many of its fractures being filled with silt and clay.

South of the site, potential receptors of groundwater from the overburden system include the South Drainage Ditch, the wetlands area adjacent to the South Drainage Ditch and Main Stream. Once groundwater discharges to these receptors, it can move via overland flow to Ambrose Creek, which in turn discharges to the Raritan River, approximately 1.6 km (1 mi) from MSP. Groundwater in the overburden is not used for water supply. To the north, groundwater in the overburden may discharge to a drainage ditch in the railroad right-of-way, which in turn, during periods of heavy runoff, flows to Ambrose Creek and eventually Raritan River. Groundwater in the shallow bedrock flows south-southeast and no surface water bodies or topographic features are present in this area that might serve as a potential receptor. Some local area residents do use groundwater from the deeper bedrock as a source of water. However, these supply wells are many hundreds of feet deep and are not likely to be influenced by the shallow bedrock groundwater at MSP.

4.0 FIELD ACTIVITIES

This section summarizes the field activities for the RI and provides the rationales, logistics, methods and procedures used to obtain representative environmental samples of groundwater, surface water and sediment at the MSP site. Field activities were conducted to provide physical and chemical data needed to characterize subsurface site conditions and groundwater quality at the site. These data will be used in development and evaluation of remedial alternatives under the CERCLA feasibility study process and to ultimately design and implement an effective remedy for this site. The activities performed during the RI include the installation and sampling of monitoring wells, collection of surface water and stream sediment samples, and measurement of aquifer characteristics. All field work was conducted to meet the requirements and the scope of work and procedures as outlined in the approved Groundwater OU Field Work Plan.

4.1 DRILLING ACTIVITIES

Drilling and well installation activities conformed to Federal, state and local regulations and were conducted by CT&E Environmental Services, Drilling Division (New Jersey-licensed drilling subcontractor), West Creek, New Jersey, under the direction of a URS field geologist. The drilling subcontractor provided the necessary equipment and obtained the appropriate permits required by state authorities. Drilling activities conformed to Occupational Safety and Health Administration (OSHA) requirements as stated in the MSP Health and Safety Plan and Groundwater RI Work Plans (USACE, 2000e).

Drilling equipment was cleaned with steam and pressurized hot water prior to entering the site and before starting drilling activities. Drilling equipment was decontaminated between boreholes prior to mobilization to a new monitoring well location.

4.1.1 Monitoring Well Installations

Twenty-four monitoring wells were installed at, or adjacent to, MSP as part of RI field activities. Seventeen wells were completed in the overburden water bearing zone and seven into the shallow, competent bedrock. Monitoring Well Installation Form A and Monitoring Well Survey Form B can be found in Appendices F and G, respectively. A summary of monitoring well installation data is presented in Table 4-1.

4.1.1.1 <u>Overburden Monitoring Wells</u>

To complete the groundwater characterization of the MSP site, radiological and chemical analytical data were collected to determine the extent of contamination. This included areas near suspected sources (i.e., the former process building), in the backfill along the former stormwater drainage system, in areas that may have been impacted by off-site sources, and in the area of the South Drainage Ditch.

The strategy for placement of these additional overburden monitoring wells included one well in each of the following locations (Figure 4-1):

- Northeast of existing well B18W24S in the northern portion of the site, near the southwest corner of the administration building. This well (URSMW1S) was installed to provide data on upgradient extent and water-level elevation.

- Southeast of the center of the former process building, just north of the former sump water discharge line that connected to the former storm water line. This well (URSMW2S) was installed to provide data on this potential radiological source area.

- In the approximate center of the former MML pile asphalt pad, near the former storm water drainage line. This well (URSMW4S) was installed to provide data on these potential radiological and chemical source areas.

- On the eastern edge of the former MML pile between the asphalt pad and the chain link fence. This well (URSMW5S) was installed to provide data on lateral extent of potential groundwater quality impacts in this area.

- In the approximate center of the former VP pile asphalt pad, near the former storm water drainage line. This well (URSMW10S) was installed to provide data on these potential radiological and chemical source areas.

- On the eastern edge of the former VP pile between the asphalt pad and chain link fence. This well (URSMW11S) was installed to provide data on lateral extent of potential groundwater quality impacts in this area.

- Upgradient or sidegradient of the site. This well (URSMW20S) was installed to provide data on background water table elevation/quality information.

- Three shallow monitoring wells, approximately 1.5 m (5 ft) deep, were completed within the backfill material of the former pipe chases. Well locations were selected using borehole gamma logging data collected during the Soils OU RI (USACE, 2003).

- In the South Drainage Ditch, seven 5.08 cm (2 in) PVC wells were installed to a depth of between 3 and 4.5 m (10 and 15 ft) south of the MSP site to delineate the lateral extent of groundwater contamination in this area and to supplement the data collected at B18W30A. Two of the seven wells were installed between well B18W30S and the Main Stream, which receives water from the drainage ditch.

The overburden monitoring wells were installed using a 20.03 cm (8 in) drill-through casing driver in conjunction with a down-hole air percussion hammer that simultaneously drilled the borehole and advanced the casing. The casing/air hammer was advanced in 0.6 m (2 ft) intervals. The air hammer was removed from the casing and replaced with a stainless steel spilt-spoon that was advanced with a 64 kg (140 pound) cylinder hammer in 0.6 m (2 ft) intervals, removed from the borehole, and replaced with the air hammer to drill/advance the casing another 0.6 m (2 ft). This process was repeated until the borehole was advanced to the required depth. The soil and rock characteristics of each borehole were continuously observed and logged by the site field geologist. Monitoring Well Construction Diagrams have been provided in Appendix H of this document.

Cuttings, water and air removed from the borehole were collected by an Allyn diverter and directed to a covered container for later characterization and disposal. The Allyn diverter was attached directly to the top of the surface casing and was designed specifically for spoils containment and dust collection/suppression applications. Well installation began within 12 hours of the completion of the boring.

The monitoring wells were constructed using flush-threaded, 10.16 cm (4 in) diameter, Schedule 40 PVC casing and screen. The well screens were 3.3 m (10 ft) long with continuous slotted PVC screen and a PVC bottom plug. The slot size of the well screen was selected based on grain size analyses; a 0.0254 cm (0.010 in) slot size was selected. The grain size analysis is found in Appendix I

The filter pack material was clean, inert, well-rounded siliceous sand with a grain size distribution and uniformity coefficient compatible with the formation materials and well screen. The filter pack material was mixed with potable water and pumped around the well screen. Water used during this process and introduced into the well during drilling was sampled and tested for the groundwater RI constituents prior to its use during well construction. Analytical results are found in Table 4-2. The filter pack extended from the bottom of the boring to 0.9 to 1.5 m (3 to 5 ft) above the top of the screen.

Bentonite was installed between the filter pack and the cement grout. The bentonite seal consisted of 100 percent granular sodium bentonite that was installed as a slurry and extended at least 0.6 m (2 ft) above the top of the filter pack. In some instances, the shallow nature of the well prohibited the placement of 0.6 m (2 ft) of bentonite; therefore thickness adjustments were made to accommodate the well depth. The bentonite seals were installed as a slurry by pump tremie methods and allowed to set for at least 60 minutes prior to the emplacement of the cement grout and protective stick-up casing.

Cement grout used in the monitoring well construction was composed of Type I Portland cement. The grout was pumped from the mixing container through a rigid grout pipe located just over the top of the bentonite seal to an approximate depth of 0.9 mbg (3 fbg). After 24 hours, grout settlement was checked, and additional grout was added, if required.

Locking protective steel casings were installed around the PVC wells and consisted of a 1.5 m (5 ft) length of 15.2 cm (6 in) diameter black steel pipe extending 0.76 m (2.5 ft) above ground surface. The annulus formed between the monitoring well and the protective casing was left empty (air space) and a 6.35 mm (0.25 in) diameter hole (drainage port) was drilled in the protective casing centered 3.18 mm (0.125 in) above ground level. The outside of the protective casing, hinges, and covers/caps were painted yellow.

Concrete pads were installed at each well location. The pads were constructed to slope away from the borehole (to encourage surface runoff) and extended radially 0.6 m (2 ft) from the protective casing. Pads were tapered into the borehole below the ground surface to reduce the potential for frost heaving.

Each well was surrounded with protective bumper posts. Paired monitoring wells were surrounded by six sections of 7.6 cm (3 in) diameter steel pipe, 1.8 m (6 ft) in length, that were installed radially around the well. A single well was surrounded by four bumper posts, which were secured in place with the same grout mixture used to complete the well. Bumper posts were also painted the same yellow as the steel protective casings.

Well designation and NJDEP permit numbers were stenciled to the outside of the protective casings, and each well was secured with a corrosion-resistant pad lock.

4.1.1.2 Bedrock Monitoring Wells

To obtain additional information as to the aquifer properties and water quality conditions within the bedrock aquifer, seven bedrock groundwater monitoring wells were installed (Figure 4-1).

At each proposed well location, the bedrock well was installed adjacent to an overburden groundwater monitoring well to allow comparison of data. All bedrock groundwater monitoring wells were completed as open hole wells. The seven bedrock wells were completed to an average depth of 14.3 mbg (47 fbg). The placement of the bedrock wells proceeded using the following techniques:

- Four bedrock wells were installed around the perimeter of the site. Two of the wells are east of the former VP and MML piles, between the chain link fence and the asphalt pads (URSMW5D, URSMW11D). One well was installed west of the former MML pile (URSMW3D). One well was installed at the southwest corner of the former VP pile between the chain link fence and the asphalt pads (URSMW9D). These wells were installed to provide data on groundwater quality and water table elevations in this area.

- A bedrock well was installed near the northwestern wall of the administration building (URSMW1D). This well was installed to provide information on upgradient contaminant delineation and groundwater flow directions in this area.

- A bedrock well was installed southeast of the center of the process building slab (URSMW2D). This location is south of the discharge pipe that drained the former building sump, a potential radiological source area.

- A bedrock well was installed up or side gradient of the site to provide information on background groundwater quality/elevation (URSMW20D).

Each bedrock well borehole was initially drilled using a 10.16 cm (4 in) inside diameter (nominal) hollow stem auger. This bedrock pilot borehole was used to log the overburden material overlying the bedrock surface at MSP and to collect overburden samples for laboratory analysis. The pilot borehole was advanced to split-spoon refusal. During the drilling of each borehole, split-spoon soil samples were collected of the overburden at 0.6 m (2 ft) intervals for logging and analytical purposes. Monitoring Well Construction Diagrams have been provided in Appendix H of this document.

A water-cooled NX 5 cm (2 in) diameter diamond-tipped coring bit was inserted into the borehole to drill and collect rock cores at 3 m (10 ft) intervals into the competent bedrock. In the field, competent bedrock was defined as formation materials, which would sustain an open borehole with RDQs in the range of 60 to 70%. A summary of RQD calculations is provided in Table 4-4. The core drill was removed and the borehole was reamed to a 25.4 cm (10 in) diameter opening 3 m (10 ft) into competent bedrock using air rotary drilling techniques. A 15.2 cm (6 in) outside diameter steel casing (the isolation casing) was installed in the 25.4 cm (10 in) borehole and seated 3 m (10 ft) into the competent bedrock. The steel casing was pressure grouted in accordance with NJDEP protocols. The grout was permitted to cure for at least 24 hours prior to further advancement of the borehole.

After 24-hours, the water-cooled NX diamond-tipped coring bit [5 cm (2 in)] was reinserted into the borehole and the bedrock was cored to a depth corresponding to 7.6 m (25 ft) below the bottom of the casing. After collection of rock cores, an air rotary/percussion hammer was used to expand the borehole to 15.2 cm (6 in) (nominal) in diameter.

Cuttings, water and debris removed from the borehole were collected by the Allyn diverter and directed to a covered container for eventual characterization and disposal.

The bedrock monitoring wells were installed in the fashion described above, with the exception of the first bedrock well installed, URSMW1D. This well was completed as a 20.3 cm (8 in) diameter well instead of a 15.2 cm (6 in) diameter well. The diameter of the subsequent wells was reduced to 15.2 (6 in) to reduce the volume of investigation derived wastes (IDW).

Surface completion of the bedrock monitoring wells (cement pads, bumper posts, etc.) was accomplished using the same methods and requirements as the overburden monitoring wells.

4.1.2 Monitoring Well Development

The newly installed monitoring wells were developed no sooner than 48 hours after and not longer than seven days beyond final grouting. The monitoring wells were developed using decontaminated submersible pumps or bottom filling bailers when slow recharge rates restricted pump usage. Development proceeded until:

1. The sediment thickness remaining in the well was less than one percent of the screen length or less than 0.25 cm (0.1 ft) for screens less than 3 m (10 ft) long,

2. A minimum of five times the standing water volume in the well was removed (including the well screen and casing plus saturated annulus, assuming 30 percent porosity), and

3. Five times the amount of water was added or lost to the formation.

During development, the groundwater was removed across the well screen by periodically lowering and raising the pump intake.

A monitoring well development/purge log was completed for each well (Appendix J). Monitoring well development parameters are presented in table format in Table 4-3.

4.1.3 Geophysical Borehole Logging

To aid in the interpretation of site stratigraphy and bedrock fracture patterns, geophysical borehole logging was conducted in the site bedrock monitoring wells. The identification of bedrock fractures via caliper logging was done to select depths for the installation of permanent submersible pumps used for groundwater collection. Earth Data, Inc. of Exton, Pennsylvania completed temperature/conductivity, gamma, and caliper logging on the six bedrock monitoring wells. Results of the geophysical logging are found in Appendix K and are summarized in Table 4-7 where they are tabulated along with bedrock core observations, television camera inspection observations, and ground water sampling pump intake depths. To aid in the interpretation of site stratigraphy and bedrock fracture patterns, geophysical borehole logging was conducted in the site bedrock monitoring wells. The identification of bedrock fractures via caliper logging combined with rock core observations (i.e., low RQDs), and in consideration of the gamma log results, was done to select depths for the installation of permanent submersible pumps used for groundwater collection. Earth Data, Inc. of Exton, Pennsylvania completed temperature/conductivity, gamma, and caliper logging on the six bedrock monitoring wells.

4.1.4 Television Inspection

A Wellcam color camera was used to visually inspect the boreholes at locations URSMW1D and URSMW9D. The locations were selected as they represented the northern-most and southern-most bedrock wells. As the camera was lowered into the borehole, video images were recorded on VHS tape cassette. The video images provided visual identification of water-bearing fractures and other characteristics such as in-filled vertical and horizontal fractures.

4.2 SLUG TESTS

Slug tests were performed in monitoring wells to evaluate the hydraulic conductivity of the overburden and bedrock water-bearing zones at the site. The result of these evaluations is discussed in Appendix L.

The slug test consisted of introducing an object (a ‘slug”) into a well, or removing a slug from a well, to cause a rapid water level change or head displacement. The response or change of the water table elevation in the well was then monitored. The elevation data, along with information regarding the well and the aquifer, was used to estimate hydraulic conductivity.

Prior to the start of each test, depth to water and total depth in the well to be tested was measured. A pressure transducer was then secured near the bottom of the well and connected to a Hermit SE2000 or 3000 automatic data logger (In-Situ, Inc., Laramie, Wyoming) at the surface. Both rising and falling slug tests were performed in each well. The falling head slug test was performed by introducing a slug into the well, causing a rapid rise of water level. The subsequent water level decline was then monitored with the data logger. When the water level adjusted to be within 90 percent of the original head or level, a rising head slug test was performed. For the rising head slug test, the slug was removed from the well, causing a rapid water level drop. As the water level within the well adjusted (rose), it was monitored with the data logger.

In the 10.2 cm (4 in) diameter wells, a 8.9 cm (3.5 in) diameter, 61 cm (2 ft) long steel slug was used to induce the head changes. In the 5.1 cm (2 in) diameter wells, a slug constructed of 4.4 cm (1.75 in) diameter PVC filled with cement was used.

4.3 LOW FLOW GROUNDWATER SAMPLING

Groundwater samples were collected from newly installed overburden and bedrock groundwater monitoring wells. Dedicated low-flow (less than 0.5 L/m [0.13 gpm]) bladder pumps were used to purge each monitoring well of stagnant groundwater. Groundwater samples were collected two weeks after the completion of well development. Groundwater sampling procedures are detailed in the Standard Operating Procedure (SOP) in Appendix M. Additionally, a technical guidance procedure for low-flow sampling is also presented in Appendix N.

Information pertaining to the purging and stabilization of each monitoring well was recorded on Groundwater Field Sampling Data Sheets, Appendix O, and in the field logbooks, as necessary. The stability indicator parameters: specific conductance, pH, oxidation/reduction potential (Eh), temperature, turbidity, and dissolved oxygen (DO) as outlined in Appendix O, were measured in the listed order during monitoring well purging and sampling. The data were collected using an in-line, flow-through chamber equipped with a Horiba U-22 water quality meter. The in-line, flow-through chamber was connected directly to the bladder pump's groundwater discharge hose. The monitoring wells were purged until three consecutive readings of the indicator parameters stabilized in accordance with the following criteria: electrical conductivity ±3 percent; pH ±0.1 units; temperature ±0.5 °C; turbidity <10 NTU; Eh ± 10 mV; and DO ±10 percent. Once the indicator parameters stabilized, groundwater samples were collected.

In several instances, all indicator parameters stabilized with the exception being turbidity. A total of 46 samples were collected from wells with turbidity above 10 Nephalometric Turbidity Units (NTUs). When turbidity failed to stabilize at values less than 10 NTUs, a 0.45 micron filter was added and a dissolved metals sample was collected in conjunction with the total metals sample. In the event turbidity values failed to stabilize at values less than 50 NTUs, two 0.45 micron filters were added.

4.4 SEDIMENT AND SURFACE WATER SAMPLING

Twenty samples were collected along two transects of the South Drainage Ditch, oriented perpendicular to the drainage ditch, during the groundwater OU events of April 2001 and January 2002 (Figure 4-2). Within each transect, four sediment samples were collected in the drainage ditch and three soil samples were collected on either side of the ditch channel, within the floodplain soils. Each sample was taken with a dedicated, decontaminated, stainless steel sampling trowel. The samples were analyzed for metals by EPA SW-846 Methods 6000 - 7000 series and radionuclides by HASL-300. Analytical results are discussed in the next section and can be found on Tables 5-24 and 5-25, respectively. The goal of the sampling and analysis of these samples was to identify whether the sediment and floodplain soils provide a continuing source of contamination to surface water.

Surface water samples were collected at two locations during two Groundwater OU events of April 2001 and January 2002 (Figure 4-2). These correspond to surface water gauging stations discussed in Section 4.6. Surface water samples were analyzed for metals by EPA SW-846 Methods 6000 - 7000 series and radionuclides by HASL-300. At these locations, constituent mass-loading rates were calculated by multiplying the measured constituent concentration or activity by the recorded surface water discharge rate. Analytical results are discussed in the next section and can be found on Tables 5-27 and 5-28, respectively.

4.5 STREAM HYDROPUNCH® INSTALLATION AND SAMPLING

Two HydroPunch® temporary sampling points were installed into the streambed of the South Drainage Ditch on April 19 and 23, 2001, to obtain groundwater analytical data from the water-bearing zone beneath the South Drainage Ditch. The HydroPunch® sampling points consisted of 5 cm (2 in) PVC well screen that were driven into the streambed inside drill rods. The drill rods were raised approximately 30.5 cm (1 ft) thus exposing the PVC well screen to the groundwater beneath the drainage ditch.

Piezometer URSHP1 was installed on April 19, 2001 in the center of the South Drainage Ditch channel approximately 12.2 m (40 ft) south of the MSP boundary. Piezometer URSHP2 was installed on April 23, 2002, in the center of the South Drainage Ditch channel approximately 33.5 m (110 ft) south of the MSP boundary (Figure 4-1). The drive points were advanced approximately 0.6 to 1.2 m (2 to 4 ft) below the bottom of the drainage ditch to refusal. Details of the HydroPunch® sampling are presented in Table 4-5 and include screened interval and, depth to ground water referenced to the surface of the water in the South Drainage Ditch. The elevations of the top of the temporary casings were not surveyed at the time of installation and sampling. Therefore, ground water elevations cannot be calculated from the available data and would not be useful without synoptic water level measurements from nearby overburden monitoring wells.

Groundwater was collected from the drive points following installation and was analyzed for VOCs by EPA SW-846 Method 8260b, SVOCs by EPA SW-846 Method 8270c, metals by EPA SW-846 Methods 6000 - 7000 series and radionuclides by HASL-300. Analytical results on the samples collected by URS can be found in the tables located in the back of this report.

4.6 STREAM GAUGE INSTALLATION AND MEASUREMENTS

Two stream gauges were installed to aid in the calculation of stream flow. One stream gauge was installed downgradient of the MSP surface water outfall and the other upgradient of the confluence with the South Drainage Ditch and Main Stream.

The stream gauges were constructed during June 27 to 28, 2001 and consist of a 2.54 cm (1 in) diameter galvanized pipe upon which the graduated stream gauge was permanently attached. Stream Gauge 1 was constructed mid-channel of the South Drainage Ditch approximately 6 m (20 ft) south of the MSP boundary. Stream Gauge 2 was constructed mid-channel of the South Drainage Ditch approximately 167.6 m (550 ft) south of the MSP boundary.

The elevation of each stream gauge was measured and noted on the gauge. Stream measurements were recorded during groundwater sampling events in conjunction with groundwater elevation measurements. However, due to the disturbance of the gauge over time, and a review of the available data, it was determined that the elevation data is not reliable, and has not been included in this report. Stream gauge locations are shown on Figure 4-2. Relative water depths and flow observations recorded between 2001 and 2003 are presented in Table 4-6.

4.6.1 Stream Flow and Discharge

Stream flow and discharge data were collected from the South Drainage Ditch at two locations corresponding to Stream Gauge 1 and Stream Gauge 2. At these two locations, cross-sectional areas were surveyed every 15.2 cm (6 in) horizontally and to the nearest 0.3 cm (0.01 ft) vertically to obtain a profile of the stream channel. Surface water elevations were measured from the installed stream gauges. This information was used to prepare an area cross-section diagram at each steam gauge location. Stream flow measurements were recorded using a Gurley Instruments Pygmy 625 flow meter with digital readout. When stream flow was below the flow meter's operational range of 0.61 cm/sec (0.02 ft/sec), the flow was estimated using the minimum operational range of the meter in the calculated discharge. As a result of this assumption, flow rates will be a high-end estimate.

The cross-sectional area at Stream Gauge 1 was 0.17 m^2 (1.84 ft^2) as measured on June 28, 2001. Stream flow was below the flow meter's operational range of 0.61 cm/sec (0.02 ft/sec). Therefore, the meter's minimum operational range was used to calculate stream discharge. The following open channel flow equation was used:

$$Q=VA \qquad \text{(Eq. 4)}$$

where:

Q = discharge
V= velocity
A=area

The calculated stream discharge at Stream Gauge 1, as measured on June 28, 2001, was 90,000 L/day (23,782 gallons/day).

The cross-sectional area at the location of Stream Gauge 2 as measured on June 28, 2001, was 0.14 m^2 (1.55 ft^2). Stream flow was below the flow meter's operational range of 0.61 cm/sec (0.02 ft/sec). Using the flow meter's minimum operational range, the calculated stream discharge at Stream Gauge 2, as measured on June 28, 2001, was 75,800 L/day (20,034 gallons/day).

4.7 ABANDONMENT OF LACKLAND PROPERTY MONITORING WELLS

Two overburden monitoring wells in the South Drainage Ditch were abandoned due to expiration of the right-of-entry permits. Abandonment was verbally requested by the owner of the property as the land parcel was undergoing residential development. URSMW17S and URSMW18S were abandoned in March 2002 by a certified well driller in accordance with NJDEP well abandonment protocols. Both wells were off-site and between monitoring well B18W30S and the Main Stream, and were constructed of 5.1 cm (2 in) diameter PVC surrounded by a steel outer casing and concrete pad. Abandonment consisted of the demolition of the concrete pad and steel outer casing. The 5.1 cm (2 in) PVC casing was removed from the ground and the resultant open hole was grouted to the surface. The former well area was graded to the original elevation using hand tools.

In addition to the abandonment of URSMW17S and URSMW18S, two environmental surveillance overburden monitoring wells were also abandoned. B18W28S and B18W29S, each along the southern boundary of the site, were sealed due to increased turbidity levels and poor groundwater recharge. Two replacement wells were installed adjacent to the sealed wells and were designated B18W28SR and B18W29SR. The 5.08 cm (2 in) PVC replacement wells were installed using the same guidelines and protocols discussed in Section 4.1.1.1.

5.0 NATURE AND EXTENT OF CONTAMINATION

This section presents an overview of data available for use in identifying the nature and extent of groundwater, sediment and surface water contamination at MSP. Although groundwater at the site is not used as a source of potable water, the most stringent of SDWA MCLs, NJ SDWA MCLs or NJ Class IIA Groundwater Quality Criteria (collectively called the comparison criteria) have been used to evaluate the concentrations of potential contamination.

Historic groundwater data are presented in Tables 5-1 through 5-7. Analytical results obtained from sampling activities completed in 2001 and 2002 are presented in Tables 5-8 through 5-28. Groundwater sample locations and analytical results greater than comparison criteria are shown on Figures 5-1 through 5-4. Sediment and surface water sample locations and analytical results greater than comparison criteria are shown on Figures 5-5 through 5-7. Due to sporadic occurrence and distribution of contaminants, plume maps are not presented as part of this report. Review and analysis of the data collected during the ES and two rounds of groundwater sampling events conducted as part of this Groundwater OU RI sampling events shows that the contaminants of concern have been adequately characterized for evaluating feasible remedial alternatives for the contaminants of concern identified at MSP.

5.1 DATA REVIEW AND EVALUATION

Historical sampling activities at MSP have resulted in the collection of a large quantity of data for groundwater, sediment and surface water. For this RI, previously collected data, as well as recent sampling data collected in 2001-2002 By URS have been evaluated. However, only the more recent data generated during this RI are used in the risk assessment.

5.1.1 Data Quality Assessment

Analytical data used to evaluate the nature and extent of contamination include the following:

Results of groundwater, surface water and sediment sampling during quarterly Environmental Surveillance monitoring in 2000 (three rounds), 2001 (four rounds) and 2002 (two rounds).

Two rounds of groundwater, surface water and sediment sampling. These are referred to as the “RI sampling” events. Round 1 took place in May-June 2001 and Round 2 was completed in December-January 2002. Groundwater samples were collected from 17 overburden wells and 7 bedrock wells. Surface water and sediment samples were collected from two locations in both rounds.

Sampling of seven monitoring wells in the South Drainage Ditch in July 2001.

Sampling of URSMW17S and URSMW18S in March 2002.

Analytical data were validated using guidelines and procedures described in Appendix B of this report. Overall, the data are acceptable, usable and, for the most part, in compliance with the Full CLP Data Deliverable Format. Less than one percent of the entire data set has been rejected as unreliable. The quality assurance review did identify aspects of the analytical data that require qualification. Data qualifiers, when applicable, are placed next to the results in tables and on figures so that the data user can assess the qualitative and/or quantitative reliability of the reported concentration. Groundwater samples collected during each of the environmental surveillance events were analyzed for VOCs by USEPA SW-846 method 8260B, SVOCs by USEPA SW-846 method 8270C, metals by USEPA SW-846 methods 6000 - 7000 series and radionuclides by method HASL-300. Surface water and sediment samples collected during environmental surveillance events were analyzed for SVOCs by USEPA SW-846 method 8270C, metals by USEPA SW-846 methods 6000 - 7000 series and radionuclides by method HASL-300. The analytical results associated with the environmental surveillance events have been incorporated with the groundwater RI sampling data and can be found in Tables 5-8 through 5-28.

Analytical data qualified with "R" (rejected) and "B" (contaminated blank) are discussed in this chapter, however, these data are regarded as unreliable and have not been considered in the risk assessment.

Eighteen samples exhibited turbidity in excess of 50 NTUs, which was the guideline established in the Groundwater OU RI Work Plan and Field Sampling Plan for the collection of unfiltered groundwater samples. Analytical results obtained from the analysis of these samples are presented in this section. However, since the metal and radionuclide data from samples exceeding 50 NTUs are regarded as unrepresentative, those samples are not used in the risk assessment for MSP.

Please note that in this section, the concentrations of the analytes are presented without data qualifiers. The reader is referred to the summary tables and figures referenced in the text for specific data qualifiers associated with the reported concentrations.

5.1.2 Overburden and Bedrock Groundwater Data

Environmental surveillance groundwater samples were collected from a monitoring network of seven wells that were installed at MSP in Spring 1994. Surface water and sediment samples were also collected as part of this program from four locations at the site. Analytical results from these sampling events are presented in their respective environmental surveillance technical memorandums that were submitted to NJDEP and EPA on a quarterly and annual basis. Groundwater samples collected during each of the environmental surveillance events were analyzed for VOCs, SVOCs, metals and radionuclides. Surface water and sediment samples collected during environmental surveillance events were analyzed for SVOCs, metals and radionuclides.

As part of this Groundwater OU RI, groundwater samples were collected from 17 overburden and seven bedrock wells that were installed between February and September 2001. These samples were analyzed for VOCs, SVOCs, metals and radionuclides. In addition to the samples collected from monitoring wells, two groundwater samples were collected from temporary (Hydropunch®) well points in the South Drainage Ditch area. These samples were analyzed for the same parameters as the monitoring well samples.

Two background groundwater monitoring wells (URSMW20S and URSMW20D - Figure 4-1) were installed off site and sampled as part of the Groundwater OU RI program. The samples were analyzed for the same suite of parameters as the on-site groundwater samples.

5.1.3 Previous Groundwater Investigations

5.1.3.1 Groundwater Environmental Surveillance Program

The groundwater-monitoring program for MSP was initiated in May 1980 with the installation of 20 monitoring wells. Six additional monitoring wells were later installed in July 1981. Due to well construction methods and uncertainty associated with analytical data collected from these wells, several of these monitoring wells were replaced in 1994, and all but one of the 1981 monitoring wells were abandoned. A summary of the environmental monitoring data collected since the installation of the new wells is presented in Tables 5-1 through 5-7. Additional wells were installed in 1996 during a shallow groundwater investigation completed by Bechtel in order to obtain localized groundwater data for installation of the *in situ* granular activated carbon filter (BNI, 1997b). However, these wells were not sampled as part of the environmental surveillance program. With the exception of seven wells that are used for the environmental surveillance program, all of the 1996 wells have been abandoned. Historically, chemical concentrations in groundwater have been evaluated based on several standards, the strictest of which are generally the EPA Drinking Water MCLs. The data collected during these historical sampling events between 1985 and 1993 are compared with applicable regulatory criteria during that period in lieu of current regulatory standards. The regulatory criteria used to evaluate these historic data are referred to as "historic comparison criteria" in the following discussion.

Organic Compounds

Annual sampling of the groundwater at the MSP site for chemical contaminants began in 1985 (BNI, 1991b) and has continued to the present. Chemical analyses for New Jersey priority pollutants (organics) were performed on groundwater samples annually. Water quality parameters such as total organic carbon (TOC), total organic halides (TOX), specific conductance, and pH were also measured. In 1990, metals and metal ions were added to the groundwater sampling parameters.

During the years 1985 to 1993, organic compounds have been detected in groundwater sporadically across the site. VOCs were not detected in the groundwater in 1986 or 1987. TCE was detected at levels above 5 µg/L in groundwater from Well MSP-21D at the southeastern edge of MSP in 1985 (14 µg/L), 1988 (17 µg/L), and 1989 (53 µg/L). In 1992, 1,2,4-trichlorobenzene was detected in groundwater from Well MSP-4 at a concentration of 75 µg/L. This contaminant was also detected in the same well in 1988 (43 µg/L) and 1993 (66 µg/L). Benzene and xylene were detected in groundwater from groundwater from Well MSP-9 in 1989. This well is on the western edge of the site adjacent to the VP storage pile. In 1985, toluene was detected in groundwater from 7 wells (MSP-3, 3A, 9, 11, 20D, 20S, and 21S) with concentrations ranging from 94 to 140 µg/L and again in 1989 in groundwater from Well MSP-9 (25 µg/L). Although widespread in distribution, other VOCs, such as carbon disulfide, methylene chloride, and trichloroethene, and total petroleum hydrocarbons (TPH) have been detected only once or were detected due to laboratory contamination of the samples. No other VOCs, SVOCs, PCBs, or pesticides were detected during previous (1982 to 1993) monitoring activities.

MTBE, a common gasoline additive, was detected in groundwater from wells B18W26S, B18W27S, and B18W28S in 1996. The highest concentrations (700 µg/L to 800 µg/L) were found in groundwater from well B18W27S, which is at the southwestern corner of the site. MTBE was detected in 1994 in groundwater from this well at a concentration of 300 µg/L. This indicates that the concentration of MTBE may have increased from 300 µg/L during 1994 to 800 µg/L during 1996. MTBE is more soluble and more mobile than other constituents of gasoline (e.g., benzene, toluene, and xylene) and would probably be present at the leading edge of a gasoline plume. Thus, MTBE is likely an indicator of petroleum migration onto the site from an adjacent property (BNI, 1997a). The west side of MSP borders an industrial vehicle salvage facility. No MTBE was detected in groundwater from the northern well close to the MSP garage. The MSP garage was used for vehicle parking during past MED operations (1943 to 1968) and during the U.S. Marine Corps occupancy of the site (1969 to 1979). MTBE was produced and used in the United States from 1979, which implies that MED and USACE operations have not contributed to MTBE impacts observed at MSP.

From 1994 through 1997, organic compounds have been detected in samples from all the existing groundwater monitoring wells except B18W30S. Of the compounds detected, bis(2-ethylhexyl)phthalate collected during monitoring events in 1994, 1996, 1997 and 1,2,4-trichlorobenzene collected during monitoring events in 1994 had the highest concentrations. A summary of organic compounds detected above comparison criteria is shown in Table 5-1.

Inorganic Compounds

Aluminum, iron, and manganese were detected in groundwater during sampling events in 1990 and 1991. Aluminum concentrations in 1990 ranged from 246 to 19,900 µg/L, and in 1991 from 573 to 16,127 µg/L. In 1990, iron and manganese concentrations ranged from 810 to 42,400 µg/L and from 72.7 to 3,350 µg/L, respectively. In 1991, the iron and manganese concentrations ranged from 320 to 23,620 µg/L and 72.7 to 5,913 µg/L, respectively.

Other metals were found less frequently in 1990 and 1991. During the 1990 sampling event, concentrations of lead in groundwater samples from Well MSP1 at the north upgradient end of the site and Well MSP 4 at the southern downgradient edge of the site were measured at 66 µg/L and 505 µg/L, respectively. However, in 1991, samples collected from the same groundwater monitoring wells were below 15 µg/L. Boron was reported in groundwater from 15 wells in 1990 and in groundwater from 12 wells in 1991 with concentrations ranging from 62 to 426 µg/L and 86.7 to 429 µg/L in 1990 and 1991, respectively. Boron was also detected in groundwater from the background well at MML (MML-17) for both years. MML-17 is located in the vicinity of the Middlesex Municipal Landfill. No historic comparison criteria exist for boron. MML-17 exceeded the historic comparison criteria for aluminum, iron, and manganese in 1990 and 1991.

In 1992, testing for aluminum, iron, and manganese was done in the groundwater from downgradient off-site wells for the first time. Concentrations ranged from 211 to 162,000 µg/L for aluminum, 578 to 205,000 µg/L for iron, and 730 to 11,300 µg/L for manganese. The concentrations of these metals in groundwater from off site Well MSP-14 were 12,800 µg/L, 13,800 µg/L, and 3,230 µg/L for aluminum, iron, and manganese, respectively. Lead was also detected in groundwater from Well MSP-14 at 16.7 µg/L and in Well MSP-11 on the north edge of the MML pile at a concentration of 70.4 µg/L. Both of these values exceed the historic comparison criterion (15 µg/L). Nickel, chromium, and barium were tested for and found above MCLs of 100 µg/L (nickel and chromium) and 2,000 µg/L (barium) for the first time in 1992. Nickel was detected at 458 µg/L, chromium was detected at 274 µg/L, and barium was detected at 3,250 µg/L, all in groundwater from Well MSP-4. Several other metals were tested for and found for the first time in 1992, including cobalt in groundwater from Well MSP-4 (216µg/L); molybdenum in groundwater from Wells MSP-4, 9, 11, 14 (8.9 to 145 µg/L); and beryllium in groundwater from Well 4 (18.2 µg/L). The beryllium concentration in groundwater from Well MSP-4 exceeded the comparison criterion of 4 µg/L. Boron and vanadium were also detected in five wells and two wells, respectively.

In 1993, there were fewer occurrences of many of the metals previously measured above historic comparison criteria. Antimony was detected above the historic comparison criterion (6 µg/L) for the first time with a measured concentration of 60.1 µg/L in groundwater from Well MSP-9. This well is on the northeast edge of the VP pile. In addition, boron was reported in groundwater from four wells (MSP-4, 9, 11, 14), cobalt was detected in groundwater from Well MSP-9, and silver was found in groundwater from Well MSP-4. Metals previously detected in groundwater at the Middlesex site that exceed historic comparison criteria are shown in Table 5-2. Exceedances in concentrations of metal contaminants (arsenic, beryllium, chromium, lead, and nickel) were observed in groundwater from several on-site wells but concentrations were considerably lower in the downgradient, off-site well.

Groundwater samples were collected at MSP on an annual basis from 1994 through 1998, however, the period of sample collection has varied from April to October. Generally, nickel and chromium concentrations have been decreasing in groundwater from well B18W28S. The sporadic occurrence of metals in groundwater indicates some influence from local industrial operations (BNI, 1997a). No significant constant source of metal contamination is present at the site; however, lead and beryllium have been detected in several surface soil samples along the western portion of the site. Both lead and beryllium are probable constituents of the uranium, thorium, and beryllium ores that were handled at the Middlesex site (BNI, 1993c).

Radionuclides

Groundwater monitoring for radionuclides at MSP was initiated in 1980, primarily to monitor the effect of construction activities at the site on groundwater quality. The 1980 and 1981 data indicates that groundwater from up to five wells along the eastern edge of MSP exceeded EPA historic comparison criteria for Ra-226 and Ra-228 combined (5 pCi/L). From 1982 through 1991, the MSP groundwater-monitoring network was made up of 19 wells that were monitored for radiological constituents on a quarterly basis.

A comparison of 1982-1993 radionuclide data from the monitoring wells to the background well at MML showed elevated total uranium activity (over background of 3 to 6 pCi/L in groundwater from five wells). During the 1982-1993 period, elevated concentrations of uranium in 1982 (39 to 138 pCi/L) generally decreased in groundwater from most wells by 1993. Groundwater from two wells, MSP-11 and MSP-5 (on the northern edge of the former MML pile and along the southeast edge of the site, respectively), showed a trend of increasing uranium concentrations throughout mid to late 1980s, then the trend reversed and fluctuated by 1993. Groundwater from Well MSP-5 concentrations of uranium decreased between 1988 and 1993. Groundwater from Well MSP-11 indicated that concentrations of uranium have decreased since 1989, with the exception of 1992, when the concentration more than tripled, reaching 187.3 pCi/L. When the uranium concentration was measured in groundwater from

Well MSP-11 in 1993, the concentration had dropped to 36.5 pCi/L, five times less than the previous year, indicating that the 1992 data may have been anomalous.

Radium concentrations in groundwater remained low between 1982 and 1993. However, one sample taken from Well MSP-9 (7 pCi/L) in 1989 slightly exceeded the comparison criterion of 5 pCi/L for Ra-226 and Ra-228 combined.

Wells installed as part of the 1980/1981 Weston investigation, except for Well MSP-12, were abandoned and sealed consistent with NJDEP regulations. In 1994 due to concern over their integrity. The wells under the two interim storage piles (MSP-2, 6, 6A, 7, 8, and 10) were plugged in 1980 and 1981 prior to the construction of an asphalt pad. For these reasons, the validity of the groundwater data including the environmental surveillance data obtained prior to 1994 is uncertain. The monitoring wells that were installed in 1994 now comprise the groundwater monitoring network that has been sampled as part of environmental surveillance activities from 1994 to date.

Radionuclide concentrations in groundwater have been evaluated based on several criteria, the strictest of which are the SDWA MCLs established by EPA. The current MCL standards are 5 pCi/L for Ra-226 and Ra-228 combined and 30 μg/L for uranium. In addition, a 4 mrem/yr MCL limit for man-made beta-gamma emitters in water also applies. There are no current criteria for thorium and Ra-224. However, comparison criteria for gross alpha (i.e., 15 pCi/L) includes the combined activities associated with Th-232, Th-230, Th-228, and Ra-228. The comparison criterion for gross alpha excludes uranium and radon.

Radioactive constituents have been detected above historic comparison criteria in groundwater at the Middlesex site as follows:

1994 – Ra-226 + Ra-228: wells B18W24S, B18W26S, and B18W28S
1994 – Gross Alpha (Th-230 + Th-238): well B18W24S)
1995 – Ra-226 + Ra-228: well B18W29S
1997 – U-238: well B18W24S
1998 – U-238: well B18W24S
1998 – Ra-226+Ra228: well B18W28S

Groundwater samples from B18W24S have shown increasing concentrations of U-238 during the 1994 to 1997 period, with the greatest increase in 1997. This well is downgradient from the process building and the elevated concentration of U-238 is likely attributed to contaminant migration from a former building sump. The sump was 3 m (10 ft) deep (BNI, 1997c) and extended into the weathered bedrock. The sump was cleaned out and filled with concrete in 1996. Groundwater samples collected from B18W30S consistently contained high concentrations of U-238. These groundwater results were consistent with the distribution of U-

238 in surface and subsurface soil. Table 5-3 summarizes previous radiological constituent analytical results.

5.1.3.2 Surface Water and Sediment Monitoring

Four locations have been sampled since 1980 for surface water and sediment as part of the environmental monitoring program. Three sampling stations were downstream of the site with one location (SWSD004) within a small stream that does not contain water contributed from the site. This sample location (Location 4) is designated as MSP background location. Progressing downstream from the site, the locations are designated SWSD001 (Location 1) at the outfall location, SWSD006 (formerly termed Location 2 and currently termed location 6) within Main Stream, and SWSD003 (Location 3) at the confluence with Ambrose Brook. Historically, surface water and sediment samples have been collected from the following four locations (Figures 5-5 through 5-7)**.**

- Location 1 (SWSD001) – Plant outfall.

- Location 2A (SWSD006) – Confluence of South Drainage Ditch and Main Stream. (Note: Location 2A (SWSD006) replaced Location 2 (SWSD002) in the third quarter of 1992.)

- Location 3 (SWSD003) – Main Stream near confluence with Ambrose Brook.

- Location 4 (SWSD004) – Main Stream - upgradient of the MSP site (background).

Analysis of surface water included only Ra-226 and isotopic uranium, with the addition of other radionuclides and inorganics during the 1990s. Data exists for total uranium and Ra-226 for the years 1980 to 1998 with data for Ra-228, Th-230, and Th-232 added since 1992. Inorganic chemical surface water data is available starting with samples collected in 1992 and is presented in Tables 5-4 through 5-7.

Chemical

Inorganic and organic chemicals have been periodically tested for in surface water since 1992. Environmental reports have compared analytical results to historic comparison criteria to identify potential impacts from MSP. The conclusions from these reports are summarized as follows:

1992 Pesticides, PCBs, VOCs or SVOCs are not reported above the detection limits. No significant differences in total organic compounds or total organic halides between upstream and downstream locations. No metals have been detected above New Jersey surface water quality criteria in effect at that time.

1996 Arsenic and lead were detected downstream at concentrations greater than historic comparison criterion. Maximum concentrations of each were detected at the outfall sample location (Location 1). (Note the arsenic regulatory standard was lower than the achievable detection limit, thus, any detection exceeds the limits).

1997 Arsenic concentrations, ranging from 0.075 to 2.2 μg/L, exceeded historic comparison criterion at all locations. Lead was detected downstream at Location 3 at concentrations greater than a surface water quality criterion of 5 μg/L . This location receives runoff from numerous off-site roads and commercial properties, which may contribute to the elevated lead levels.

1998 Arsenic concentrations exceeded the historic comparison criterion of 0.02 μg/L. The lead concentration at Location 1 was 3.1 μg/L for the July 1998 sample, the highest of the four sampled locations, which is below the water quality criterion of 5 μg/L in effect at that time.

A comparison of inorganic concentrations at Locations 1, 3 and 6 to Location 4 (background location) is shown in Table 5-5. Maximum and minimum concentrations are listed along with the location of the maximum detected concentration. As indicated, several analytes exceeded background concentrations measured at Location 4. Several analytes also had a low frequency of detection (e.g., beryllium, cadmium).

Radionuclides

The historic and current presence of radionuclides in surface water in the South Drainage Ditch and Main Stream is likely the result of site operations at MSP. Table 5-6 provides average annual surface water activity levels for isotopic uranium and Ra-226 for the years 1980 to 1998. Average annual concentrations for isotopic uranium at the outfall location (Location 1) range from a maximum of 134 pCi/L in 1980 to a minimum of 34 pCi/L in 1989. The average concentration at the background location (Location 4) was 0.13 pCi/L for the 1998 samples.

Average concentrations for Location 1 were erratic, with an overall decline during the mid- to late-1980s. For the years 1991 to 1993, average uranium concentrations at this location have shown a gradual increase from 39 to 82 pCi/L. A concentration decline at Location 1 was measured following the outfall remediation (32.6 pCi/L for October 1996) versus a sample earlier in the year prior to remediation (73.4 pCi/L in April). Since the remediation, average isotopic uranium concentrations measured in surface water at Location 1 increased from slightly above post-remediation levels (33.1 pCi/L in June 1997) to substantially higher (115 pCi/L in October 1998). This increase may have been affected by 1998 pile removal actions at the site.

Average Ra-226 concentrations measured at Location 1 between 1980 and 1998 in surface water were slightly above average background concentrations (Table 5-6). Initial measurements taken in 1980 (17.6 pCi/L) and monitoring data obtained in 1992 (26.9 pCi/L) represent the highest average concentrations. However, the concentration of Ra-226 measured at sampling Location 1 in 1993 was an order of magnitude lower (2.7 pCi/L) than the 1992 levels. Thus, the 1992 data may be anomalous.

Average concentrations of Ra-228, Th-230, and Th-232 for the years 1990 to 1998 are listed in Table 5-7, with no data available for several years during this period. Average values Ra-228 changes dramatically, even at the background location. For the 1998 samples, Ra-228 concentrations at Location 6 are the highest of all locations, suggesting the concentration may be a variation of natural levels versus contributions from MSP. As listed in this table, average Th-232 concentrations, for Locations 1, 6 and 3 are within the range of average background concentrations.

In summary, the prior sampling of surface water from 1990 through 1998 indicated that a few inorganic constituents were present at elevated concentrations, probably due to the fact that MSP soils have been paved over. Arsenic and lead exceeded criteria in earlier sampling events, yet lead concentrations appear to have declined in latter years. Isotopic uranium levels were consistently elevated in surface water at the plant outfall, with elevated levels also detected downstream of the site. Other radionuclides (Ra-226, Th-230, Ra-228, and Th-232) were detected with only sporadic instances of elevated measurements at all locations except the site outfall (Location 1). The elevated levels of radionuclides in surface water is likely due to contact with site soils and the possible contribution of contaminated shallow overburden groundwater to stream flow.

Sediment sampling in the South Drainage Ditch and Main Stream commenced in 1981 during remedial action activities. Stream sediment samples were collected monthly at the Main Stream (Location 3) and plant outfall (Location 1) water sample locations during 1981 and analyzed for isotopic uranium and Ra-226. Over the course of monitoring activities, sampling locations were expanded to include three more sampling locations (Locations 2, 4 and 5), and the analyte list grew to include Ra-228, Th-230, and Th-232. Quarterly sediment sampling is currently part of the Environmental Surveillance program.

In 1998 sediment sampling and analysis results displayed slightly elevated concentrations of metals in two locations; SWSD004 (background) and SWSD006. The metals detected included cadmium, beryllium and arsenic.

5.2 NATURE AND EXTENT OF SHALLOW GROUNDWATER CONTAMINATION

The Groundwater OU RI was implemented to characterize the nature and extent of potential groundwater contamination at the site. In addition to collecting groundwater monitoring data, surface water and sediment samples were also obtained to investigate mechanisms for contaminant transport. Groundwater samples were collected from 24 overburden groundwater monitoring wells. Of these wells, seven are part of the environmental surveillance network and 17 wells are part of the groundwater RI monitoring well network. The overburden background groundwater monitoring well, URSMW20S is included as part of the 17 wells in the groundwater RI network. In addition to these overburden groundwater monitoring wells, groundwater from seven bedrock monitoring wells was also sampled and analyzed. Analytical results from bedrock monitoring wells are discussed in the section 5.3 - Nature and Extent of Bedrock Groundwater Contamination.

5.2.1 Volatile Organic Compounds

Groundwater from 24 MSP monitoring wells completed in the overburden water-bearing zone has been sampled and tested for VOCs. A discussion of the occurrences and distribution of VOCs is provided in this section. Figure 5-1 shows the locations, types and concentrations of VOCs detected in MSP overburden groundwater.

5.2.1.1 Overburden Groundwater

Groundwater samples from seven overburden environmental surveillance wells were collected quarterly (i.e., Q1, Q2, Q3, & Q4) and analyzed for VOCs between calendar year (CY) 2000 and CY 2002. Two rounds of groundwater samples were collected and analyzed for VOCs in May 2001 and January 2002 from 16 overburden RI wells. VOC analytical results from these sampling events are summarized in Tables 5-8 through 5-10.

Site Overburden Analytical Data

CY 2000

During CY 2000 three environmental surveillance events were conducted. As part of these events, groundwater samples were collected from seven ES network wells. Analytical results from these sampling events indicated that methylene chloride and carbon disulfide, two common laboratory reagents, were found in low concentrations (<5 μg/L) in trip blanks and rinsate blanks. Therefore, the presence of these compounds in analytical results from groundwater samples can be attributed to laboratory analytical procedures. Chlorobenzene was found in the groundwater samples collected from B18W27S at concentrations of 3.54 μg/L, 0.7 μg/L and Non Detect (ND) during the Q2 2000, Q3 2000 and Q4 2000 ES sampling events, respectively. These concentrations are below groundwater quality comparison criteria. In addition, acetone was found at concentrations of 3.44 µg/L and 5.27µg/L (duplicate sample) in groundwater from B18W30S during Q4 2000. Both of these results were below the comparison criterion of 700 µg/L.

CY 2001

During CY 2001 four environmental surveillance events and two groundwater RI sampling events were conducted. Groundwater samples were collected from seven ES wells and 17 overburden RI network wells.

MTBE was the only VOC detected above the comparison criteria. Other VOCs detected in CY 2001 included cis-1,2-dichloroethene, 1,1-dichloroethane, 1,3-dichlorobenzene, 1,4-dichlorobenzene, chlorobenzene, chloromethane, carbon disulfide, di-isopropyl-ether (DIPE), tert-butyl alcohol (TBA) and toluene.

MTBE was detected in groundwater samples from B18W25S, B18W26S, B18W27S, B18W28S, B18W28SR, B18W29S, B18W29SR, URSMW4S, URSMW5S, URSMW6S, URSMW7SR, URSMW10S, URSMW11S, URSMW12S, URSMW14S, and URSHP1. The highest concentration of MTBE detected during CY 2001 was found in the groundwater sample from on March 21, 2001. The reported concentration is 951 µg/L. MTBE was also detected above the comparison criterion in a groundwater sample collected from B18W28S. The reported concentration at B18W28S was 74.6 µg/L. No other exceedances of MTBE were detected in groundwater samples collected from other overburden groundwater monitoring wells during CY 2001. The comparison criterion for MTBE is 70 µg/L.

Cis-1,2-dichloroethene was detected in groundwater from URSMW4S at a concentration of 1.23 µg/L during the first round RI sampling event. 1,1-dichloroethane was found in a groundwater sample from URSMW4S at a concentration of 1.35 µg/L. DIPE was detected in a groundwater sample from B18W27S on December 13, 2001 at a concentration of 1.15 µg/L. No other concentrations of DIPE were observed in overburden groundwater samples during CY 2001. During CY 2001, TBA was present in groundwater samples collected from B18W27S, URSMW4S, URSMW6S and URSMW10S. The highest concentration of TBA detected at the site during CY 2001 was in a sample from B18W27S on May 30, 2001 with a concentration of 3,170 µg/L (J qualifier). The next highest concentration detected was from the same monitoring well on October 4, 2001 at a concentration of 2,380 µg/L (J qualifier).

Chlorobenzene was observed in groundwater samples collected from B18W28S, B18W28SR and B18W27S, at concentrations ranging from 1.02 µg/L to 1.11 µg/L. Both of these results were below the comparison criterion of 50 µg/L. Chloromethane was detected in a groundwater sample collected from URSHP1 at a concentration of 1.68 µg/L. Carbon disulfide was detected in groundwater samples collected from URSMW13S, URSMW14S and

URSMW16S at concentrations ranging from 1.16 µg/L to 1.69 µg/L during the first round of RI groundwater sampling. Carbon disulfide was not detected in groundwater samples collected as part of Round-2 and ES sampling events. 1,3-dichlorobenzene and 1,4-dichlorobenzene were present in a groundwater sample collected from B18W28S at concentrations of 0.7 µg/L and 0.8 µg/L, respectively. Toluene was detected in one groundwater sample collected from URSMW16S on July 5, 2001. The concentration of toluene in the sample was 1.69 µg/L. No other VOCs were detected in the overburden groundwater samples collected during CY 2001.

CY 2002

Groundwater samples were collected from two ES events during CY 2002. These were Q1 and Q3 ES events. Analytical results from these sampling efforts indicated that 1,2-dichlorobenzene, 1,3-dichlorobenzene, bromomethane, chloromethane, DIPE, MTBE and TBA were found in the groundwater samples collected. MTBE was the only compound that exceeded the groundwater quality comparison criterion at a concentration of 130 µg/L. this compound was reported in a groundwater sample collected from B18W27S during Q2 2002. The next highest concentration of MTBE detected during these sampling events was 6.4 µg/L, which is below the comparison criterion of 70 µg/L.

5.2.1.2 <u>Off-Site Overburden Groundwater</u>

One offsite groundwater monitoring well URSMW20S was sampled as part of the groundwater RI. Two rounds of groundwater samples were collected from this well. No exceedances of the comparison criteria were detected in the samples collected from this background groundwater monitoring well.

5.2.1.3 <u>Summary of VOC Analytical Data – Overburden</u>

VOC analysis of groundwater samples collected as part of this RI and during the course of the environmental surveillance program from 2000 through 2002 indicated that concentrations of MTBE exceeded the comparison criterion. Other VOCs detected in groundwater samples from environmental surveillance monitoring wells are chlorobenzene, acetone, carbon disulfide and chloromethane. In the samples collected from the Pipe Chase overburden wells, no VOCs were detected that exceeded comparison criteria. However, cis-1,2-dichloroethene, 1,1-dichloroethane, MTBE and TBA were present. In the groundwater samples collected from the South Drainage Ditch, methylene chloride and acetone were detected. Both methylene chloride and acetone detected in the South Drainage Ditch groundwater samples are likely to be laboratory artifacts.

5.2.2 Semivolatile Organic Compounds

Groundwater from 24 MSP monitoring wells completed in the overburden water-bearing zone has been sampled and tested for SVOCs. A discussion of the occurrences and distribution of SVOCs is provided in this section. Figure 5-2 shows the locations, types and concentrations of SVOCs detected in MSP groundwater.

5.2.2.1 On-Site Overburden Groundwater

Groundwater samples from 24 overburden groundwater monitoring wells at MSP were collected and analyzed for SVOCs between CY 2000 and CY 2002. Overburden groundwater SVOC analytical results are summarized in Tables 5-11 through 5-13.

CY 2000

Groundwater samples were collected from the ES network wells during three quarterly sampling events (Q2, Q3 and Q4). No SVOCs were detected in the groundwater from sampled wells with the exception of bis(2-ethylhexyl)phthalate and 1,2,4-trichlorobenzene. Bis(2-ethylhexyl)phthalate was detected in groundwater from B18W25S (Q2-2000), B18W25S (Q4, 2000) and B18W26S (Q4-2000) at concentrations of 5 μg/L, 15 μg/L and 29 μg/L, respectively. 1,2,4-trichlorobenzene was detected in groundwater from B18W28S Q4-2000 at a concentration of 6 μg/L. The comparison criteria for bis(2-ethylhexyl)phthalate and 1,2,4-trichlorobenzene are 6 μg/L and 9 μg/L, respectively.

CY 2001

During CY 2001, groundwater samples were collected from on-site groundwater monitoring wells during four ES events and two groundwater RI sampling events. Analytical results from the groundwater sampling events indicate that a few SVOCs were detected in groundwater samples. The SVOCs detected in site groundwater samples are 1,2,4-trichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, di-n-butyl phthalate, di-n-octyl phthalate, diethyl phthalate, diene, bis(2-ethylhexyl)phthalate, methylphenol and phenol. Of these detected compounds 1,2,4-trichlorobenzene and bis(2-ethylhexyl)phthalate were reported at concentrations above the comparison criteria of 9 μg/L and 6 μg/L, respectively. 1,2,4-trichlorobenzene was found at a concentration exceeding the comparison criteria in a groundwater sample collected from B18W28S on March 20, 2001. Bis(2-ethylhexyl)phthalate was present at a concentration exceeding the comparison criterion in numerous groundwater samples. However, no specific pattern in the distribution of this compound has been identified. In addition, bis(2-ethylhexyl)phthalate is a common laboratory contaminant and is not considered to be a site related compound. Further justification for not considering bis(2-ethylhexyl)phthalate as a site related compound will be presented in the human health risk assessment section.

CY 2002

Two quarterly (Q1 and Q3) rounds of groundwater samples were collected from the ES network wells during CY 2002. SVOCs were detected in groundwater samples collected from B18W28SR and B18W30S. The SVOCs detected in the groundwater from these monitoring wells are di-n-butyl phthalate and bis(2-ethylhexyl)phthalate. The concentration of bis(2-ethylhexyl)phthalate in B18W28SR and B18W30S was 270 μg/L (J qualifier) and 13 μg/L, respectively. Though di-n-butyl phthalate was detected at the site, the concentrations of this compound did not exceed the comparison criterion during CY 2002 sampling events. Both of the above-mentioned concentrations are above the comparison criterion of 6 μg/L. No other SVOCs were detected in groundwater samples taken during CY 2002.

5.2.2.2 Off-Site Overburden Groundwater

CY 2000-2002

Groundwater samples from one off site environmental surveillance well (B18W30S) were analyzed for SVOCs between CY 2000 and CY 2002. Bis(2-ethylhexyl)phthalate was found in groundwater samples collected from B18W30S at 10 μg/L during Q1 2001 and 13 μg/L during Q2 2002. Both of these concentrations exceed the comparison criterion.

5.2.2.3 Summary of SVOC Analytical Data - On-site Overburden

SVOC analysis of groundwater samples collected as part of the Environmental Surveillance program from 2000 through 2002 indicated that concentrations of bis(2-ethylhexyl)phthalate exceeded the comparison criterion in B18W25S, B18W26S, B18W27S, B18W28SR and B18W29SR. The highest concentration of bis(2-ethylhexyl)phthalate detected in the Environmental Surveillance wells during this period was 270 μg/L (X qualifier). It should be noted that bis(2-ethylhexyl)phthalate has a low potential to migrate to groundwater due to its high organic carbon partition coefficient (K_{oc} = 10,000 - 100,000). In addition, bis(2-ethylhexyl)phthalate is detected sporadically in numerous groundwater samples during both groundwater sampling rounds conducted as part of the Groundwater OU RI. However, the concentration of bis(2-ethylhexyl)phthalate exceeded the applicable regulatory criteria in only one Groundwater OU RI well during the April 2002 groundwater sampling event. Bis(2-ethylhexyl)phthalate is a common laboratory contaminant and therefore is not considered a site related contaminant and is not considered in the risk assessment for MSP. The other SVOC that exceeded comparison criterion is 1,2,4-trichlorobenzene. No other SVOCs exceeded comparison criteria in ES groundwater samples. SVOCs did not exceed comparison criteria in groundwater samples collected during the Groundwater RI. In the samples collected from the Pipe Chase overburden wells, no SVOCs were detected above the laboratory's method detection limit. In the groundwater samples collected from the South

Drainage Ditch overburden wells, bis(2-ethylhexyl)phthalate exceeded the comparison criterion.

5.2.2.4 Summary of SVOC Analytical Data - Off-site Overburden

SVOC analysis of a groundwater sample collected during April 2002 from the background groundwater monitoring well URSMW20S, contained 49 µg/L and 3.4 µg/L (J qualified) of bis(2-ethylhexyl)phthalate and phenol, respectively. The concentration of bis(2-ethylhexyl)phthalate exceeded the applicable regulatory criteria of 6 µg/L. No other SVOCs were detected in this sample.

5.2.3 Metals

Groundwater from 24 MSP monitoring wells completed in the overburden water-bearing zone has been sampled and tested for TCL metals. A discussion of the occurrences and distribution of metals is provided in this section. Figure 5-3 shows the locations, types and concentrations of metals found in MSP groundwater.

5.2.3.1 Overburden Groundwater Metals Data

Groundwater samples from 24 wells were analyzed for metals between CY 2000 and CY 2002. Two rounds of groundwater samples, one in May 2001 and one in January 2002 from overburden RI wells, were analyzed for TCL metals. In addition, nine quarterly ES sampling events were conducted during CY 2000 (3 events), CY 2001 (4 events) and CY 2002 (2 events). Overburden groundwater analytical results for metals are summarized in Tables 5-14 through 5-16.

CY 2000

Manganese concentrations in groundwater from five out of the seven overburden wells sampled (B18W25S, B18W26S, B18W27S, B18W29S and B18W30S) during Q2 2000 sampling exceeded the comparison criterion. Iron in groundwater from three of these same wells (B18W26S, B18W29S and B18W30S) also exceeded the comparison criterion. During Q3 2000, manganese and iron concentrations in groundwater from all seven wells sampled (except for B18W24S) exceeded comparison criteria. Similarly, four out of seven groundwater samples collected during the Q4 2000 event contained manganese and iron concentrations above comparison criteria. However, these metals are common, naturally occurring constituents of soil and groundwater and are probably not directly related to previous site activities.

Chromium was detected at 702 µg/L in groundwater samples collected from monitoring well B18W29S, which exceeded the comparison criterion of 100 µg/L. This represents a significant increase over the 1999 value of 169 μg/L for the groundwater from the same well. Similarly, during the Q3 2000 monitoring event, chromium concentrations reported from wells B18W29S and B18W28S exceeded the comparison criterion of 100 μg/L with values of 1,110 and 194 μg/L, respectively. However, the concentration of chromium decreased from 1,110 and 194 μg/L to 141 μg/L and ND in groundwater from monitoring wells B18W29S and B18W28S, respectively, during the Q4 monitoring event. Historic groundwater analytical results were evaluated to establish a specific trend in chromium concentrations. Groundwater samples collected from B18W24S (two exceedances, December 1998 and October 1998) and B18W29S (two exceedances, June 1997 and December 1998) were observed. It should be noted that groundwater samples collected from B18W28S (Q3 and Q4) and B18W29S (Q2 and Q4) were turbid. Therefore, the concentrations in metals detected in samples collected from these monitoring wells are influenced by high turbidity in groundwater (greater than 50 NTUs). Specific temporal or spatial trends in chromium groundwater concentration were not evident. The pH of groundwater samples collected during CY 2000 ranged between 6.18 and 7.34 standard units. This indicates that pH was generally within a neutral range and would not have influenced concentration of metals in groundwater.

CY 2001

During CY 2001 Aluminum concentrations exceeded the comparison criterion of 200 μg/L at 15 groundwater sampling locations. These locations are B18W24S, B18W25S, B18W27S, B18W28S, B18W29S, B18W30S, URSHP1, URSHP2, URSMW13S, URSMW15S, URSMW17S, URSMW18S, URSMW1S, URSMW5S and URSMW6S. The groundwater sample collected from URSMW18S on January 4, 2002 contained the highest concentration (77,700 μg/L) of aluminum detected at the site. Other high concentrations of aluminum detected at the site were from samples of groundwater collected from B18W28S (13,600 μg/L) on March 20, 2001, B18W25S (8,200 μg/L) on March 22, 2001, URSHP1 (3,000 μg/L) on April 20, 2001, B18W29S (2,690 μg/L) on March 20, 2001 and URSMW6S (1,730 μg/L) on May 16, 2001. The remaining exceedances of aluminum were below 1,000 μg/L. Aluminum is a naturally occurring metal in soil and groundwater and its presence is not related to documented historic activities at the site.

One concentration of antimony above the comparison criterion was detected during CY 2001. This groundwater sample was collected from B18W29S on March 20, 2001. The concentration of antimony was 6.9 μg/L with the comparison criterion being 6 μg/L.

One concentration of arsenic above the comparison criterion was reported. This groundwater sample was collected from URSMW18S on January 4, 2002. The concentration of was 11.9 μg/L with the comparison criterion being 8 μg/L.

Groundwater samples collected from three monitoring wells during CY 2001 contained chromium concentrations greater than the comparison criterion of 100 μg/L. These monitoring wells are B18W28S, B18W29S, and URSMW18S. The highest concentration of chromium detected at the site is 2,190 μg/L.

Iron exceeded the comparison criterion in 20 of the 26 sample locations (24 overburden groundwater monitoring wells and two Hydropunch locations). The highest concentration of iron detected at the site was 103,000 μg/L at URSMW18S in the groundwater sample collected on January 4, 2002. Other groundwater samples that contained high concentrations of iron were collected from B18W28S (23,200 μg/L) and B18W29S (13,800 μg/L). The comparison criterion for iron is 300 μg/L. Iron is a naturally occurring metal in soil and groundwater and its presence is not related to documented historic activities at the site.

Lead exceeded the comparison criterion in two of the 26 sample locations (24 overburden groundwater monitoring wells and two Hydropunch locations). The groundwater samples collected from URSMW18S on January 4, 2002 and B18W28S on March 20, 2001 contained concentrations of lead at 77.5 μg/L and 22.8 μg/L, respectively. The comparison criterion for lead is 10 μg/L.

Manganese exceeded the comparison criterion in 23 of the 26 sample locations (24 overburden groundwater monitoring wells and two Hydropunch locations). The highest concentration of manganese detected at the site was 7,240 μg/L at URSMW2S in the groundwater sample collected on May 15, 2001. The comparison criterion for manganese is 50 μg/L. Manganese is a naturally occurring metal in soil and groundwater and its presence is not related to documented historic activities at the site.

Nickel exceeded the comparison criterion in two of the 26 sample locations (24 overburden groundwater monitoring wells and two Hydropunch locations). The groundwater samples collected from URSMW18S on January 4, 2002 and B18W29S on March 20, 2001 and June 5, 2001 contained concentrations of nickel at 193 μg/L, 291 μg/L and 502 μg/L, respectively. The comparison criterion for nickel is 100 μg/L.

Sodium exceeded the comparison criterion in four of the 26 sample locations (24 overburden groundwater monitoring wells and two Hydropunch locations). The groundwater samples collected from B18W29S (and B18W29SR, replacement well for B18W29S), URSMW2S, URSMW8S and URSMW15S exceeded the comparison criterion. The highest concentration of sodium detected at the site is 76,400 μg/L at URSMW15S in the groundwater sample collected on July 11, 2001. The comparison criterion for sodium is 50,000 μg/L.

It should be noted that groundwater samples collected from B18W24S (Q1), B18W25S (Q1), B18W27S (Q1), B18W28S (Q1), B18W29S (Q1), B18W30S (Q1), URSMW13S (Round 1a), URSMW14S (Round 1a), URSMW16S (Round 1a), URSMW17S (Round 1a), and URSMW18S (Round 1 and 2) contained high turbidity. Therefore, exceedances of metals concentrations on groundwater from these monitoring wells can be attributed to high turbidity (greater than 50 NTUs). No other metal concentrations in groundwater samples collected at the site during CY 2001 exceeded their respective comparison criteria. The pH of groundwater samples collected during CY 2001 ranged between 5.12 and 8.66 standard units with the exception of URSMW6S, which had a pH of 10.46 standard units. This indicates that with the exception of URSMW6S, pH was generally within a neutral range and would not have influenced concentration of metals in groundwater. The groundwater sample collected from URSMW6S contained aluminum at a concentration greater than the applicable regulatory criteria. Since, total aluminum was measured in the sample, concentration changes due to pH variation are negligable. No other analytes were detected in URSMW6S above the applicable regulatory criteria.

CY 2002

Manganese concentrations in groundwater exceeding the 50 μg/L comparison criterion were detected in the groundwater sample from B18W25S during Q1 and Q3 2002. Exceedances were also noted in groundwater from B18W26S and B18W27S during Q2 2002.

Iron was found in many groundwater samples at concentrations exceeding the comparison criterion of 300 μg/L. However, this metal is a common, naturally occurring constituent of soil and groundwater and its presence is probably not related to previous site activities.

The turbidity and pH of the samples that contained analytes at concentrations above the regulatory criteria were within the normal turbidity and pH range. Therefore, influences of turbidity and pH on concentration of analytes are not expected.

5.2.3.2 <u>Off-Site Overburden Groundwater</u>

Samples collected from offsite monitoring well URSMW20S were analyzed for metals during CY 2001. Manganese and thallium were detected above the comparison criteria in the sample collected from URSMW20S. No other exceedances of metals were detected in groundwater from this monitoring well.

5.2.3.3 <u>Summary of Metals Analytical Data - Overburden</u>

Analytical testing of groundwater samples indicated that concentrations of several metals exceeded applicable comparison criteria. These included: aluminum, arsenic, chromium, iron, lead, manganese, nickel and sodium. Of these exceedances, aluminum, iron, manganese, and sodium are commonly occurring metals, and their presence may not be related to site activities. The other metals detected (arsenic, chromium, lead and nickel) were found in the southern portions of the site, beyond the VP Pile. Exceedances of these metals were reported in groundwater samples from B18W28SR, B18W28S, B18W29SR, B18W29S, B18W30S and URSMW18S. Of these wells, B18W28SR, B18W28S, B18W29SR and B18W29S are adjacent to the VP Pile within MSP boundaries and B18W30S and URSMW18S are along the South Drainage Ditch. The highest concentrations of the metals detected are 77,700 μg/L of aluminum in groundwater from URSMW18S; 11.9 μg/L of arsenic in groundwater from URSMW18S; 2,190 μg/L of chromium in groundwater from B18W29S, 103,000 μg/L of iron in groundwater from URSMW18S, 77.5 μg/L of lead in groundwater from URSMW18S; 7,240 μg/L of manganese in groundwater from URSMW2S; 479 μg/L of nickel in groundwater from B18W29S; and 55,400 μg/L of sodium in groundwater from B18W29S. The groundwater sample collected from URSMW18S contained the highest number of total metal exceedances when compared with other MSP groundwater samples.

5.2.4 Radionuclides

Between CY 2000 and CY 2002, groundwater samples from 24 monitoring wells were collected and analyzed for radionuclides. The location of these wells are depicted in Figure 4-1. Testing included gross alpha, gross beta, gamma emitters, isotopic thorium, isotopic uranium, total uranium, and radium. NJDEP and EPA comparison criteria have been used to evaluate reported radionuclide concentrations. Analytical results are summarized in Tables 5-17 through 5-19. Net alpha concentrations were compared with the SDWA MCL of 15 pCi/L after subtraction of the isotopic concentrations of U-234 and U-238. Figure 5-4 shows the locations, types and concentrations of radionuclides found in MSP groundwater.

5.2.4.1 On-Site Overburden Groundwater

Groundwater samples for analysis of radioactive constituents were collected from six overburden environmental surveillance monitoring wells between CY 2000 and CY 2001. Two rounds of groundwater samples were collected between May 2001 and January 2002 from six RI overburden wells.

CY 2000

Concentrations of radium (sum of Ra-226 and Ra-228) were detected above the 5 pCi/L comparison criterion in groundwater samples from B18W24S and B18W28S during the Q3 2000 ES sampling event. Total uranium concentrations in groundwater samples collected from monitoring wells B18W24S and B18W25S exceeded the comparison criterion of 30 μg/L during the three CY 2000 ES sampling events (Q2, Q3, and Q4). The groundwater sample collected from B18W28S during Q3 2000 contained a total uranium concentration of 27.6 μg/L, which is slightly below the comparison criterion of 30 μg/L. A net alpha concentration of 24.24 pCi/L was reported in the groundwater sample collected from B18W28S during Q3 ES sampling. This concentration exceeded the comparison criterion of 15 pCi/L for net alpha. Net alpha has been reported after subtracting uranium from gross alpha results.

None of the reported radionuclide concentrations exceeded the comparison criteria in groundwater samples collected from B18W26S, B18W27S and B18W29S during the three CY 2000 quarterly sampling events. The highest concentrations of net alpha, radium and uranium detected in the samples collected during 2000 were 24.237 pCi/L, 11.39 pCi/L and 554 +/- 17.7 μg/L, respectively.

CY 2001

Following the subtraction of the isotopic concentrations of U-234, U-235, and U-238, net alpha concentrations exceeding the comparison criterion of 15 pCi/L were detected in groundwater samples collected from monitoring wells B18W24S at 19.13 pCi/L on March 23, 2001 and at 52.95 pCi/L on December 12, 2001, B18W25S at 15.11 pCi/L on November 2, 2001, B18W28SR at 15.14 pCi/L on October 5, 2001, and at 15.2 pCi/L on December 14, 2001, URSHP2 at 68.52 pCi/L on April 23, 2001 and URSMW18S at 82.22 pCi/L on January 4, 2002. It should be noted that the groundwater sample collected from B18W25S (15.11 pCi/L) during Q3 exceeded the comparison criterion, however, the duplicate groundwater sample (8.77 pCi/L) collected from the same well during Q3 did not.

Activity of radium (sum of activity of Ra-226 and Ra-228) in groundwater exceeded the 5 pCi/L comparison criterion in samples collected from URSMW10S on May 15, 2001 with an activity of 7.16 pCi/L, URSMW4S on May 15, 2001 and January 2, 2002 at activities of 9.46 and 5.047 pCi/L, respectively. Groundwater samples collected from the overburden monitoring wells at MSP during CY 2001 did not exceed radium comparison criteria.

Total uranium concentrations in groundwater samples collected from monitoring wells B18W24S, B18W25S, B18W28SR, URSMW2S, URSMW10S and URSHP2 exceeded the comparison criterion of 30 μg/L. This occurred during sampling events conducted in CY 2001. The highest concentration of total uranium in groundwater at MSP during CY 2001 was observed in the sample collected from B18W24S on May 25, 2001. This sample contained uranium at a concentration of 761 +/- 168 μg/L.

No other isotopes were found in excess of comparison criteria.

CY 2002

Net alpha concentrations in groundwater were evaluated against a comparison criterion of 15 pCi/L, after the subtraction of the isotopic concentrations of U-234, U-235, and U-238. Net alpha concentrations exceeding the comparison criterion of 15 pCi/L were found in groundwater samples from monitoring wells B18W24S, B18W25S and B18W28SR. In B18W24S, exceedances of the comparison criterion were detected in groundwater samples at 24.97 pCi/L during Q1 2002 and at 68.8 pCi/L during Q3 2002; in B18W25S at 31.66 pCi/L during Q3 2002 and in B18W28SR at 15.89 pCi/L during Q3 2002.

Concentrations of Ra-226 and Ra-228 in groundwater were not reported above the 5 pCi/L comparison criterion in the wells sampled during 2002.

Total uranium concentrations in groundwater samples collected from monitoring well B18W24S, B18W25S and B18W28SR exceeded the comparison criterion of 30 μg/L during both of the 2002 sampling events. However, the concentration of total uranium in groundwater detected at B18W28SR during Q1 2002 was 29.4 μg/L, which is slightly below the 30 μg/L comparison criterion considering the positive error of quantification.

The highest concentrations of net alpha, radium and uranium detected in groundwater samples collected during CY 2002 were 68.8 pCi/L, 1.70 pCi/L and 396 +/- 52.4 μg/L, respectively. Concentrations of radionuclides in groundwater from monitoring wells and at HydroPunch® locations sampled as part of the groundwater RI were below comparison criteria with the exception of URSHP2 and URSMW18S. Net alpha was above the comparison criterion in groundwater samples from both locations, and uranium was above the comparison criterion in the groundwater sample from URSHP2. The highest concentration of net alpha detected was 82.22 pCi/L, and the only exceedance of uranium was 200 +/- 22.2 μg/L. Groundwater samples collected from the Hydropunch® well points were turbid (greater than monitoring well samples), therefore, suspended solids contained in the Hydropunch® samples have likely contributed to the elevated net alpha and uranium values.

No other isotopes were found to exceed the comparison criteria.

5.2.4.2 <u>Off-Site Overburden Groundwater</u>

Groundwater samples collected from URSMW20S, the offsite groundwater monitoring well did not contain radionuclides above comparison criteria.

5.2.4.3 <u>Summary of Radionuclide Analytical Data - Overburden</u>

Concentrations of radionuclides in groundwater samples collected as part of the environmental surveillance program from CY 2000 through CY 2002 had total uranium and net alpha concentrations above comparison criteria. Radium concentrations were detected above comparison criterion only in groundwater samples collected during the 2000 ES sampling. No other radionuclides were detected above comparison criterion in ES groundwater samples. Radium concentrations were reported above comparison criteria in groundwater samples taken during the May 2001 groundwater RI sampling event. No other radionuclides were detected above comparison criteria. None of the groundwater samples collected from wells in the pipe chase backfill contained radionuclide concentrations in excess of comparison criteria. Net alpha and uranium concentrations were found above comparison criteria in the groundwater samples collected from the South Drainage Ditch during the groundwater RI. No other radionuclides were detected above comparison criteria in samples collected during the groundwater RI.

5.3 NATURE AND EXTENT OF BEDROCK GROUNDWATER CONTAMINATION

Groundwater samples were collected from six bedrock wells at MSP. Five of the six wells are on site and one is an offsite, background well (URSMW20D). Groundwater samples collected from these wells were analyzed for VOCs, SVOCs, radionuclides and metals. Summaries of analytical data are presented in Tables 5-20 through 5-23 and results are discussed below. Bedrock well locations are shown on Figure 4-1.

5.3.1 Volatile Organic Compounds

Analytical results indicate that groundwater samples collected from bedrock monitoring wells, with the exception of URSMW2D and URSMW3D, contained concentrations of VOCs below comparison criteria. Groundwater samples collected from bedrock monitoring wells contained carbon tetrachloride, chloroform, MTBE and TCE at concentrations above comparison criteria. At URSMW2D, concentrations of carbon tetrachloride and chloroform exceeded the comparison criteria in the samples collected in May and December 2001. TCE exceeded comparison criterion in the samples collected from monitoring well URSMW2D on December 20, 2001. The concentration of TCE detected in this sample was 35.7 µg/L and the comparison criterion for TCE is 1.0 µg/L. No other exceedances of TCE in groundwater were reported in samples collected from MSP bedrock monitoring wells. The highest concentration of carbon tetrachloride and chloroform detected in the bedrock groundwater samples was 46.2 and 22.4 µg/L, respectively. At URSMW9D and URSMW3D, concentrations of MTBE were greater than the comparison criterion in samples collected in May and December 2001 at concentrations of 586 µg/L, 185 µg/L, 213 µg/L and 227 µg/L, respectively. These results were greater than the MTBE comparison criterion of 70 µg/L. These analytical results are summarized in Table 5-20. Figure 5-1 displays the locations, types and concentrations of VOCs found in groundwater samples collected from bedrock monitoring wells.

5.3.2 Semivolatile Organic Compounds

Groundwater samples collected from the bedrock monitoring wells, with the exception of URSMW20D, contained concentrations of SVOCs below comparison criteria. At URSMW20D, the concentration of bis(2-ethylhexyl)phthalate exceeded the comparison criterion of 6 μg/L. The 6 μg/L standard is listed under di(2-ethylhexyl)phthalate, which is the same compound as bis(2-ethylhexyl)phthalate. The samples collected from URSMW20D (background well) contained 68.9 μg/L and 11 μg/L of bis(2-ethylhexyl)phthalate during the January 4, 2002 and October 3, 2002 sampling events. The other SVOCs detected in groundwater from bedrock monitoring wells are di-n-octyl phthalate and diethyl phthalate. No other SVOCs were detected in groundwater from these wells at the site. Analytical results are summarized in Table 5-21. Figure 5-2 shows the locations, types and concentrations of SVOCs detected in the groundwater samples collected from bedrock monitoring wells.

5.3.3 Metals

Analytical results of bedrock groundwater samples indicate that concentrations of iron and manganese exceeded the comparison criteria of 300 μg/L and 50 μg/L, respectively. Exceedances of iron were detected in groundwater from all six bedrock monitoring wells and exceedances of manganese were detected in groundwater from four of the six monitoring wells. No other metals concentrations in groundwater were greater than comparison criteria. Concentrations of manganese in groundwater samples exceeded the comparison criterion at URSMW2D, URSMW3D, URSMW5D and URSMW9D. The highest concentration of iron and manganese detected in onsite groundwater was 4,620 μg/L in URSMW5D and 886 μg/L in URSMW9D, respectively.

Exceedances of both iron and manganese were detected in samples from the background bedrock groundwater monitoring well URSMW20D. The concentration of iron and manganese detected in the bedrock groundwater monitoring well samples are 14,500 and 1,530 μg/L, respectively. These concentrations are greater than the highest concentrations of iron and manganese detected in onsite bedrock groundwater monitoring wells. As indicated in earlier, aluminum, iron and manganese are commonly occurring metals naturally present in the soil, bedrock and groundwater in the formation at MSP. They are not considered site related compounds. Turbidity, pH and temperature of all the groundwater samples collected from bedrock groundwater monitoring wells were within the normal range indicating that analytical results are not influenced by the physiochemical properties of groundwater samples.

Analytical results are summarized in Table 5-22. Figure 5-3 shows the locations, types and concentrations of metals found in samples collected from bedrock groundwater monitoring wells.

5.3.4 Radionuclides

Samples were analyzed for gross alpha, gross beta, gamma emitters, isotopic thorium, isotopic uranium and total uranium. NJDEP and EPA comparison criteria have been used to evaluate detected radionuclide concentrations. Net alpha concentrations were compared with the SDWA comparison criterion of 15 pCi/L after subtraction of the isotopic concentrations of U-234 and U-238. Net alpha concentrations were detected above the 15 pCi/L comparison criterion in the sample collected from URSMW2D during the May 2001 sampling event at 64.8 pCi/L. Concentrations of radium (sum of Ra-226 and Ra-228) were detected above the 5 pCi/L comparison criterion in wells URSMW1D and URSMW2D during the May 2001 sampling event at 5.35 and 5.19 pCi/L, respectively. Total uranium concentrations in groundwater samples collected from bedrock monitoring wells did not exceed the comparison criterion of 30 μg/L during the May and December 2001 sampling events. These analytical results are summarized in Table 5-23. Figure 5-4 shows the locations, types and concentrations of radionuclides found in samples collected from bedrock groundwater monitoring wells.

5.4 NATURE AND EXTENT OF SEDIMENT CONTAMINATION

Sediment samples were collected from four locations (SWSD001, SWSD003, SWSD004 and SWSD006) as part of the environmental surveillance program. Sediment sampling was conducted nine times from CY 2000 to CY 2002. Two rounds of sediment sampling were done as part of the groundwater RI from 20 sample locations (SDDA01 through SDDA10 and SDDB01 through SDDB10) collected in April 2001 and January 2002. Samples were analyzed for the presence of metals and radionuclides. The data generated from the environmental surveillance program and from the RI have been consolidated and are compared against relevant criteria to provide a qualitative understanding of whether the concentration of an analyte may be of concern. For metals, the comparison criteria are sediment quality guidance from New Jersey (NJDEP 1998) and the EPA (EPA 2000), or background (upstream levels). Radionuclide concentrations in the sediments are compared to the clean-up criteria developed for soils in the MSP Soils Operable Unit Feasibility Study and the background results. A complete evaluation of risk posed by each contaminant in the sediment is presented in the risk assessment discussed in Chapters 7 and 8.

A summary of metals analytical data for SWSD004, the upstream (background) location is presented in Table 5-24a. Summaries for SWSD001, SWSD003, SWSD006, and from the RI effort (SDDA01 to SDDA10 and SDDB01 to SDDB10) are presented in Table 5-24b. Tables 5-25a and 5-25b present the radiological results for the same samples. These sediment sample locations are shown on Figures 5-5 and 5-6, and discussed below.

5.4.1 Sediment Analytical Data For Metals

The following is a summary of the results of comparing the 80 sediment metal sample results (including duplicates) from the Environmental Surveillance and RI efforts with the sediment criteria stated above and upstream values (background) for the respective parameter. The results were compared to the lesser of the two criteria, or background if background was greater than both criteria. This comparison is provided as an aid to the reader, and the actual projected risks and chemical hazards from the metal contaminants are evaluated in Chapters 7 and 8 of this RI Report.

- All the reported concentrations of aluminum are above the detection limits and ranged from 2,700 mg/kg to 35,600 mg/kg. Three samples in two locations are higher than the maximum background concentration of 23,600 mg/kg.

- Only 14 of the reported concentrations of antimony are above the detection limits, with values that range from 0.44 to 12.90 mg/kg. Of these, six are above the maximum background value of 3.47 mg/kg. These six samples are from 3 separate locations. There are a number of samples where antimony was not detected, but the detection limit is greater than the maximum criteria.

- Sixty-nine of the reported concentrations of arsenic are above the detection limits, in the range from 0.44 to 46.4 mg/kg. Of these, twenty-six are above the NJDEP Sediment Quality Guidance value of 6.0 mg/kg, from eight different locations.

- Seventy-nine of the reported concentrations of barium are above the detection limits, in the range from 23.6 to 311 mg/kg. Of these, 17 are greater than the maximum background value of 156 mg/kg and are from three locations.

- Thirty-one of the reported concentrations of beryllium are above the detection limits, in the range of 0.30 to 1.87 mg/kg. Of these, four are greater than the maximum background concentration of 1.38 mg/kg and are from two locations.

- Thirty-three of the reported concentrations of cadmium are above the detection limits in the range of 0.27 to 6.5 mg/kg. Of these, eighteen exceeded the maximum background concentration of 1.4 mg/kg and are from 13 locations.

- All eighty of the reported concentrations of calcium are above the detection limits in the range of 1,340 to 15,400 mg/kg. Of these, 76 are above the maximum background concentration of 2,000 mg/kg and are in the range from 1,340 to 15,400 mg/kg. All locations had elevated values.

- Seventy-five of the reported concentrations of chromium are above the detection limits in the range of 8.46 to 99.3 mg/kg. Twenty-four are greater than the maximum upstream sediment concentration of 37.2 mg/kg and are from eleven locations.

- Seventy-eight of the reported concentrations of cobalt are above the detection limits in the range of3.82 to 35.1 mg/kg. Fifty-one are greater than the maximum background concentration of 14.0 mg/kg and are from 18 locations.

- All of the eighty reported concentrations of copper are above the detection limits in the range of 19.1 to 363 mg/kg. Forty-eight are above the maximum background concentration of 52.5 mg/kg and are from sixteen locations.

- All of the eighty reported concentrations of iron are above the detection limits in the range of 6,520 to 68,400 mg/kg. Three are above the 38,300 maximum background value and are from two locations.

- All of the eighty reported concentrations of lead are above the detection limits in the range of 14.9 to 483 mg/kg. Fifty-six are above the maximum background concentration of 40.4 mg/kg and are from sixteen locations.

- All of the eighty reported concentrations of magnesium are above the detection limits in the range of 1,970 to 15,200 mg/kg. Twenty-one are above the maximum background concentration of 7,110 mg/kg and are from thirteen locations.

- All of the eighty reported concentrations of manganese are above the detection limit in the range of 95.6 to 2,820 mg/kg. Fifty-eight are above the NJDEP criteria of 460 mg/kg and are from twenty-one locations.

- Twenty-three of the reported concentrations of mercury are above the detection limits in the range of 0.03 to 0.52 mg/kg. Two are above the maximum background concentration of 0. 28 mg/kg and are from one location.

- Seventy-nine of the reported concentrations of nickel are above the detection limits in the range of 11.0 to 94.4 mg/kg. Twenty-one are above the maximum background concentration of 32.7 mg/kg and are from nine locations.

- Seventy-six of the reported concentrations of potassium are above the detection limits in the range of 331 to 3,290 mg/kg. Four are above the maximum background concentration of 2,550 mg/kg and are from three locations.

- Twenty-five of the reported concentrations of selenium are above the detection limits in the range of 0.28 to 5.2 mg/kg. Three are above the maximum background concentration of 3.47 mg/kg and are from two locations.

- Twenty-five of the reported concentrations of silver are above the detection limit in the range of 0.44 to 4.0 mg/kg. None of the detected results were above the maximum background concentration of 4.3 mg/kg. There are however, numerous results with detection limits above the maximum background concentration.

- Thirty of the reported concentrations of sodium are above the detection limits in the range of 256 to 2,230 mg/kg. Eight are above the maximum background concentration of 866 mg/kg and are from four locations.

- Seventy-eight of the reported concentrations of vanadium are above detection limits in the range of 14.2 to 139 mg/kg. Twenty-one are above the maximum background concentration of 53.7 mg/kg and are from twelve locations.

- Seventy-eight of the reported concentrations of zinc are above the detection limits in the range of 57.1 to 3,050 mg/kg. Fifty are above the maximum background concentration of 145 mg/kg and are from seventeen locations.

5.4.2 Sediment Analytical Data For Radionuclides

Comparison criteria for radionuclides in the sediments, shown in Tables 5-25a and 5-25b, are based on the Derived Concentration Guideline Levels (DCGLs) developed in Chapter 3 of the MSP Soils Operable Unit Feasibility Study. DCGLs were calculated for three nuclides – Ra-226, U-235, and U-238. DCGLs were not calculated for the Th-232 chain because the Soils OU RI determined that those nuclides were present in concentrations equivalent to background and did not pose unacceptable risk or hazard. The DCGLs that were calculated in the Soils FS include the risk contribution from associated decay products. The DCGLs are used as the comparison criteria for those nuclides that are included in the respective DCGLs. Thus, the calculated U-238 DCGL of 20 pCi/g is used for Th-234, Pa-234, U-234, and Th-230. Likewise, the calculated DCGL for U-235 is used for itself.

However, within the Soil FS a modified DCGL for Ra-226 was calculated as a surrogate clean-up criterion to account for the dose contributions of the other site nuclides of concern (U-238, U-235, and their progeny). This lower DCGL of 5 pCi/g (6 pCi/g inclusive of background) is retained here as a conservative basis for comparing site concentrations of Ra-226 and its decay products, Pb-214 and Bi-214.

For other nuclides that have been detected, the comparison criteria are the maximum detected values in upstream sediment samples (Location SWSD004) for the respective nuclides. These comparative criteria are provided to assist in the evaluation of the significance of nuclide concentration. Chapters 7 and 8 of this report address fully the human health and ecological impacts of the levels of contamination detected on-site, and identify any unacceptable risk from contaminants in the sediments.

Generally, levels of radionuclides detected were higher in sediment samples collected within the South Drainage Ditch streambed (SDDA04 to SDDA07) ditch compared to samples collected along the bank (SDDA01 to SDDA02 and SDD08 to SDD10). Additionally, sediment samples (SDDA01 to SDDA10, SWSD001) collected closer to the outfall (Figure 5-6) exhibited higher levels of radiological constituents compared to downstream sediment samples (SDDB01 to SDDB10, SWSD003). The following is a summary of these comparisons.

Actinium-228, bismuth-212, bismuth-214, lead-212, lead-214, protactinium-234m, thallium-208, and thorium-234 were reported for only the July 6, 2000 environmental surveillance event (at SWSD001, SWSD003, SWSD004, and SWSD006). The following is a summary of the results of comparing these results to the criteria.

- Actinium-228 exceeded the maximum upstream sediment sample concentration, 1.27 pCi/g, at one location (1.44 pCi/g), bismuth-212 exceeded the maximum background concentration, 0.86 pCi/g, at one location (1.8 pCi/g).

- Bismuth-214 only exceeded the DCGL (6.0 pCi/g) in one location (7.1 pCi/g).

- Lead-212 exceeded the maximum background concentration, 1.32 pCi/g at one location (1.63 pCi/g).

- Lead-214 exceeded the DCGL of 6.0 pCi/g at one location (6.83 pCi/g).

- Protoactinium-234m slightly exceeded the DCGL of 20 pCi/g with one result (20.66 pCi/g).

- Thallium-208 slightly exceeded the maximum background concentration, 1.2 pCi/g, at one location (1.4 pCi/g).

- Thorim-234 slightly exceeded the DCGL of 20 pCi/g at one location (20.57 pCi/g).

Samples collected from all locations had results reported for cesium-137, radium-226, radium-228, thorium-228, thorium-230, total uranium, uranium-233/234, urainium-235/236, and urainium-238. A summary of these results is as follows.

- Cesium-137 ranged from 0.0019 pCi/g to 0.201 pCi/g. Eighteen of fifty-eight samples exceeded the maximum background concentration of 0.108 pCi/g.

- In four locations, ten of seventy-five sediment concentrations of detected radium-226 exceeded the DCGL, 6 pCi/g. The concentrations above this criterion were from samples taken in four locations. All sample concentrations ranged from 0.503 to 13.3 pCi/g.

- Radium-228 in all the samples in which this analyte was detected ranged from 0.374 pCi/g to 3.3 pCi/g. Six of seventy-five sediment samples from five locations exceeded its maximum background concentration, 1.74 pCi/g.

- Thorium-228 detections exceeded the maximum background concentration of 1.64 pCi/g in twenty samples at eight locations. The measured concentrations ranged from 0.258 pCi/g to a maximum of 3.91 pCi/g.

- None of the 79 samples analyzed for thorium-230 detected it above the DCGL of 20 pCi/g. Thorium232 detections ranged from 0.173 pCi/g to 2.32 pCi/g.

- Concentrations of total uranium ranged from 1.41 to 334 micrograms per grams (µg/g). Forty out of seventy-five (75) samples were higher than the maximum background concentration of 9.24 ug/g.

- Detected concentrations of urainium-233/234 exceeded the DCGL for single radionuclides criterion of 20 pCi/g in twelve samples at five locations. The detections ranged from 0.476 pCi/g to 113 pCi/g.

- Urainium-235/236 detections exceeded the DCGL 6 pCi/g in six samples at five locations. The results ranged from 0.106 pCi/g to 9.29 pCi/g.

- Urainium-238 exceeded the DCGL 20 pCi/g in twelve samples at five locations. The detections ranged from 0.468 pCi/g to a maximum of 111 pCi/g.

5.5 NATURE AND EXTENT OF SURFACE WATER CONTAMINATION

Surface water samples were collected from six locations (SDDSG01, SDDSG02, SWSD001, SDSD003, SWSD004 and SWSD006) during two groundwater RI sampling events and from four locations (SWSD001, SWSD003, SWSD004 and SWSD006) as part of the environmental surveillance program. These surface samples were analyzed for the presence of SVOCs, metals and radionuclides. Summaries of analytical data are presented in Tables 5-26 through 5-28 and the results are discussed below. Surface water sampling locations are shown on Figures 5-5 and 5-7.

5.5.1 Semivolatile Organic Compounds

The evaluation of surface water sampling results to comparison criteria indicate that, with the exception of bis(2-ethylhexyl) phthalate, no other compounds exceeded comparison criteria. The sample collected from SWSD003 (April 2002) contained 60 μg/L of bis(2-ethylhexyl) phthalate (Figure 5-7).

5.5.2 Metals

As indicated above, surface water samples for the analysis of metals were collected from four locations. Analysis of these samples shows that concentrations of aluminum, iron, lead and manganese exceeded comparison criteria. The highest concentration of aluminum, iron, lead, manganese and sodium detected were 10,900 (SWSD004, September 2000), 13,100 (SWSD004, September 2000), 16.1 (SWSD004, July 2000 and September 2000), and 2,080 μg/L (SWSD004, June 2001), respectively (Figure 5-5).

5.5.3 Radionuclides

Surface water samples were collected from six locations (SDDSG01, SDDSG02, SWSD001, SDSD003, SWSD004 and SWSD006) during two groundwater RI sampling events. In addition to these sampling events, surface water samples were collected from SWSD001, SWSD003, SWSD004 and SWSD006 during routine environmental surveillance monitoring. Analytical results indicate that activity/concentration of net alpha and total uranium exceeded the comparison criteria of 15 pCi/L and 30 μg/L, respectively.

Net alpha concentrations exceeded the comparison criterion in samples collected from SWSD001 in April 2002, and from SWSD004 in July 2000, September 2000 and June 2001. The highest net alpha concentration reported in these samples was 29.27 pCi/L on July 6, 2000 at SWSD004. Uranium concentrations exceeded the comparison criterion in samples collected from SDDSG01 in January 2002, and from SWSD001 in July 2000, September 2000, December 2000, March 2001, June 2001, November 2001, December 2001 and April 2002. The highest concentration of total uranium found in these samples was 135 +/-

18.9 μg/L in April 2002 at SWSD001. Radium concentrations did not exceed the comparison criterion of 5 pCi/L. The highest activity of radium detected in the surface water samples is 4.41 pCi/L.

5.6 SUMMARY OF FINDINGS

Groundwater, surface water and sediment samples from MSP and the south drainage ditch have been collected as part of the groundwater RI and environmental surveillance program. Groundwater samples were analyzed for the presence of VOCs, SVOCs, metals and radionuclides, and surface water samples were analyzed for the presence of SVOCs, metals, and radionuclides. Sediment samples collected during the course of this investigation were analyzed for metals and radionuclides. The analytical results obtained were evaluated to identify contaminant distribution patterns, and confirm potential contaminant release mechanisms. Trend graphs of select analytical data of groundwater samples collected from monitoring wells B18W24S, B18W25S, B18W27S, B18W28SR and B18W29SR are presented on Figures 5-8 through 5-12. The results of this evaluation are presented below.

5.6.1 Contaminant Distribution

5.6.1.1 Volatile Organic Compounds

VOCs (MTBE, methylene chloride, and TBA) were detected in groundwater samples from overburden monitoring wells at MSP in excess of comparison criteria. Of these compounds, methylene chloride is a potential laboratory contaminant and has been eliminated from further consideration in this RI. MTBE was detected in the groundwater at the southern portion of the site, specifically in the monitoring wells on the southwest and southern edge of the site near the South Drainage Ditch. The highest exceedance of MTBE was 14 times the comparison criterion of 70 μg/L. It should be noted that MTBE concentrations did not exceed the comparison criterion from the other monitoring wells located across the remainder of the site. Similarly, a TBA exceedance of the comparison criterion of 100 μg/L was reported in groundwater from the southwestern portion of site. The maximum concentration of TBA detected was greater than 31 times the comparison criterion. A review of historic activities at the site indicates that MTBE and TBA would not be related to site activities. These are compounds generally associated with gasoline and other petroleum related hydrocarbons that came into widespread use in the late 1970s. The distribution of MTBE and TBA in the groundwater at MSP is in the southwest corner and along the western property boundary of the site, which adjoins a property occupied by an automobile salvage yard. Therefore, the presence of MTBE and TBA in the shallow groundwater may indicate the migration of these compounds on offsite source.

MTBE, carbon tetrachloride, chloroform and TCE were also detected at concentrations exceeding the comparison criteria in groundwater from the bedrock groundwater monitoring wells. No other VOCs exceeded the comparison criteria in groundwater from bedrock wells.

5.6.1.2 Semivolatile Organic Compounds

The only SVOC detected in groundwater at the site above the comparison criterion was bis(2-ethylhexyl)phthalate. This compound was found at a concentration greater than the comparison criterion at one location in the vicinity of the administration building. However, numerous compounds were detected in the groundwater from southern portion of the site as well as in the South Drainage Ditch.

5.6.1.3 Metals

Samples collected at MSP contained numerous metals that exceeded comparison criteria. These include: aluminum, arsenic, chromium, lead, nickel, iron, manganese, and sodium. A groundwater sample collected from URSMW18S contained numerous metals in excess of the comparison criteria. However, the turbidity of this sample was noted to be greater than 800 NTU and not representative of groundwater quality. This indicates that the concentrations of metals reported at this location are likely to be biased high and not representative of site groundwater quality. Other groundwater samples (with lower NTU values) collected from the same location contained concentrations of these metals below comparison criteria. Metals, such as aluminum, iron and manganese, are found to be distributed in the groundwater throughout the site. As described in Section 2.0, the Passaic Formation underlies MSP. This formation is rich in minerals such as feldspar, hematite, and other trace minerals, which contain aluminum, iron and manganese. Therefore, the presence of these metals at MSP is considered to be part of the natural setting and representative of regional background. Other metals, such as chromium, nickel and lead, were detected in excess of comparison criteria in groundwater from monitoring wells in the southern and southeastern portion of the site. None of these metals exceeded the comparison criteria in samples collected from groundwater monitoring wells in the northern portions of the site. Sediment samples collected from the South Drainage Ditch contained arsenic, iron, lead, manganese, and zinc at concentrations exceeding comparison criteria. Surface water samples contained aluminum, iron, lead, and manganese at levels above the comparison criteria.

5.6.1.4 Radionuclides

Net alpha, radium and total uranium were detected at concentrations above the comparison criteria in groundwater sample from overburden wells and net alpha and radium exceeded the comparison criteria in groundwater sample from bedrock wells. Overburden radionuclide contaminants were reported in groundwater samples from wells north of the former process building slab, west of the former MML Pile, and south and southeast of the VP Pile.

Radionuclides were also detected in groundwater samples from bedrock monitoring well URSMW2D at concentrations exceeding comparison criteria.

Groundwater plume maps are not presented as part of this report due to the sporadic presence of contaminants. The sporadic exceedances that have been observed at the site could be related to changes in the turbidity of the groundwater during sampling. Turbidity in samples correlates to changes in suspended solid concentrations, hence, changes in radionuclide activity in samples. The occasional reported occurrence and widespread nature of the contaminants found in MSP groundwater serves to make the reliability of generated constituent plume maps doubtful.

5.6.2 Contaminant Release Mechanisms and Migration Pathways

As discussed in Section 4.0, the leaching of impacted materials from surface soils to the groundwater was most likely a significant pathway in the past (prior to the Late 1940s). Since that time, leaching is probably only a factor with regards to a fluctuating water table. Water levels at the site have been known to fluctuate as much as 1 m (3 ft) annually. Such fluctuations would promote leaching from contaminated soils that are not typically saturated.

5.6.3 Proposed Supplemental Remedial Design Activities

An extensive groundwater sampling effort was conducted at MSP as part of the groundwater RI and environmental surveillance programs. Review of this information indicates that sufficient data exists for evaluating potential remedial measures to address impacted groundwater at the Site. However, the need for collecting additional data has also been identified. The primary data needs were identified in the overburden and bedrock groundwater monitoring system. These data will be gathered as part of the remedial planning and will not greatly affect the outcome of remedial alternative analysis or selection.

5.6.3.1 <u>Overburden</u>

Exceedances of MTBE and TBA were detected in the southwestern corner of the site in groundwater from B18W27S. These compounds were found at concentrations exceeding 10 times the comparison criteria. No monitoring wells are north, west or south of B18W27S, therefore the extent of MTBE and TBA impacted groundwater cannot be established. Samples collected from groundwater, surface water, and sediment sampling locations in the vicinity of the South Drainage Ditch and the southeastern corner of the site contained arsenic, chromium, lead, net alpha, radium and uranium in excess of comparison criteria. The extent of impacted groundwater to the west and northwest of the site cannot be further evaluated, since, monitoring wells B18W24S and B18W25S on the western and northwestern boundaries of the site contained groundwater with radionuclide concentrations in excess of comparison criteria.

5.6.3.2 <u>Bedrock</u>

Groundwater sampling and analysis, conducted as part of the groundwater RI, indicate that VOCs and radionuclides were detected in excess of comparison criteria. Groundwater from monitoring wells that contained these compounds and radionuclides are URSMW2D and URSMW3D. No other bedrock monitoring wells are available to the west or east of these monitoring wells to delineate the presence of these compounds and radionuclides.

5.6.3.3 <u>Sediment</u>

Sufficient data pertaining to sediments at MSP and its vicinity have been collected and evaluated to evaluate potential impacts to ecology and human health. No additional sediment data will be required in order to move forward with the remedial planning process.

5.6.3.4 <u>Surface Water</u>

Sufficient data pertaining to surface water at MSP and its vicinity have been collected and evaluated to evaluate potential impacts to ecology and human health. No additional surface water quality data will be required in order to move forward with the remedial planning process.

5.7 CONCLUSIONS

Review and analysis of the data collected during the ES and two rounds of groundwater sampling events conducted as part of groundwater RI sampling events shows that contaminants of concern have been adequately characterized to support the development of the Feasibility Study for the Site. However, additional assessment of the extents of MTBE and TBA in the overburden and certain VOCs and radionuclides in URSMW2D and URSMW3D should be conducted as part of remedial planning activities for the Site.

6.0 CONTAMINANT FATE AND TRANSPORT

This section presents an overview of the fates of groundwater contaminants at the MSP. Those processes significantly influencing both the movement and the retention of contaminants in the groundwater system at the MSP are identified and quantified. Simple, but site-specific, predictive calculations incorporating these processes have also been carried out as decision support aids.

There are a variety of processes impacting the groundwater transport of contaminants at the MSP. These include physical, chemical, and biological processes acting on the contaminants, and physical processes impacting the movement of the groundwater itself. Section 6.1 discusses contaminant properties and processes that are important to the fate and transport at MSP. Section 6.2 considers how those contaminant properties described in 6.1 act in concert with basic groundwater flow processes—advection and dispersion—to both move and attenuate contaminants onsite. Here the discussion is in terms of chemical persistence of the contaminants in the MSP groundwater environment. Finally, a groundwater screening model, BIOSCREEN, has been applied to contaminant transport in both the overburden and shallow bedrock groundwater systems at the MSP. Model set-up for and limitations to application at the site are described in Section 6.3. The results of the model calculations are presented in Section 6.4.

6.1 PHYSICAL AND CHEMICAL PROPERTIES

Physical and chemical properties that influence contaminant fate and transport at MSP have been summarized in the following text. In general, the metals, radionuclides and organic compounds detected in MSP groundwater tend to sorb to sediment particles, are resistant to biodegradation, volatilize slowly and bioaccumulate in aquatic organisms. Some chemical-specific measures, which are generally interrelated, that affect these tendencies include the following:

- Density and Viscosity,
- Water solubility,
- Vapor pressure and Henry's Law constant (K_h) vapor/water partitioning coefficient,
- Organic carbon partitioning coefficient (K_{oc}) and octanol-water partitioning coefficient(K_{ow}), and
- Degradation rate (*i.e.* half-life).

These are usually the most important factors affecting the overall fate of a chemical in the environment. They can also be used to predict the mechanisms by which each contaminant (or group of contaminants) will move through or transform in the environment. Typical values for some of these chemical factors are included on Table 6-1.

6.1.1 Organics

VOCs, including carbon tetrachloride (CTET), chloroform, TCE, and MTBE have been identified in the groundwater at MSP (see Section 5.0). The physical and chemical properties of VOCs that most influence the mobility and behavior in the subsurface include: density, viscosity, water solubility, vapor pressure, Henry's Law constant (K, the octanol-water partition coefficient (K_{ow}), and the organic carbon partition coefficient (K_{oc}). These properties are described in the following sections.

6.1.1.1 Density and Viscosity

Density is a significant physical property for organic compounds in the free phase, otherwise known as non-aqueous phase liquids (NAPLs). Generally, NAPLs are divided into two classes based on density: those lighter than water (LNAPLs) and those denser than water (DNAPLs). Viscosity is a measure of fluid resistance to flow. Generally, a less viscous fluid (NAPL) will more readily penetrate a porous media, and fluids with higher densities and lower viscosities than water will be more mobile in the subsurface (Knox, Sabatini, and Canter, 1993).

No free phase compounds (NAPLs) have been detected at MSP.

6.1.1.2 Water Solubility

Water solubility is defined as the saturated concentration of the compound in water at a given temperature and pressure (Montgomery and Welkom, 1989). Organic compounds with high solubility tend to desorb from soils and sediments, are less likely to volatilize from water, and are susceptible to biodegradation. Conversely, organic compounds with low solubilities tend to adsorb onto soils and sediments, volatilize more readily from water, and bioconcentrate in aquatic organisms (Montgomery and Welkom, 1989).

Values of solubility for VOCs detected in MSP groundwater range from 800 mg/L in CTET to 50,000 mg/L in MTBE, as shown in Table 6-1. In general, the solubility of these compounds is moderate to relatively high.

6.1.1.3 Vapor Pressure and Henry's Law Constant

The vapor pressure of a substance is defined as the pressure exerted by the vapor (gas) in equilibrium with the solid or liquid phase of the same substance, given specific temperature and total pressure (Montgomery and Welkom, 1989). This parameter is used to calculate the K_h, which is the ratio of the partial pressure of a compound in air to the concentration of the compound in water at a given temperature under equilibrium conditions.

Henry's Law constant is a function of both solubility and vapor pressure. It is directly proportional to the vapor pressure, and inversely proportional to the solubility. Chemicals with a K of less than 10^{-7} atmosphere-m^3 per mol (atm-m^3/mol) are considered to have a low volatility. Chemicals with a K_h constant on the order of 10^{-7} to 10^{-5} atm-m^3/mol are considered moderately volatile and will volatilize slowly. Volatilization becomes an important transfer mechanism if K_h is in the range of 10^{-5} to 10^{-3} atm-m^3/mol.

Values of K_h exceeding 10^{-3} atm-m^3/mol indicate volatilization will proceed rapidly (Montgomery and Welkom, 1989). K_h values for VOCs found in MSP groundwater range from 0.02 x 10^{-5} m^3/mol in MTBE to 3,000 x 10^{-5} m^3/mol in CTET.

6.1.1.4 Octanol-Water Partition Coefficient and Organic Carbon Partition Coefficient

The octanol-water partition coefficient, $K_{ow,}$ is a measure of the degree to which an organic substance will preferentially dissolve in an organic solvent compared to water. The coefficient is the ratio of the equilibrium concentration of the substance in octanol to the equilibrium concentration in water (Fetter, 1999). The greater the K_{ow} value, the greater the tendency for the chemical to partition from dissolved phase to solid phase. The organic carbon partition coefficient, K_{oc}, is defined as the ratio of adsorbed chemical per unit weight of organic carbon to the aqueous solute concentration (Montgomery and Welkom, 1989). This parameter provides an indication of the tendency of dissolved organic compounds to partition on geologic materials containing organic carbon. The greater the K_{oc} value, the greater the tendency for a chemical to partition on to geologic materials. The K_{ow} and K_{oc} values for VOCs found in the groundwater at MSP are listed in Table 6-1.

6.1.2 Radionuclides

Radionuclides detected in the groundwater at MSP include U-238, U-234, Th-234, Ra-228, and Ra-226. The physical and chemical properties that most influence their mobility and behavior are discussed in this section. These include valence state, solubility, and radioactive decay.

6.1.2.1 Solubility and Valence States

Low pH waters tend to carry more dissolved radionuclides than high pH waters. Uranium solubility is largely controlled by redox conditions with U^{+6} about 10,000 times more soluble than U^{+4}. Solubility of uranium is further increased by its complexing with carbonates. Groundwater flowing through soil and/or rock with high uranium content may or may not have a high uranium concentration, depending on the other various chemical parameters of the groundwater.

Thorium in the +4 valence state (Th^{+4}) is immobile in the aqueous environment. Ra^{+2} is often mobile. Uranium behaves differently in oxidizing and reducing waters because of its two valence states (U^{+4} and U^{+6}). In the reduced state, uranium, like thorium, is relatively immobile. In the oxidized state, uranium forms soluble complexes such as $UO_2(CO_3)_2^{2-}$ (McKelvey et al., 1955), and thus is mobile in most natural surface water and shallow groundwater.

6.1.2.2 Radioactive Decay and Daughter Products

Radioactivity refers to the processes by which nuclei of unstable atoms spontaneously decay or disintegrate by one or more transmutations until a stable state is reached. Certain elements are unstable as they occur in nature and are therefore called natural radionuclides. The stability of an atom is governed by the particular arrangement and the number of protons and neutrons in the nucleus. If this arrangement does not fall within a stable range of energy state, then the nucleus is unstable. An unstable nucleus attempts to achieve stability by changing the configuration or ratio of protons and neutrons by spontaneous disintegration, or radioactive decay. This occurs by the emission of three types of radiation: alpha particles (a combination of two protons and two neutrons), beta particles (negatively charged high-speed electrons), and gamma rays. Gross alpha and gross beta are measurements of all the alpha and beta activity present, regardless of specific radionuclide source.

When a radioactive nucleus decays, the decay product (or daughter product) is an atom of a different element with chemical properties unlike those of the parent element. Each radioactive nuclide has its own unique characteristic pattern and rates of decay. The rate of decay is specific to each radioactive nuclide and is measured by "half-lives", or the time it takes for one-half of the original element to decay to its daughter product. The half-lives of radioactive elements found at MSP vary widely, from days to billions of years as shown in Table 6-1.

An important factor of radioactive decay that influences the mobility of these isotopes in aqueous systems is the alpha-recoil affect. Each of the U-238 alphagenic daughters (Th-234, Th-230, Ra-226, Rn-222, etc) has its origin in a decay event that displaces it about 20 nanometers through the solid mineral in which it is found. This alpha recoil may actually propel the daughter across phase boundaries (Osmond and Cowart, 2000). For example, the alpha recoil associated with the transmutation of U-238 to Th-234 may push the daughter Th-234 out of a solid mineral grain and into the surrounding aquifer, which may lead to considerable disequilibrium between members of the decay chain in natural groundwater. The extent of disequilibrium caused by this process is dependent on the time available for radioactive decay and the residence time of the water within the aquifer. The alpha recoil affect also may contribute to disruption of the mineral lattice, making the mineral grain more vulnerable to acid leaching processes.

6.2 CONTAMINANT PERSISTENCE

Persistence is the measure of how long a chemical will exist in the environment before it degrades or transforms, physically, chemically or biologically, into some other chemical. Some of the factors that affect the persistence of a chemical include the state of the chemical, the availability of the chemical, exposure to sunlight, oxygen availability, the types and quantities of microorganisms present, availability of nutrients, temperature, pH, radioactivity, as well as the presence of other chemicals, which may inhibit or enhance degradation. Usually, persistence is expressed in terms of a half-life and can be on the order of days, weeks, or years.

The persistence of contaminants in groundwater is controlled by transport processes including advection and dispersion and by a variety of physical and chemical fate processes, such as adsorption and degradation. The fate processes tend to retard the transport of contaminants by reducing transport velocity or by transforming one chemical to another. Therefore, to understand the persistence of various chemicals in the groundwater at MSP, it is necessary to understand how the physical and chemical processes influence their mobility and behavior.

6.2.1 Advection

Advection is a mass transport process in which the movement of dissolved phased contaminants are due to the flow of water in which the contaminant mass is dissolved (Domenico and Schwart, 1990). The direction and rate of transport coincides with the movement of groundwater. Reactive contaminants (i.e., those that interact with the aquifer materials) usually move at rates slower than the average linear groundwater velocity. Non-reactive dissolved contaminants are carried at an average rate approximately equal to the average linear velocity of the groundwater flow.

6.2.2 Dispersion

As contaminated groundwater flows through a porous medium there is a tendency for dissolved contaminants to spread out from the path they would follow solely under advective transport (Freeze and Cherry, 1979). This phenomenon, known as hydrodynamic dispersion, is primarily due to variations in flow rates as groundwater passes through different portions of the aquifer matrix. Hydrodynamic dispersion occurs both parallel to and perpendicular to the direction of advective groundwater flow (i.e., longitudinal and transverse dispersion, respectively). Hydrodynamic dispersion is the process that results in the spreading of contaminant plumes with increasing distance from contaminant sources.

6.2.3 Adsorption

Adsorption is a process by which dissolved contaminants partition from the liquid to the solid phase. Adsorption is considered to be a key process that affects the rate of migration of certain contaminants in groundwater. Contaminants that have a tendency to adsorb onto the solid matrix (soils or other geologic materials) in the saturated zone migrate more slowly than the advective transport rate (i.e., slower than the average groundwater velocity).

The degree of retardation experienced by a particular organic contaminant will depend on the fraction of organic carbon (f_{oc}) of the aquifer materials. The higher the f_{oc} the more sites available for adsorption. Adsorption of a given chemical is described by its soil-water partition coefficient (K_d). The higher the K_d value, the more retarded (less mobile) the chemical. Estimates of the distribution coefficients for the various compounds detected in MSP groundwater are presented in Table 6-1.

6.2.4 Volatilization

Volatilization is a process in which organic chemicals are transferred from a dissolved phase (in water) or an adsorbed phase (on soil) into a vapor phase (soil gas or the atmosphere). The tendency of a chemical to volatilize depends upon its physical properties (vapor pressure and Henry's Law constant [Table 6-1]) and environmental factors (temperature, pressure, and available pathways). Volatilization generally occurs more readily from shallow groundwater than from deep groundwater because atmospheric temperature and pressure effects are greater at shallow depths.

6.2.5 Biodegradation

Biodegradation is the biological process by which aerobic or anaerobic microbes break down organic chemicals to either a higher or a lower molecular weight chemical(s). This is done by way of chemical transformations, including oxidation, reduction and dehydrohalogenation that are catalyzed by the action of microorganisms in the subsurface environment. The process may also result in the formation of a more toxic chemical. Chemicals that are highly water-soluble can biodegrade, but those with low water solubility usually will not.

6.2.6 Colloidal Transport

Colloids are macromolecules (particles) of organic or mineral matter with diameters in the range of 10^{-3} to 10^{-6} mm that can be suspended in water (Freeze and Cherry, 1979). Colloidal particles may be mobile in the subsurface environment, potentially moving vertically with infiltrating water through the vadose zone, or laterally by advection with groundwater flow in the saturated zone. Colloidal particles can adsorb organic and inorganic contaminants. Mobile colloids can, therefore, transport contaminants, thereby increasing the amount of contaminants that flow with groundwater (McCarthy and Zachara, 1989). It is very difficult to predict or simulate colloid behavior in subsurface environments.

6.2.7 Dilution

Dilution results when contaminated groundwater or surface water mixes with uncontaminated (or less contaminated) water resulting in reduced concentrations in the contaminated water. Dilution generally occurs where clean precipitation infiltrates groundwater, where plumes of differing contaminant concentrations converge, or where groundwater discharges to surface water.

6.3 CONTAMINANT MIGRATION

Computer models have been employed in the Groundwater RI to assist in the evaluation of contaminant fate and transport. While field data generally defines the extent of contamination, models can interpolate among, and extrapolate from, isolated field samples to areas and times when sampling has not occurred.

6.3.1 Model Selection and Approach

BIOSCREEN (Newell *et al.*, 1997) is an EPA-approved natural attenuation decision support program based upon the Domenico analytical solute transport model (Domenico, 1987). The analytical solution is programmed into a Microsoft® Excel spreadsheet and contains the ability to simulate advection, dispersion, adsorption, and both aerobic and anaerobic decay reactions. The model allows easy input of site-specific data and fast computation of solutions applicable to developing remedial action scenarios incorporating natural attenuation. The model is designed to simulate biodegradation by either first-order decay or "instantaneous" reactions (Connor *et al*., 1994). Two primary limitations that are inherent to the MSP modeling effort are:

- The model is based on an analytical solution and assumes simple groundwater conditions, hence situations in which pumping or significant vertical gradients are present are not applicable to the use of this model; and

- The model only approximates the effects of natural degradational processes occurring at a site and this level of accuracy of the model solution should be evaluated as such (Newell *et al.*, 1997).

This model was developed to identify natural attenuation of fuel compounds, but can also be used for chlorinated compounds if the first-order decay coefficient is used to predict biodegradation. Similarly, this model is also suited to simulate radionuclide behavior using first-order kinetics to approximate radioactive decay.

The objective of the modeling effort was to estimate the attenuation time of contaminant concentrations from presumed source areas and the distance that the contaminant will travel downgradient before degrading below groundwater quality comparison criteria. The modeling involved two stages: simulating the current (2002) observed conditions at MSP following hypothetical releases, then using the information derived to simulate future contaminant transport. To simulate the current distribution of the contaminants detected in the groundwater, a source of each contaminant was introduced into the model domain at designated locations.

Simulations were performed for contaminants in each hydrogeologic unit that exceeded one of the following groundwater quality comparison criteria:

- NJDEP Class IIA Groundwater Quality Standards;
- New Jersey Safe Drinking Water Act MCLs; and
- USEPA Safe Drinking Water Act MCLs.

These include MTBE within the overburden and bedrock, TCE in the bedrock, CTET in the bedrock, chloroform in the bedrock, total uranium in the overburden, U-238 in the over burden, U-234 in the overburden, Th-234 in the overburden, and Ra-226+Ra-228 in the overburden and bedrock.

Once the model had been calibrated, the predictions were repeated for a 10-year interval. The approximate migration distances from the source area for the comparison criteria isoconcentration contours in the overburden and bedrock are presented in Table 6-2.

6.3.2 Model Assumptions

Though a complete history of groundwater migration is not known, site-wide data is available for 2001, 2002 and 2003. The following conservative assumptions were made in order for the transport model to use the available data and to estimate the potential attenuation of groundwater:

- Concentrations in the wells were assumed to be indicative of the center of contaminated groundwater at the appropriate distance from the source.

- The highest reported contaminant concentrations found in the overburden and bedrock groundwater monitoring wells, respectively, represent the approximate vicinity of source locations.

- Co-precipitation, solid solutions, colloid-facilitated transport, and changes in redox state were not considered explicitly during simulations of radionuclides, but rather simulated implicitly using the partition coefficient as a lumped parameter.

- The contaminant attenuation observed between the modeled wells is approximately representative of conditions across the Site.

- The direction of groundwater flow is horizontal and vertical flow between the overburden and bedrock is negligible.

- The overburden and fractured bedrock are homogeneous, isotropic, and of uniform thickness.

- Recharge rates are insignificant relative to regional flow.

- Groundwater flow directions and velocities are constant over time.

Soil-water partition coefficients (K_d) for the radionuclides have been taken from the published literature. Default K_d's for the contaminants were chosen from the low end of their respective ranges. This was done in order to preserve the conservative nature of the simulation. A number of other simplifying assumptions (as described in the previous sections) have also been used in developing the BIOSCREEN simulations. This was done to ensure that modeling results describe migration scenarios that are conservative overstatements of potential contaminant distribution from MSP. In addition, the simulations further assume that no remedial actions for soil or groundwater will take place at the site. As described in Sections 7 and 8 of this RI report, the presence of radionuclides, metals and organic compounds in MSP groundwater in excess of acceptable risk levels does result in the need for future remedial action. Remedial alternatives for groundwater will be evaluated in a site-specific FS as part of the CERCLA process for NPL sites.

6.3.3 Summary of Model Parameters

Assumptions were made in deriving model input-parameters. These assumptions were necessary due to the current site data available to perform the BIOSCREEN simulations. Data used to constrain values on model parameters were potentiometric surface maps, well logs, and select monitoring wells within the contaminant flow path lines. Relationships and values tabulated from literature were also utilized. Table 6-2 presents a summary of parameters and their respective values used in the BIOSCREEN simulation.

6.3.3.1 Hydrogeology

The bedrock unit underlying the overburden is fractured; therefore estimates of effective porosities and bulk densities must account for both the rock matrix and fractures. A value of 10 percent and 2.2 g/cm^3 for effective porosity and bulk density were assigned to the model, respectively, based on typical porosity ranges of 5 to 15 percent for these types of sedimentary rocks. The overburden was assigned a porosity of 20 percent and bulk density of 2.1 g/cm^3 based on typical literature values.

Hydraulic gradients within the overburden and bedrock were estimated from potentiometric surface maps (Figures 3-15 through 3-18). Comparison of tabulated water levels shows moderate seasonal water table fluctuation within gradients of 0.01 to 0.02 ft/ft within the overburden and 0.008 to 0.012 ft/ft in the bedrock. Groundwater flow in the overburden is generally to the south, with the exception of the northern end of the site, which flows northward. It is presumed that the hydraulic gradient of flow to the north is comparable to the gradient throughout the site.

6.3.3.2 Dispersivity

Monitoring data indicates that contaminants may traverse the property boundaries. However, groundwater sampling data outside the property boundaries does not indicate the presence of impacted groundwater (ATSDR, 2002). A conservative estimate of 1,000 ft (the approximate distance north to south across the site) was used for dispersivity estimates.

The BIOSCREEN default relationship defined by Xu and Eckstein (1995) was used as the longitudinal dispersivity for simulations in the overburden. But for simulations in the bedrock, the relationship of longitudinal dispersion was estimated as approximately 10 percent of the plume length to yield a higher dispersivity value. This represents the increased anisotropy and potentially higher dispersivity imparted by the fractures in the Passaic Formation. The transverse dispersivity is typically about ten percent of the longitudinal dispersivity and was therefore assumed to be 0.3 m (1 ft). Estimated dispersivity values are shown in Table 6-2.

6.3.3.3 Sorption/Retardation

Table 6-1 lists soil-water partitioning coefficient, K_d, for each contaminant, as calculated by $K_d=f_{oc}K_{oc}$. The organic carbon partition coefficient (K_{oc}) is well documented, particularly for VOCs. The fraction of organic carbon (f_{oc}) in geologic materials is strongly correlated with the potential for adsorption of contaminants in the subsurface, especially for adsorption of organic compounds. The partitioning of organic contaminants from the dissolved phase to the solid phase is usually proportional to the organic carbon content of the media. No organic carbon data was available for use in the model; therefore a conservative default value of 0.0012 (McCarty *et al.*, 1981) was used.

DOE's users manual for the RESRAD dose assessment code (Yu and others, 1993) lists the following K_d ranges for soils and sand: Thorium, 6000 to 60,000 milliliters per gram (mL/g); Uranium, 5 to 50 mL/g; Radium, 7 to 70 mL/g. However, to be conservative, values on the lower end of the range were used in the modeling of MSP groundwater (Table 6-1).

6.3.3.4 Biodegradation

Degradation rates for VOCs are well documented and rate constants for them have been taken from the literature. The uncertainty associated with using generic default values is anticipated to be large. For model simulations, when a range of biodegradation half-lives is documented in the literature, the largest published half-life was used to maintain conservatism and illustrate a worst-case scenario.

Radioactive decay follows first-order kinetics and will be represented by biodegradation. Based on the data presented in Table 6-1, half-lives of the majority of the radionuclides are upwards of several hundred thousand to several billion years. These will essentially be modeled as non-decaying constituents.

The groundwater quality comparison criterion for radium combines Ra-226 and Ra-228. Therefore, to simulate these two radionuclides simultaneously and to maintain conservatism in the attenuation estimates, the half-life of Ra-226 (1,622 yrs) was utilized over Ra-228 (6.7 years).

6.3.3.5 Source Locations and Concentrations

Selection of source location and concentrations was based on the results of groundwater monitoring on site and in the vicinity (and/or downgradient) of potential source areas. During modeling, the transient behavior of downgradient wells (contaminants were not consistently detected) was used as a constraint in estimating the mass of contamination in the source areas (e.g., continuous; slug,).

Radionuclides:

The source area is presumed to be within the vicinity of the former ore process building slab. This is based on past site history and the fact that groundwater samples collected from well B18W24S contained the highest concentrations of the various compounds of concern, although prior concentrations of the radionuclide detected in B18W24S are highly variable. For example, total uranium concentrations increased to 554 µg/L on June 29, 2000, dropped to 186 μg/L on December 29, 2000, increased again to 761 μg/L on May 25, 2001, and then decreased to 396 μg/L on 04/01/02.

Sensitivity tests were done to develop an appropriate source concentration for modeling. Based on the results of these tests, source concentrations and activities for each radionuclide were calculated as:

- Total Uranium: 800 μg/L
- U-238 (overburden): 225 pCi/L
- U-234 (overburden): 200 pCi/L
- Ra-226+Ra-228 (overburden): 25 pCi/L
- Ra-226+Ra-228 (bedrock): 10 pCi/L

Given the site history, indicating operation between 1943 and 1965, the date of a hypothetical release for the simulations was selected as 1955.

Carbon Tetrachloride/Chloroform/TCE:

The source area is presumed to be approximately 100 feet north of URSMW2D within the vicinity of the garage where it is thought that solvents may have been used. Contamination is assumed to have migrated in all directions, diverging from a groundwater divide present in this area (Figure 3- 18).

Source locations were assumed to be in the shallow saturated zone of the overburden with the exception of the chlorinated VOCs: TCE, CTET, and Chloroform. These compounds are presumed to be within the bedrock due to their potential to migrate downward. The density of these compounds is heavier than water.

The presence of chloroform is presumed to be the result of degradation of CTET. Simulations were conducted using a related model called BIOCHLOR to recreate the sequential degradation of CTET to chloroform. This model was also used to confirm that input parameters used for BIOSCREEN simulations produced the observed chloroform concentrations. Chloroform is found at lower concentrations in the groundwater and has a half-life lower than that of CTET. Chloroform is presumed to degrade to levels below the comparison criteria in equivalent or less time than CTET.

Based on the results of groundwater monitoring at URSMW2D, source concentrations for the chlorinated VOCs were calculated as:

- CTET (bedrock): 1,000 μg/L
- TCE (bedrock): 1,500 μg/L

The above listed values were used to calibrate the simulations and are less than 1 percent the aqueous solubility listed in Table 6-1. This also indicates that the presence of DNAPL is unlikely.

Based on the site history indicating operation between 1943 and 1965, a hypothetical release date assigned to the simulations was selected as 1955.

MTBE:

The source of MTBE present in both overburden and bedrock groundwater is thought to be from an off-site source to the west of the former VP pile. Decreasing concentrations observed in groundwater samples from B18W27S (951 μg/L, March 21, 2001; 687 μg/L, May 30, 2001; and 130 μg/L, April 3, 2002) indicates a declining source zone and this was modeled as such.

MTBE is present in groundwater samples collected from both hydrogeologic units. MTBE is very mobile and may have migrated to bedrock in response to the downward hydraulic gradient at the site.

A source concentration for MTBE in both hydrogeologic units was assigned as 250,000 μg/L. This value is less than 1 percent of the MTBE's aqueous solubility listed in Table 6-1. The actual release time of the MTBE is unknown; therefore, model simulations were conducted assuming the release occurred around the onset of MTBE usage in fuel, a little more than 20 years ago.

6.3.4 Sensitivity Analysis

BIOSCREEN simulates and provides a conservative estimate on the extent of contaminant attenuation. However, the lack of site-specific data for some input parameters could affect overall modeling results. A sensitivity analysis was performed on the variables utilized in calibrating the model. The variables included: effective porosity, fraction of organic carbon, and half-lives. These variables used in the model calculations were not empirically determined. Hydraulic conductivity was not subjected to sensitivity analysis; the conservative value used in the model was taken as the upper limit of the observed range.

Four successive model iterations were completed for four time periods (0, 1, 5, and 10 years) in which the value of one variable was increased or decreased by 25 percent. For each time period and parameter combination, the comparison metric is the maximum distance the contaminant traveled at concentrations above the comparison criteria. The sensitivity analysis has been carried out using uranium as the test analyte since the risk assessment shows that radionuclides are the most significant contaminants on site.

Table 6-3 lists the nominal results for the model based on the Table 6-2 parameter values and the impact of varying the key factors discussed above. The results for the varied parameters are shown for the change in that parameter only. All other parameters are held at their nominal values. The long-half life of the uranium (consistent with the non-decaying heavy metals) does not impact the results. Shorter half-lives, or degrading compounds would have shorter travel distances. Organic carbon has a slight impact, varying the results by only a few percent when the parameter is varied by 25%. The travel distance is inversely proportional to porosity when hydraulic conductivity is held constant (velocity increases).

The sensitivity analysis suggests that the nominal values used in the model are appropriate and that estimates utilized in the model are conservative, but reasonable values based on scientific literature. However, they are not site-specific and may predict results that could be different than actual on site conditions. By using values from published literature an exact understanding of contaminant fate and transport may not be attained. However, a conservative, fairly reliable order of magnitude estimate may be extrapolated to help assess the effects of contaminant migration.

6.3.5 Model Limitations

BIOSCREEN approximates more complicated processes that occur in the groundwater. The use of values presented in the published literature and the lack of site-specific data used during calculations of the model may lead to gross under or over estimation of model results.

The model should not be applied where extremely detailed accurate results that closely match site conditions are required, particularly in light of those assumptions stated in Section 6.3.2.

6.4 FATE AND TRANSPORT SUMMARY

As described in Section 6.0, a summary of fate and transport processes of contaminants identified at the MSP site has been developed. Available data have been used to characterize and develop a conceptual understanding of the flow systems at work at MSP. Mathematical models have been established and calibrated to represent site conditions using available hydraulic and contaminant data. Simulations for U-238, U-234, RA-226, Ra-228, MTBE, TCE, and CTET were performed. The models provide a quantification of fate and transport processes of contaminants that exceed limits of the groundwater quality comparison criteria outlined in Section 6.3.1.

Assuming no remedial actions are implemented, Table 6-4 lists distances and concentrations that impacted groundwater could potentially migrate off the MSP site over the next 10 years. Off-site groundwater monitoring data (ATSDR, 2000) have not detected contaminants in potable water supply wells near MSP. As described later in Sections 7 and 8, the presence of radionuclides, metals and organic compounds in MSP groundwater in excess of acceptable risk levels does trigger the need for remedial action at the site. Various remedial alternatives for both soils and groundwater will be evaluated in a site-specific feasibility study, which will be conducted in accordance with the CERCLA process for NPL sites.

BIOSCREEN could not simulate the distribution of Th-234. The model could not approximate the release of thorium due to the alpha recoil of U-238. However, it is reasonable to assume that because of its short half-life (25 days), Th-234 would not persist longer than U-238 and U-234. Concentrations and migration distances for U-238 and U-234 have been simulated.

Further evaluation of remedial alternatives for groundwater at MSP may not address the presence of MTBE, a non-FUSRAP related constituent. BIOSCREEN simulations show that MTBE will attenuate in overburden groundwater over the next 40 years. However, bedrock simulations indicate that MTBE will be more persistent, requiring 100 years to attenuate below the 70 μg/L water quality comparison criteria.

7.0 BASELINE HUMAN HEALTH RISK ASSESSMENT

A Baseline Human Health Risk Assessment (BHHRA) has been performed as part of the MSP Groundwater RI. The BHHRA estimates the potential risks to humans that result from exposure to contaminated groundwater, surface water, and sediment at MSP. These risks include those from both radiological and non-radiological constituents. They are discussed in terms of potential carcinogenic risk, radiation dose, and non-carcinogenic hazards. If particular characteristics or properties are relevant for only radiological or non-radiological constituents, the appropriate nomenclature has been used for clarification.

7.1 TECHNICAL APPROACH AND METHODOLOGY

The BHHRA provides risk information to support remedial decision making for the site. The method for assessing human health concerns is taken primarily from the *Risk Assessment Guidance for Superfund (RAGS): Human Health Evaluation Manual, Part A, Interim Final* (EPA 1989b) and has been supplemented with the following guidance:

- *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim* (EPA 2001a).

- *Exposure Factors Handbook* (EPA 1997b).

- *U.S. EPA Integrated Risk Information System (IRIS)* (EPA, 1998a), *Health Effects Assessment Summary Tables (HEAST)* (EPA, 1997a), *and Health Effects Assessment Summary Table Radionuclide Table* (EPA, 2001b).

- Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion,* EPA-520/1-88-020, Sept. 1988.

- Federal Guidance Report No. 12, *External Exposure to Radionuclides in Air, Water, and Soil,* EPA-402-R-93-081, Sept 1993.

- Federal Guidance Report No. 13, *Cancer Risk Coefficients for Environmental Exposure to Radionuclides*, EPA-402-R-99-001, Sept 1999.

The concentrations of the inorganic, organic, and radiological constituents found in groundwater, surface water, and sediments were quantified and analyzed, where possible, to characterize their potential risks to human health. The results of the risk assessment are used to:

- Identify contaminants of potential concern (COPCs).

- Document and evaluate potential risks to human health.

- Assess the need, if any, for remedial action.

- Support the evaluation of remedial alternatives in the FS relative to the “no action” alternative.

- Identify contaminants of concern (COCs) that require the development of compound-specific remediation levels.

The risk calculations use the results from the RI groundwater characterization and the environmental surveillance monitoring program. These data represent current conditions at the site. As described in Chapter 5, completion of earlier remedial actions significantly changed site conditions from those described by previous sampling campaigns and earlier monitoring efforts.

Measured contaminant levels may include contributions from off-site sources, anthropogenic, and/or naturally occurring levels. As such, risk levels based on site concentrations may include risks from chemicals that are not site-related. In order to account for these effects, data were screened against the regional data reported by the local water company for their groundwater sources. This reduced the possibility of assessing risks due to naturally occurring levels in the water. Data from wells believed to be unaffected by site operations were considered in evaluating the selection of COCs based on risk levels or hazard indices.

7.2 IDENTIFICATION OF CONTAMINANTS OF POTENTIAL CONCERN

Analytical results for groundwater, surface water, and sediments indicate different mixes of contaminants. Therefore, the data for the different media are evaluated separately to allow for appropriate evaluation of the potential risks. These analytical data are used to identify what chemicals and radionuclides have been released on or under MSP, and to evaluate those materials as COPCs. These COPCs are then analyzed in a risk assessment to determine what level of risk or hazard could be posed by the concentrations identified on site. COPCs found to pose potentially unacceptable risk or hazard to receptors are then classified as COCs, and are the basis for considering remedial actions in a feasibility study.

7.2.1 Groundwater

Groundwater was sampled at 37 locations, including shallow and deep wells at a background location. These wells include the environmental surveillance wells that are sampled on a quarterly basis. Other wells were installed for RI site characterization and have been sampled twice.

Groundwater data gathered prior to 2000 have not been included in the risk assessment database. These data were collected using different field sampling protocols and procedures. In addition, various site activities, including remedial actions, have altered conditions since these data were acquired. Therefore, pre-2000 groundwater data are not considered representative of current or future site conditions.

7.2.1.1 Initial Data Reduction - Groundwater

The database of validated groundwater analyses contains results from 37 wells, with over 19,000 individual results organized by analyte and location. Some of the results have been assigned qualifiers based on the laboratory QC criteria. To identify the subset of this data that would be used in the risk assessment, the following screens were implemented:

1. As discussed in Chapter 5, data qualified as unreliable were removed from the risk assessment data set.

2. Any analyte not detected in any groundwater sample (i.e., all results for that analyte received a "U" qualifier as a non-detect) was removed from further consideration as contributing to risk from the groundwater.

3. Calcium, magnesium, potassium, and sodium were screened out as essential human nutrients.

As discussed in Chapter 5, eighteen samples exhibited turbidity in excess of 50 NTUs, which is the guideline established in the GWOU RI Work Plan and Field Sampling Plan for the collection of unfiltered groundwater samples. The turbidity in the groundwater at the time of sampling is believed to be due to incomplete well development (i.e., development time was limited due to expiring rights of entry onto the property where the well was located or the fine grained nature of local soils). Therefore, the data from these sampling events are regarded as unrepresentative, and the metal and radionuclide data from those samples have been removed from the risk assessment database.

Several organic compounds were detected in groundwater samples that are attributed to off-site operations or laboratory contaminants. As described in Chapter 5, the following chemicals are not considered as COPCs in the MSP groundwater:

- Methyl Tert Butyl Ether (MTBE)
- Bis(2-ethylhexyl)phthalate
- Tert Butyl Alcohol (TBA)
- Di-isopropyl ether

7.2.1.2 Background Screening – Groundwater

Background screening levels were based on Wells URSMW20S and URSMW20D. These wells were installed in a location considered to be uninfluenced by site conditions (background). Four radiological samples and two chemical sampling events have been conducted in these wells. In a RCRA compliance context the EPA has recommended the use of upper tolerance limits or UTLs for the comparison of site monitoring well data with background (EPA 1992, *Statistical Analysis of Groundwater Data at RCRA Facilities, Addendum to Interim Final Guidance*). If the number of samples is limited, as is the case for the chemical analytes, then the maximum detected concentration is used as the background in the comparison. The sample number for radionuclides were sufficient, however, and those background 95% UTLs were calculated. The maximum detected concentration is used as the background value for the chemical analytes, while a 95% Upper Tolerance Limit (UTL) was calculated for the radionuclides. Table 7-1 lists the maximum detections and UTLs for both the on-site and background samples. Five analytes had maximum detections in on-site wells that were below the background wells. Barium was measured at 583 µg/L, with a background well measurement at 925 µg/L. The maximum site measurement of iron was 13,800 µg/L, compared to the background well sample at 14,500 µg/L. Di-n-butyl phthalate had a maximum on-site value of 1.1 µg/L, compared to a concentration in the background well of 1.4 µg/L. Since di-n-butyl phthalate is man-made and not a naturally occurring chemical, its presence in an offsite background well is indicative that it is not site-related, and could possibly be due to laboratory contamination. Thorium-230 had an on-site maximum concentration of 0.92 pCi/L with a background UTL of 1.8 pCi/L, and Thorium-232 had an on-site maximum concentration of 0.23 pCi/L with a background UTL of 2.1 pCi/. These five analytes are screened out as COPCs because their reported concentrations are below background.

Based on the low detection frequency of arsenic and its general presence in the region, further evaluation was conducted of arsenic background The NJDEP has published a brochure "*A Homeowner's Guide to Arsenic in Drinking Water*" that identifies the Piedmont Physiographic Province, where MSP is located, as an area with high levels of naturally occurring arsenic in the groundwater. The brochure indicates that 11 out of 72 samples (15 percent) had arsenic in excess of 10 µg/L, with a maximum value of 57 µg/L. Out of a total of 118 samples from the MSP wells analyzed for arsenic, only two (less than 2 percent) had reported detectable concentrations, one at 4.8 µg/L and the other at 5 µg/L. The laboratory reported detection limits in the range of 3.2 to 7.5 µg/L. The arsenic results are consistent with the reported regional background. The two detections in MSP wells are below the USEPA's Drinking Water Standard (MCL) of 10 µg/L. Therefore, arsenic is screened out as a COPC based on the comparison with background.

7.2.1.3 Frequency of Detection Screening – Groundwater

A number of analytes were detected in a few samples at low concentrations. A frequency of detection screen was carried out for those analytes detected at less than 5% of the samples with a maximum value below the EPA Region IX Preliminary Remediation Goal (PRG) for tap water. This combination of low detection frequency and low relative toxicity indicates that the identified analytes pose little risk or hazard to the public. The groundwater analytes had between 100 and 120 sample results each. Therefore, five or fewer detections were established as the screen cutoff. Table 7-1 shows the results used in performing the screen. These screenings left 13 metals, 2 SVOCs, and 6 VOCs in the data set as COPCs for the risk assessment. Nine radionuclides were detected and included in the baseline risk and dose assessments. Table 7-4 lists the contaminants carried forward from the initial data reduction to the risk assessment.

7.2.2 Surface Water

7.2.2.1 Initial Data Reduction – Surface Water

The database of validated surface water sample analyses contains data from 5 locations and a total of 36 sampling events, with over 4,700 individual results organized by analyte and location. Some of the results have been assigned qualifiers based on the laboratory QC criteria. To identify the subset of these data that would be used in the risk assessment, the following screens were implemented:

1. As discussed in Chapter 5, data qualified as unreliable were removed from the risk assessment data set.

2. Any analyte not detected in any surface water sample (i.e., all results for that analyte received a “U” qualifier as a non-detect) was removed from further consideration.

3. Calcium, magnesium, potassium, and sodium were screened out as essential human nutrients.

7.2.2.2 Background Screening – Surface Water

Background for MSP Surface Water is determined based on seven sample events at the upstream location D004. Statistical analyses, described in Appendix Q, were performed on the background data to determine the mean, 95% Upper Confidence Level on the mean (UCL), and 95% Upper Tolerance Limit (UTL) based on the normality or log-normality of the data. Results are listed in Table 7-2. The only organic compound found in background surface water (di-N-octyl phthalate) was not detected in downstream surface water. Analytical results for the following metals in surface water, as shown in Table 7-2, exceeded the background UTL:

- Antimony
- Chromium
- Nickel
- Uranium
- Zinc

Three radionuclides were detected at concentrations below background. Radium-228, Thorium-230, and Thorium-232 are therefore screened out based on these below background concentrations.

Six organic compounds were detected in surface water at MSP:

- Chrysene
- Fluoranthene
- Phenanthrene
- Pyrene
- Benz(a)anthracene
- Benz(b)fluoranthene

7.2.2.3 Frequency of Detection Screening – Surface Water

A number of analytes were detected in a few of samples in the surface water at low concentrations. A frequency of detection screen was carried out for those analytes detected at less than 5% of the samples with a maximum value below the EPA Region IX PRG for tap water. This combination of low detection frequency and low relative toxicity indicates that the identified analytes pose little risk or hazard to the public. The surface water analytes had approximately 30 sample results each. Therefore, 2 or fewer detections was established as the screen cutoff for analytes. Table 7-2 shows the results used in performing the screen.

These screens left five metals and three organics in the surface water data set as COPCs for the risk assessment. Eight radionuclides were detected and included in the baseline dose assessment. Table 7-4 lists the contaminants carried forward from the initial data reduction to the risk assessment.

7.2.3 Sediments

7.2.3.1 Initial Data Reduction - Sediments

The database of validated sediment sample analyses contains data from six locations and four sampling events, with over 3,000 individual results organized by analyte and location. Some of the results have been assigned qualifiers based on the laboratory QC criteria. To identify the subset of these data that would be used in the risk assessment, the following screens were implemented:

1. As discussed in Chapter 5, data qualified as unreliable were removed from the risk assessment data set.

2. Any analyte that did not have a positive detection in a sediment sample (i.e., all results for that analyte received a "U" qualifier as a non-detect) was removed from further consideration as contributing to risk from sediments.

3. Calcium, magnesium, potassium, and sodium were screened out as essential human nutrients.

7.2.3.2 Background Screening – Sediments

Background for MSP sediments is determined from samples at the upstream location D004. Statistical analyses were performed on the background data to determine the mean, 95% Upper Confidence Level on the mean (UCL), and 95% Upper Tolerance Limit (UTL) based on the normality or log-normality of the data. Results are listed in Table 7-3. Organic compounds were not analyzed for either the sediment background or the downstream sediments.

As shown in Table 7-3, two metals, beryllium and iron, were detected that had maximum downstream concentrations below the background UTL. These two metals are not considered further. The remaining detected analytes exceeded the background UTL in at least one sample and were further evaluated.

7.2.3.3 Frequency of Detection Screening – Sediments

Reported metals had a detection frequency greater than 15% with more than sixty samples. Therefore, no analytes are screened out as COPCs for the sediments based on the frequency of detection.

These screens left 17 metals and no organics in the data set as COPCs for the risk assessment. Seventeen radionuclides were found and included in the baseline dose assessment. Table 7-4 lists the contaminants carried forward from the initial data reduction to the risk assessment.

7.3 CONCEPTUAL SITE MODEL

MSP has soil contaminated with a variety of radionuclides and chemicals, as described in the MSP Soils Operable Unit Remedial Investigation Report (URS, 2003). As discussed earlier, some of this contamination appears to have leached and percolated through into the groundwater. Surface water and sediments have been impacted by runoff from the contaminated soils and by discharge of the groundwater from the site.

Exposure to these media are presumed to occur through future household use of groundwater and recreation in the area of contaminated surface water and sediment. Such exposure could potentially occur if unrestricted use of the site was allowed. Exposure to groundwater is by ingestion of drinking water, dermal absorption of shower water, and inhalation of volatilized contaminants in the shower. Exposure of a recreational site user is by dermal absorption from surface water and sediment, incidental ingestion of surface water and sediment, and external exposure to radiation from contaminated sediment. Figure 7-1 describes the contaminant uptake pathways.

7.4 EXPOSURE ASSESSMENT

The exposure assessment defines the exposure setting, identifies receptors and exposure pathways associated with each receptor, estimates concentrations the receptors would encounter in contaminated media, and quantifies the intakes and doses based on exposure to contaminated media. The exposure setting provides the details about MSP (such as current uses, location, and physical characteristics) that could impact future use, and identifies potential future receptor populations and their associated exposure pathways. Exposure concentrations are the contaminant levels that the identified receptors are expected to encounter from contaminated media during exposure. Intakes and doses were quantified using the methodology from RAGS and EPA dermal guidance.

Three types of assessments were performed for exposure at MSP, using different concentration statistics as measures of contamination levels.

- The Reasonable Maximum Exposure (RME) analysis is based on the site concentrations and exposure parameters at upper confidence levels (95% UCL), and represents a bounding estimate for potential impacts. The results of the RME are used as the basis for remedial decision making.
- The Central Tendency Analysis (CTA) incorporates average values for the contaminant concentrations and exposure parameters. The CTA represents the average potential impacts from the site and is considered representative of risks posed to a typical/ average individual. A CTA will be done only for scenarios where the RME generates an estimate of an unacceptable risk level.

- A dose assessment was performed to evaluate impacts from the radiological contaminants (using concentrations and exposure parameters at RME bounding levels) for evaluation with comparison criteria. The dose assessment provides the radiological dose for comparison to potential ARAR levels.

7.4.1 Exposure Setting

MSP is bordered by residential neighborhoods, commercial establishments, undeveloped fields, and an industrial salvage yard. It is an inactive industrial facility surrounded by a chain link fence. The gates are kept locked and access is restricted. No personnel currently work full time on site. The majority of the site is covered with asphalt, ranging from 0.2 to 0.6 m (0.66 to 2 ft) thick. There are currently two buildings on site, but there are no ongoing operations or activities.

Future land use at MSP is not expected to change greatly from current land use over the near term. The presence of the adjacent salvage yard and current industrial zoning reduces the potential for residential development at MSP. Residential development is, however, likely to continue south and southeast of the site. MSP borders the residential zone and may experience the pressures of expanding residential development. The most likely future land use for MSP is expected to be industrial but could potentially be residential. Therefore, a residential land use scenario with household use of site groundwater was evaluated. The use of residential receptors as the basis for evaluating potential impacts is likely to be protective of human health since a potential site user under an industrial land use scenario would have an uptake of groundwater less than that of a resident. A wetlands area south of MSP offers the potential for exposure to contaminated surface water and sediments. A recreational user scenario in this area was evaluated to consider the potential impacts of such an exposure.

7.4.2 Quantification of Exposure, Risk and Hazard Index

Exposure rates for each pathway are calculated according to the methodology set forth in RAGS (EPA, 1989b). For chemical (non-radiological) impacts this is accomplished by estimating the uptake of the contaminant over the period of interest, normalizing to the weight of the person, and averaging over the period of potential impacts, giving the Average Daily Dose (ADD) in milligrams of contaminant per kilogram of receptor body weight per day (mg/kg-day). For carcinogens, the averaging time is a lifetime of 70 years, giving the Lifetime ADD (LADD). The LADD is multiplied by the slope factor (SF) for the pathway (ingestion, inhalation, or dermal) to calculate the carcinogenic risk. The Hazard Index considers the potential for non-carcinogenic impacts and is based on averaging the dose over the period of exposure, with the ADD divided by the appropriate Reference Dose (RfD) for the pathway. Section 7.5 contains a description of the meanings and bases for SFs and RfDs. Radiological impacts are calculated by multiplying the estimated uptake of a radionuclide over the exposure period by the slope factor, and do not require normalization to body weight or exposure period.

Calculation of the annual radiation dose is performed by estimating the uptake of a radionuclide over a one-year exposure and then multiplying by a dose conversion factor

(DCF in mrem/pCi). For uptake of radionuclides (ingestion, absorption, and inhalation), the DCF includes the committed dose.

Mathematically, the risk, hazard, and radiological dose are calculated in the following general manners:

$$CR = LADD_o \cdot SF_o + LADD_d \cdot SF_d + LADD_i \cdot SF_i$$

$$CR_r = IF_o \cdot SF_{r,o} + IF_d \cdot SF_{r,d} + IF_i \cdot SF_{r,i} + IF_e \cdot SF_e$$

where:

CR	=	Carcinogenic Risk for chemicals
CR_r	=	Carcinogenic risk for radionuclides
LADD	=	Lifetime Average Daily Dose
IF	=	Radiological exposure factor
SF	=	Slope Factor for carcinogenic risk
o, d, i	=	Denotes oral, dermal, and inhalation pathways
e	=	Denotes external radiation pathway (radionuclides only)

$$HI = \frac{ADD_o}{RfD_o} + \frac{ADD_d}{RfD_d} + \frac{ADD_i}{RfD_i}$$

where:

HI	=	Hazard Index
ADD	=	Average Daily Dose
RfD	=	Reference Dose for non-carcinogenic hazards
o, d, i	=	Denotes oral, dermal, and inhalation pathways

$$TEDE = IF_o \cdot DCF_o + IF_i \cdot DCF_i + IF_e \cdot DCF_e$$

where:

TEDE	=	Total Effective Dose Equivalent
IF	=	Intake Factor
DCF	=	Dose Conversion Factor between radioactivity uptake and dose
o, i, e	=	Denotes oral, dermal, inhalation, and external dose pathways

The following equations from RAGS are used to calculate the intake factors for the exposure pathways postulated at the MSP:

<u>Ingestion of Drinking Water</u>

For chemical intakes:

$$IF_{DW} = \frac{CW \times IR \times EF \times ED \times CF}{BW \times AT}$$

For radiological intakes:

$$IF_{DW,r} = CW_r \times IR \times EF \times ED$$

IF_{DW}	=	LADD or ADD, based on ED and AT (mg/kg-day)
CW	=	Chemical concentration in water (µg/L)
IR	=	Drinking rate (Liter/day)
CF	=	Conversion Factor (1x10^{-3} mg/µg)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)
$IF_{DW,r}$	=	Intake of nuclide in drinking water (pCi)
CW_r	=	Radionuclide concentration in water (pCi/L)

Dermal Absorption from Water

The intake through the skin of a contaminant in water is given by:

$$IF_{derm,w} = \frac{SA \times DA_{event} \times EF \times ED \times CF1 \times CF2}{BW \times AT}$$

where:

$IF_{derm,w}$	=	LADD or ADD, based on ED and AT (mg/kg-day)
CF1	=	Conversion Factor (1x10^{-3} mg/µg)
CF2	=	Conversion Factor (1x10^{-3} L/cm3)
SA	=	Skin surface area available for contact (cm2)
EF	=	Event Frequency (events/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

The amount absorbed per event is estimated differently depending on whether the contaminant is organic or inorganic.

$$DA_{event} = 2 \cdot C_{w,sh} \cdot FA \cdot K_p \left(\frac{6 \cdot t \cdot t_1}{p} \right)^{0.5} \qquad \text{(Organics)}$$

DA_{event}	=	Dermal Aborbed dose per event (mg/cm2)
$C_{w,sh}$	=	Average chemical concentration in water (µg/L)
K_p	=	Permeability coefficient, chemical-specific (cm/hr)
t_1	=	Exposure time (hr/event)
FA	=	Fraction absorbed (chemical specific)
τ	=	Lag time, chemical-specific (hr)

$$DA_{event} = K_p^w \cdot C_w \cdot t_{event} \qquad \text{(Inorganics)}$$

DA_{event}	=	Dermal Aborbed dose per event (mg/cm2)
C_w	=	Chemical concentration in water (µg/L)
$K_{w,p}$	=	Permeability coefficient in water (cm/hr)
t_{event}	=	Duration of exposure event (hr)

Table 7-5 contains the relevant parameters used to estimate the absorption of organic chemicals contained in the groundwater and surface water.

Inhalation of Vapor

Inhalation of VOCs is postulated to occur at MSP due to volatilization during showering.

$$IF_i = \frac{CW \times ML \times IR \times ET \times EF \times ED \times CF}{BW \times AT}$$

IF_i	=	LADD or ADD, based on ED and AT (mg/kg-day)
CW	=	Chemical concentration in water (µg/L)
ML	=	Mass loading of vapor. Vapor concentration per unit water concentration (µg/m^3 per µg/L)
IR	=	Inhalation rate (m^3/hr)
ET	=	Exposure Time (hr/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
CF	=	Conversion Factor (1x10^{-3} mg/µg)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

The model used to estimate the mass loading of VOCs in the bathroom air is described in the section on residential exposure and in Appendix P.

Dermal Absorption from Sediment

A recreational site user is presumed to be exposed to contaminants in the sediment through dermal absorption. There are only inorganic contaminants detected in the MSP sediments.

$$IF_{derm,s} = \frac{CS \times CF \times SA \times AF \times ABS \times EV \times EF \times ED}{BW \times AT}$$

$IF_{derm,s}$	=	LADD or ADD, based on ED and AT (mg/kg-day)
CS	=	Chemical concentration in sediment (mg/kg)

CF	=	Conversion Factor ($1x10^{-6}$ kg/mg)
SA	=	Skin surface area available for contact (cm2)
AF	=	Adherence Factor to skin (mg/cm2-event)
ABS	=	Dermal Absorption Fraction
EV	=	Events per day (event/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

Incidental Ingestion of Sediment

A recreational site user is presumed to incidentally ingest contaminants in the sediment. There are only inorganic contaminants detected in the MSP sediments.

$$IF_o = \frac{CS \times IR \times CF \times EF \times ED}{BW \times AT}$$

For Radiological intakes:

$$IF_{o,r} = CS_r \times IR \times EF \times ED$$

IF_o	=	LADD or ADD, based on ED and AT (mg/kg-day)
CS	=	Chemical concentration in sediment (mg/kg)
IR	=	Ingestion rate (mg sediment/day)
CF	=	Conversion Factor ($1x10^{-6}$ kg/mg)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)
$IF_{o,r}$	=	Oral intake of nuclide in sediment (pCi)
CS_r	=	Radionuclide concentration in sediment (pCi/g)

External Radiation Exposure

$$IF_e = CS_r \times ET \times EF \times ED$$

IF_e	=	Exposure (year –pCi/g)
CS_r	=	Radionuclide concentration in sediment (pCi/g)
ET	=	Exposure Time (hr/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)

7.4.3 Receptors and Exposure Pathways

Two scenarios are evaluated for potential future users of the MSP site. A potential future resident on the site is assumed to use groundwater for household purposes, including drinking and bathing. A recreational user would not be exposed to groundwater directly, but would have potential uptake from the surface water and sediments in the wetlands south of the site.

7.4.3.1 Residential

An on-site residential scenario was evaluated to establish a risk baseline that represents potential risks if the site was released with no restrictions. This residential receptor represents EPA's reasonable maximum exposure residential scenario. Because the property is currently zoned industrial, such a residential scenario is unlikely to occur. The scenario assumes that a residential receptor is exposed to groundwater by direct ingestion, dermal contact during bathing, and inhalation of VOCs by volatilization during bathing.

Exposure guidance is provided in the *Exposure Factors Handbook* (EFH) (EPA 1997b). The EFH recommends a drinking water ingestion rate of 2 L/day for 350 days per year for adults and adolescents, with an anticipated span of 30 years of residential exposure. The child portion is estimated as 6 years with the remaining 24 years as adult. Assuming an age range of 0 to 6 years for child body weight ensures that the risk analysis is protective of human health. The split between adult and child exposures is used to assess carcinogenic impacts. Non-carcinogenic impacts to residential children are addressed separately to take into consideration the higher normalized dose received by children, due to lower body weight, results in a greater risk for non-cancer health effects. Residents are assumed to spend a total of 350 days per year on the site. During each day, the resident adult ingests 2 L of groundwater, a child drinks 1.3 L of groundwater, and both take a 15 minute shower.

Exposure includes dermal absorption and inhalation of VOCs that volatilize during the shower. It is estimated that the VOCs partition 75 percent into vapor and 25 percent into the liquid phase. A shower model has been implemented based on the approach of Schaum (Schaum, 1994) that calculates the average VOC air concentration in a bathroom during and after the shower. Uptake by the resident is then calculated based on inhalation of the vapors for 15 minutes in the shower and 5 minutes in the bathroom afterwards each day for 350 days per year for 30 years. A description of the shower model is included in Appendix P. Dermal exposure for a resident is based on the total skin surface area being wetted in the shower. The breathing rate for adults is taken at 0.63 m^3/hr and for children is taken as 0.35 m^3/hr based on Table 15-18 of the EFH (EPA 1997b). All exposure parameters for the RME Resident are listed in Table 7-6a.

Risk from carcinogenic effects is averaged over a lifetime of 70 years. Non-carcinogenic hazards are averaged over the 30 year period of exposure for a resident based on recommendations in the EFH (EPA, 1997b). For the Resident Child, non-carcinogenic hazards are averaged over the six year exposure period.

For the CTA, exposure parameters are changed to assume that the average length of residence time is 9 years, the mean body weight is 70 kg for adults and 15 kg for children, the average duration of a shower is 15 minutes, and the drinking water rate is 1.4 L/day for adults and 0.88 L/day for a child (EPA, 1997b). Table 7-6b lists the parameters used in the analyses.

As part of identifying probable exposure pathways during the exposure assessment, no consideration is given for indirect pathways, such as a home garden. There are only small areas of the site that would be accessible for agriculture and these have relatively low levels of contamination. The potential for significant exposure through food grown with irrigation by site groundwater is considered unlikely and was not evaluated further.

7.4.3.2 Recreational

The recreational trespassing child receptor represents land use by a trespassing child living in nearby residential areas. This receptor is designed to account for occasional exposure to contaminated surface water and sediments during recreational activities. This analysis assumes that the receptor is exposed through dermal contact to the surface water and sediment, incidental ingestion of surface water and sediment, and external radiation exposure to the sediment. The receptor is considered to be a child trespassing on site for nine years from the age of 6 to 15. Trespassing activities are assumed to average two hours per event, occurring one day every other week. This activity is likely to be greater in the summer and less frequent in the winter. The average is 39 times per year. A child was chosen to represent this exposure scenario because trespassing by a child is more likely than by an adult. The 95^{th} percentile weight for age 9 is 24 kg. For the recreational site user, the lower extremities (feet and legs) and hands are exposed for 78 hours per year to surface water and sediments. Under the RME analysis, ingestion of contaminated sediment is assumed to occur at a rate of 200 mg/day for the 39 days per year that the trespasser is on the site. Exposure parameters are listed in Table 7-6c.

For the CTA, exposure point concentrations are taken as the same as for the RME analysis, and exposure parameters changed to reflect representative exposure. Table 7-6d lists parameters for the scenarios involving sediment and surface water exposures.

Risk from carcinogenic effects is averaged over a lifetime of 70 years based on recommendations in the EFH (EPA, 1997b). Non-carcinogenic hazards are averaged over the 9 year period of exposure for the recreational user.

7.4.4 Exposure Concentrations

The exposure point concentrations (EPCs) used in the RME, CTA and dose calculations were calculated following the recent EPA guidance on the calculation of UCLs (EPA 2002, *Calculating Upper Confidence Limits for Expsoure Point Concentrations at Hazardous Waste Sites, OSWER 9285.6-10, December 2002*) and as implemented in the EPA code ProUCL.

7.4.4.1 Groundwater

The potential future residential exposure will most likely occur from a well at a single location. However, groundwater movement during the exposure period will result in a range of concentrations at the well installed by the resident. In order to evaluate the potential risks from the COPCs, the cancer risk, hazard index, and radiation dose were calculated using Exposure Point Concentrations (EPCs) based on the 95% UCL across all wells and all groundwater sampling events. This serves to identify those COPCs that may reflect risk, hazard, and/or compliance issues on an individual basis. To evaluate the range of potential risk or hazard from the site, the risk, hazard, and dose that would be received from any single well were calculated using the 95% UCL over time for the RME and CTA assessments. Table 7-7 lists the EPCs for groundwater COPCs and the statistical method used in their calculations. A detailed description of the statistical methodology is presented in Appendix Q. That Appendix also contains the full set of statistical analyses that are summarized in the main report.

An adjustment is made to the statistically derived EPC for Thorium-234. Th-234 is a decay product of Uranium-238, with a half-life of 24.1 days. With such a short half-life, Th-234 would be expected to be in radioactive equilibrium with its parent. However, the Q2 2000 ES sample from Well B18W28S had a reported value of 432 pCi/L for Th-234 while U-238 was at 2 pCi/L. This data point produces an extremely high UCL. The Th-234 concentration is reported by use of gamma spectrometry identifying a low energy, low abundance gamma, which are sensitive to very slight statistical variations in counting. Since it is highly unlikely that the Th-234 would be present in such a high concentration without a corresponding U-238 level, the EPC for Th-234 in groundwater is set equal to that of U-238. The sediment EPC for Th-234, 20.6 pCi/g at the 95% UCL, is comparable to that of U-238 (22.3 pCi/g), and therefore no adjustment is made for sediments.

Individual risk calculations were conducted for the wells with the highest concentrations of the most significant contributors to radiological risk, chemical risk, and chemical hazard. The contaminants of interest are identified based on the site wide calculations. As discussed in Section 7.5, the uranium isotopes U-234 and U-238 contribute the most (70%) to the radiological risk. Well B18W24S has the highest uranium concentrations, representing the highest radiological risk. Carbon tetrachloride is the dominant chemical carcinogen (80%) and were only detected in Well URSMW2D. Manganese was the only metal other than uranium to have a Hazard Index greater than 1, and it represents over 75% of the total site hazard. Well URSMW2S, located adjacent to URSMW2D, has by far the highest concentration of manganese, and produces the highest chemical hazard. As shown in Figure 7-2, the URSMW2 well set is in the north central portion of the site, east of the former process building and in the area of some of the highest reported concentrations of metals in soil. Well B18W24S is at the northern edge of the site, in the area of the former process building. EPCs for these wells are listed in Table 7-8.

7.4.4.2 Surface Water

Exposure to surface water may occur to a recreational user that traverses across the site, and therefore it is appropriate to identify an average concentration of contaminants over the sampling points. The RME EPC is established as the 95 percent upper confidence limit (UCL) on the mean. For the contaminants with less than five samples, and therefore insufficient statistical basis to calculate the UCL, the EPC is taken as the maximum detected concentration. Table 7-9 summarizes the EPCs for the surface water and the statistical methods used to calculate the UCLs, with a description of the statistical methodology and analysis contained in Appendix Q.

7.4.4.3 Sediments

Exposure to sediments may occur to a recreational user that traverses across the site, and therefore it is appropriate to identify an average concentration of contaminants over the sampling points. The RME exposure point concentration is calculated in the same manner as for surface water. The EPCs for chemical and radiological sediments COPCs are listed in Table 7-10, with a description of the statistical methodology and analysis contained in Appendix Q.

7.5 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to evaluate the potential of COPCs to cause adverse health effects in exposed individuals. Where applicable, the assessment provides an estimate of the relationship between the extent of exposure to a COPC and the increased likelihood or severity of adverse health effects as a result of that exposure, relative to a baseline. The toxicity assessment generally involves two steps: (1) deciding whether exposure to an agent can cause an increase in the incidence of a particular health effect (and whether that health effect will occur in humans) and (2) characterizing the relationship between the received intake or radiological dose and the incidence of adverse health effects in exposed populations.

The evaluation of potential adverse effects from exposure to contaminants is carried out for both carcinogenic (cancer) effects and non-carcinogenic impacts. The relationship between the dose to an individual and the risk of an adverse effect is based on factors developed through extensive research and evaluation. For carcinogenic effects, the relationship is contained in the slope factor (SF). At sufficiently low doses or exposures the relationship between cancer risk and dose is assumed to be linear, i.e., a straight line[1]. The slope of this line is called a slope factor. SF units are $(mg/kg/day)^{-1}$.

Non-carcinogenic impacts are quantified by comparison with a RfD for ingestion (and a Reference Concentration (RfC) for inhalation.) The RfD is a quantity derived from either a No Observed Adverse Effect Level (NOAEL) or Lowest Observed Adverse Effect Level (LOAEL)[2]. The RfD is derived from the NOAEL or LOAEL by the consistent application of order-of-magnitude uncertainty factors where the uncertainty factor values are based on the type of study - animal or human, chronic or sub-chronic. Thus, the RfD for a particular chemical is an estimate of a daily exposure to the human population that is unlikely to have deleterious effects during a lifetime. Both the SF and RfD are dependent on the specific chemical or isotope, and can vary with the chemical form of the material.

Chemical-specific RfDs and SFs for the dermal pathway are derived from the corresponding oral factors in accordance with EPA guidance in RAGS Part E (EPA, 2001a). For the chemicals identified by EPA, the Dermal RfD is calculated by multiplying the Oral RfD by the gastrointestinal (GI) absorption factor, yielding the actual uptake upon which the Oral RfD is based. Similarly, the Dermal SF is found by dividing the Oral SF by the GI absorption factor. This route-specific modification is not recommended for the organics, but is recommended for a number of metals, including antimony, barium, beryllium, cadmium, chromium, manganese, nickel, silver, and vanadium. These are materials with low (less than 50 percent) GI absorption fractions. The adjustment of Dermal RfDs from Oral RfDs is shown in Table 7-11.

Table 7-11 lists the SFs and RfDs for the non-radiological COPCs that were used in the assessment. The primary source for toxicity factors (slope factors and Reference Doses) is IRIS. For chemicals without toxicity factors on IRIS, the 1997 HEAST was examined as another source. EPA's National Center for Environmental Assessment (NCEA) policy, however, is that non-IRIS toxicity factors, including the 1997 HEAST, more than 3 years old must be reevaluated by EPA's Superfund Technical Support Section, part of NCEA.

[1] ***EPA's Approach to Assessing the Risks Associated with Chronic Exposure to Carcinogens-Background Document 2 January 17, 1992 at http://www.epa.gov/iris/ carcino.htm*** and ***Guidelines for Carcinogen Risk Assessment (NCEA-F-0644, July 1999, Review Draft) at*** http://www.epa.gov/ncea/raf/pdfs/cancer_gls.pdf

[2] ***Reference Dose (RfD): Description and Use in Health Risk Assessments Background Document 1A March 15, 1993 at http://www.epa.gov/iris/rfd.htm***

7.5.1 Special Cases of COPCs

Of the COPCs identified through the data screening process, risk and hazard factors are not available to evaluate lead and phenanthrene. Therefore, the significance of these contaminants is evaluated based on other factors such as regulatory standards.

Lead is a heavy metal that was detected at a maximum concentration of 4.6 μg/L and a 95% UCL of 3.2 μg/L in the MSP groundwater. EPA has established an action level of 15 μg/L for drinking water at the tap. This indicates that lead in the MSP groundwater is not a threat to human health.

Lead was detected in the MSP sediments at a maximum concentration of 483 μg/L and a 95% UCL of 120 μg/L. EPA Region IX has published guidance, corresponding to a hazard index of 1 for non-cancer effects, of Preliminary Remediation Goals in Residential Soil of 400 μg/L, and for Industrial Soil of 750 μg/L. The maximum detection is only slightly above the PRG, and the UCL is well below the Residential soil PRG. This indicates that lead in the MSP sediments is not a threat to human health.

Phenanthrene is a Polynuclear Aromatic Hydrocarbon (PAH) that was detected in a single surface water sample (out of 29 samples) at a concentration of 0.91 μg/L. While toxicity values are not available for Phenanthrene, New Jersey has a generic groundwater criteria that can be used to judge the potential impacts. According to the NJDEP Class 2A Groundwater Quality Standards, a synthetic organic chemical with evidence of carcinogenity lacking specific or interim specific criteria has an Interim Generic Groundwater Quality Criteria of 5 μg/L. The detected concentration of Phenanthrene is less than 20% of this criterion, indicating that the Phenanthrene is not a threat to human health.

Radiological contaminants in the environment contribute impacts to carcinogenic risk only. Radiation at environmental levels, such as found at MSP, does not cause non-carcinogenic effects. The chemical risks from elements, such as uranium, are dealt with separately, as in uranium metal.

Uranium toxicity is due to both chemical and radiological effects. Its impact from chemical effects has been evaluated using the toxicity for uranium (soluble salts). Radiological impacts from uranium as well as other nuclides are estimated based on the concentrations of the particular isotopes. Several isotopes, including Ra-226, Ra-228, Th-228, U-235, and U-238, were evaluated using the +D slope factors that account for the toxicity from short-lived decay chain members. The slope factors and dose conversion factors for radiological COPCs are listed in Table 7-12. Radiological slope factors were obtained from Federal Guidance Report No. 13, *Cancer Risk Coefficients for Environmental Exposure to Radionuclides*, EPA-402-R-99-001, Sept 1999.

Dose factors for ingestion of radionuclides were obtained from Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, EPA-520/1-88-020, Sept, 1988. External radiation dose factors were obtained from Federal Guidance Report No.12, *External Exposure to Radionuclides in Air, Water, and Soil*, EPA-402-R-93-081, Sept 1993.

7.5.2 Trichloroethene

Two cancer slope factors have been used to estimate cancer risks due to TCE: 1.) a factor that has been withdrawn by the U.S. EPA from their IRIS database and 2.) a proposed slope factor that has not been fully reviewed or incorporated into IRIS. The U.S. EPA has prepared a new assessment of TCE toxicity proposing a range of cancer slope factors and a Reference Dose for non-cancer health effects. In addition to generating significant review comment, several EPA Regions and state environmental agencies are either not using these values or using them only in evaluating potential risks at sites, but not in setting cleanup levels. The methodologies used in the new TCE assessment have thus proven quite controversial.

Several cancer slope factors have been proposed for TCE with the highest factor increasing the cancer risk estimate by a factor of 36.4. This upper bound slope factor is based on an epidemiological study that examined cancer rates in a 75-town area in New Jersey. For homes where the MCL was exceeded in this study, the average concentration was 23 µg/L with a maximum of 67 µg/L. Female residents had increased instances of leukemia and non-Hodgkin's lymphoma.

There are, however, a number of questions with respect to this study. One problem is that the increased cancer rates may be statistical anomalies. When two groups (a control group and a test group) are compared to see if an effect is occurring in the test group, the statistical tests are normally set up to determine that there is an effect if the difference has less than a 5 percent chance of being due to random variation rather than a true difference. But when two groups are compared for a number of variables (such as 20-30 types of cancer in total, male, and female populations), the 5 percent cutoff applied to 60-90 comparisons implies that some of these comparisons will appear to be statistically significant. Other studies have been done which have not documented similar increases in leukemia or non-Hodgkins lymphoma. Thus, there is a question as to whether these increased cancer incidences are truly significant.

Also, residents in the study were exposed to other contaminants in addition to TCE that may have contributed to cancer risks. There are also difficulties with the use of the average concentration based on measurements made during a limited time period; these may not be adequately indicative of the long-term concentration exposures of the residents.

With respect to the Reference Dose, uncertainty factors were applied in a substantially different manner than EPA usually uses, including an adjustment for background exposure, resulting in a Reference Dose that is about two orders of magnitude lower than those for similar chemicals.

EPA withdrew the cancer slope factor of 0.011 (mg/kg/day)-1 for TCE in 1989 from the IRIS database. Although withdrawn, this value was most commonly used in risk assessments until recently. In 1999, EPA released the new assessment of TCE toxicity, proposing a range of slope factors for cancer potential and an RfD for non-cancer health effects. EPA toxicologists in Regions 4 and 8 have stated that they have significant issues with the proposed slope factors. Regions 7, 9, and 10 currently have policies requesting that risk assessments be conducted using both the withdrawn and proposed slope factors. California has developed its own slope factor for TCE and recommends that its value be used on sites where the state has the lead.

Because of this controversy regarding TCE toxicity values, potential estimates of cancer risks from TCE presented in this BHHRA are based on the slope factor withdrawn from IRIS in 1989 (0.011 per mg/kg-d). Non-cancer health risks due to TCE are not assessed in the main body of this BHHRA because no approved Reference Dose has been developed for TCE. However, for information purposes, potential cancer risks were characterized using both slope factors and the potential for non-cancer health effects using the proposed Reference Dose have been evaluated and are presented in Appendix S.

7.6 RISK CHARACTERIZATION

Impacts due to exposure to radionuclides were considered separately from non-radionuclide impacts. This approach was based on the EPA recommendation of summing radiological and non-radiological risks. The mode of cancer induction by radiation is different than chemical modes (EPA 1996b, EPA 1989b.) The mode of cancer induction by radiation is different than chemical modes (EPA 1996b, 1989b.) Hence the risks from chemical and radiological exposures are calculated in this characterization both separately and combined. Table 7-13 summarizes the results from these calculations. Tables 7-14 through 7-30 list the pathway radiological and chemical risks and hazard indices for the RME cases for exposure to groundwater for the Resident and Resident Child, with EPCs based on site wide averages and individual wells for the highest chemical risk, radiological risk, and hazard index. Tables 7-31 through 7-35 list the risks and hazards from exposure to surface water and sediments for the RME Recreational User. CTA results for the groundwater exposure pathways are listed in Tables 7-36 through 7-51. Radiological doses for the different scenarios are presented in Tables 7-52 through 7-57. The following paragraphs discuss the dose and risk results for each receptor.

Current federal Superfund guidelines for acceptable exposures are a reasonable maximum individual lifetime excess cancer risk in the range of 10^{-4} to 10^{-6} (corresponding to a one-in-ten thousand to a one-in-a-million excess cancer risk).

For non-cancer health effects, a "hazard Index" (HI) is calculated. An HI represents the sum of the individual exposure levels compared to their corresponding reference doses (RfDs). The key concept for a non-cancer hazard index is that a "threshold level" (measured as an HI of 1) exists below which non-cancer health effects are not expected to occur.

7.6.1 Residential

Calculations of carcinogenic risk and hazard index were made assuming that exposure to groundwater was to the 95% UCL concentration of COPCs, to allow evaluation of risk across the site. Excess cancer risk and hazard indices have also been calculated for potential exposure to groundwater from three different wells, representing the highest radiological risk (well B18W24S), the highest chemical risk (well URSMW2D), and the highest hazard index and (well URSMW2S). Table 7-13 summarizes the risk, hazard index, and radiation dose estimates for each scenario.

Risk from the background concentrations of COPCs is $4x10^{-5}$ (Table 7-14) based on RME parameters, and is due entirely to radiological constituents in the drinking water. The background HI is 2 (Table 7-15), primarily due to the presence of Manganese in the drinking water. Similarly, the background HI for a Resident Child receptor is 6 (Table 7-16).

Under RME assumptions and the site wide EPCs, the excess cancer risk to a future MSP site resident is $1x10^{-4}$, including $1x10^{-4}$ from radiological uptakes (Table 7-17) and $2.1x10^{-5}$ from chemical exposure (Table 7-18). Risk from uranium isotopes (U-234, U-235 and U-238) comprises $7.2x10^{-5}$ of the risk (72 percent of the total). Chemical risk is primarily due to ingestion of VOCs in drinking water. The HI under the site RME scenario is 5 (Table 7-19), of which 78% is due to the uptake (primarily drinking) of manganese. The HI for the Resident Child is 14 (Table 7-20), of which 11 is from manganese and 1.7 is from drinking water with uranium.

The total risk due to exposure to the groundwater from well B18W24S is estimated at $6x10^{-4}$, essentially all of which is from ingestion of uranium isotopes in the drinking water (Table 7-21). There were no chemical COPC carcinogens detected in groundwater samples collected from this well. The RME HI from B18W24S is 5 (Table 7-22), of which 95% is due to the uptake of uranium. The HI for the Resident Child exposed to water from B18W24S is 15 (Table 7-23), of which 14 is due to the uptake of uranium. Groundwater from this well poses the highest radiological and total risk.

The total risk due to exposure to the groundwater from well URSMW2D is estimated at 2×10^{-4}, of which the chemical portion of 1.8×10^{-4} is due totally to organic contaminants (Table 7-24). Chemical risk from this well's groundwater is primarily due to carbon tetrachloride (1.4×10^{-4}). Radiological risk (4.2×10^{-5}) is primarily from Ra-226 (3.9×10^{-5}), as shown in Table 7-25. Groundwater from this well has an HI of 2.2 (Table 7-26), mostly from carbon tetrachloride (2.0). The Resident Child HI is 6 (Table 7-27), mostly from carbon tetrachloride (5.8). This well poses the highest chemical risk.

The total risk due to exposure to the groundwater from well URSMW2S is estimated at 1×10^{-4}, due entirely to ingestion of radionuclides in drinking water (Table 7-28). There were no chemical COPC carcinogens detected in this well. Groundwater from this well has an HI of 9 (Table 7-29), from manganese (8.0) and uranium (0.7). The Resident Child HI is 26 (Table 7-30), with manganese at 24 and uranium at 2.1. This well poses the highest chemical hazard.

7.6.2 Recreational User

The recreational trespasser assumes potential exposure to surface water and sediments. This scenario assumes a child is exposed over a period of 9 years, from the ages of 6 to 15 years. The risk includes 5×10^{-6} from chemical exposure, mostly arsenic as shown on Table 7-31, and 1.2×10^{-5} from radiological exposure (Table 7-32), for a total risk of 2×10^{-5}. The HI is 0.2, with arsenic, manganese, and uranium the largest contributors.

The background radiological risk from COPCs is 6×10^{-6} (Table 7-33), along with a chemical risk of 2×10^{-6} (Table 7-34). The Hazard Index due to background COPCs is 0.1 (Table 7-35).

When compared against background, the surface water and sediment exposure scenarios do not exceed EPA risk management guidelines.

7.7 CENTRAL TENDENCY ANALYSIS

The CTA differs from the RME risk assessment by using average (mean) values for the exposure periods of the industrial and residential receptors and for various uptake parameters. The 95% UCL concentrations are used as the EPCs, as they were for the RME analysis, and are listed in Table 7-7. Tables 7-8 and 7-9 contain the CTA EPCs for the surface water and sediments, respectively.

Cancer risks and hazard indices have been calculated using CTA values for the site wide averages and for the three wells identified as having the greatest RME radiological (and total) risk, chemical risk, and hazard index. Table 7-13 summarizes all CTA scenarios.

Tables 7-36 through 7-51 detail the CTA risk and hazard calculations for the same wells discussed under the RME analysis and for the site wide average concentrations.

Risk from the background concentrations of COPCs is 9×10^{-6} (Table 7-36) based on CTA parameters, and is due to radiological constituents in the drinking water. The background HI is 1 (Table 7-37), due to the presence of Manganese in the drinking water.

Under CTA assumptions and the site wide EPCs, the excess cancer risk to a future MSP site resident is 3×10^{-5}, including 2×10^{-5} from radiological uptakes (Table 7-38) and 8×10^{-6} from chemical exposure (Table 7-39). Risk from uranium isotopes (U-234, U-235 and U-238) comprises 1.5×10^{-5} of the risk. Chemical risk is primarily due to ingestion and inhalation of VOCs. The HI under the site CTA scenario is 3, of which 2.6 is due to the uptake (primarily drinking) of manganese (Table 7-40). The HI for the Resident Child is 9 (Table 7-41), of which 7.3 is from manganese.

The total CTA risk due to exposure to the groundwater from well B18W24S is estimated at 1×10^{-4} (Table 7-42) from radiological contaminants, and the HI is 3 for the Resident (Table 7-43) and 9 for the Resident Child (Table 7-44), due to uptake of uranium in drinking water. There were no chemical COPC carcinogens detected in groundwater samples collected from this well.

Estimates for CTA exposures from wells URS MW2D and URSMW2S do not involve different EPCs from the RME calculations. Only two sampling rounds have been completed in each of those wells, meaning that statistics can not be generated to allow calculation of a UCL, and the EPC is therefore the maximum detected concentration.

The total risk due to exposure to the groundwater from well URSMW2D under CTA assumptions is estimated at 8×10^{-5}, of which the chemical portion of 7.2×10^{-5} is due totally to organic contaminants (Table 7-45). Chemical risk from this well's groundwater is primarily due to carbon tetrachloride (5.4×10^{-5}). Radiological risk (9×10^{-6}) is primarily from Ra-226 (8.3×10^{-6}), as shown in Table 7-46. Groundwater from this well has an HI of 2 (Table 7-47), mostly from carbon tetrachloride (1.5). The Resident Child HI is 4 (Table 7-48), mostly from carbon tetrachloride (4).

The total risk due to exposure to the groundwater from well URSMW2S is estimated at 3×10^{-5}, due entirely to ingestion of radionuclides in drinking water (Table 7-49). There were no chemical COPC carcinogens detected in this well. Groundwater from this well has an HI of 6 (Table 7-50), from manganese (5.7) and uranium (0.5). The Resident Child HI is 18 (Table 7-51), with manganese at 16 and uranium at 1.4.

7.8 DOSE ASSESSMENT

A dose assessment was performed to evaluate impacts from the radiological contaminants (using concentrations and exposure parameters at RME bounding levels) for evaluation with comparison criteria. The dose assessment provides the radiological dose for comparison to potential ARAR levels.

Radiation doses from groundwater are predominantly due to ingestion of uranium in drinking water. The annual radiation dose projected for a site resident, based on RME assumptions and site-wide EPCs, is 10 mrem/year (Table 7-52), compared to a background contribution from COPCs of 3 mrem/yr (Table 7-53).

Groundwater from well B18W24S is particularly high in radioactivity. In this well, the drinking water pathway generates a dose of 66 mrem/yr, 99.5% of which is due to uranium isotopes. This is based on the use of maximum detected concentrations as the EPCs due to the limited number of samples from the well. Table 7-54 lists the contributions from each nuclide detected in the groundwater at B18W24S. This dose rate exceeds the 15 mrem per year threshold established in the NJ site remediation criteria at NJAC 7:28-12.

Using CTA exposure parameters, the annual dose from drinking water from well B18W24S is estimated at 46 mrem/yr, as listed in Table 7-55.

A recreational user of the MSP site would receive a radiation dose from the incidental ingestion of surface water and sediments, as well as from external radiation from contaminated sediments. The annual dose projected for that scenario, using RME assumptions, is 1.3 mrem/yr, shown in Table 7-56, compared to a background of 0.5 mrem/yr (Table 7-57).

7.9 UNCERTAINTY

The Baseline Risk Assessment has incorporated a number of assumptions and calculation methodologies that are intended to provide confidence that the estimated risk and hazard from the site have been conservatively described. The uncertainty associated with the assessment can be divided into the following areas:

Exposure Point Concentrations – As discussed in Section 5.0, the database for groundwater at the MSP contains data from a limited number of sampling events, with some wells having only one or two sampling events. Potential contributions from off-site contaminant sources have not been adequately characterized. Only groundwater from one well (B18W24S) shows consistently high concentrations of uranium. Most of the organic constituents have had sporadic detections in groundwater from a number of different wells.

Because of the limited duration of sampling data, the maximum detected concentrations in samples from some wells were used as the exposure point concentrations for those wells. Based on the data for wells with multiple sampling events, the use of maximum concentrations likely overstates the EPC relative to the usual use of 95% UCLs.

Background levels have also not been well defined due to limits on well placement and sampling.

Toxicity Factors – The Slope Factor used to estimate carcinogenic risk from TCE was withdrawn by EPA in 1989, for the reasons discussed in Section 7.5.2. The calculated cancer risk of $1.2x10^{-5}$ from exposure to water from well URSMW2D would increase to $3x10^{-4}$ if the proposed slope factors of 0.4 $(mg/kg\text{-}d)^{-1}$ for ingestion and 0.018 $(mg/kg\text{-}d)^{-1}$ for inhalation were used instead of the withdrawn value of 0.011 $(mg/kg\text{-}d)^{-1}$ for both exposure modes. Even with the higher slope factor, the carcinogenic risk posed by TCE is about at the upper end of the EPA risk management range. Therefore, TCE is not considered a significant contaminant at the MSP.

Exposure Parameters – It has been assumed that the prospective site resident would use MSP groundwater for household purposes, including drinking and bathing. While there is some use of groundwater in residences near MSP, it appears that the quality and availability of water in the shallow bedrock aquifer would not be adequate for general residential use. The use of residential receptors as the basis for evaluating potential health impacts is intended to be protective of human health.

7.10 SIGNIFICANT CONTAMINANTS

The cancer risk calculated for future Resident exposure to MSP groundwater exceeds the EPA risk management threshold of $1x10^{-4}$ for the RME approach. The Hazard Index calculated for future Resident and Resident Child exposure to MSP groundwater exceeds EPA risk management threshold of unity for both the RME and CTA approaches. This indicates that contamination exists on the site at potentially unacceptable levels. No COPCs exceed these criteria for the recreational trespasser scenario. Identification of COCs starts with the risk from the contaminant exceeding the EPA risk management threshold of $1x10^{-6}$ or the chemical having an HI exceeding unity (i.e., one). Those contaminants with such risk or hazard are further considered based on background levels, detection frequency, and other regulatory criteria that may be relevant.

For the site-wide EPC evaluation of groundwater impacts, carbon tetrachloride creates a risk of $1.2x10^{-5}$. For calculations based on Well URSMW2D concentrations, the risk from carbon tetrachloride is $1.4x10^{-4}$. Other COPCs have risks in the range of 10^{-5} - 10^{-6} and are not considered as COCs.

A single COPC exceeds an HI of 1 for the RME residential adult and child receptors based on site-wide EPCs: manganese (3.6 for the adult/11 for the child). Uranium (0.6/1.7) has an HI greater than 1 just for the Resident Child receptor. Carbon tetrachloride (2/6) has an HI of 2 when the EPC is based on the data from URS MW2D.

Manganese has a 95% UCL of 2990 μg/L. It was detected at a high frequency over the site and over time, and is projected to create a chemical hazard above the acceptable threshold. Manganese is therefore characterized as a COC.

Total Uranium has an HI of 2 for the Resident Child scenario. However, it was detected at a high frequency over the site and had a UCL of 60 μg/L, twice the drinking water criterion of 30 μg/L. Uranium is therefore characterized as a significant contaminant.

Carbon tetrachloride poses significant carcinogenic risk and hazard from groundwater exposure pathways. The drinking water standard is 5 μg/L. The two detections of carbon tetrachloride occurred in groundwater samples collected from the same well (URSMW2D). Based on the high concentration detected in groundwater from that well (46.2 μg/L) and the exceedance of drinking water standards, carbon tetrachloride is characterized as a significant contaminant.

Risk from radionuclides in groundwater is about $1x10^{-4}$, with corresponding background of $4x10^{-5}$, as shown in Tables 7-14 and 7-17, coming from the combination of Ra-226, Ra-228, Th-234, U-234, U-235, and U-238.

Ra-226 (95% UCL = 1.2 pCi/L) and Ra-228 (UCL = 0.4 pCi/L) have a combined (Total Radium) drinking water standard of 5 pCi/L. The detected concentrations of the radium isotopes are comparable to background, and the concentrations are below the established drinking water standards. Therefore, Ra-226 and Ra-228 are not classified as COCs.

The net risk from Uranium-238, U-235, U-234, and Th-234 is about $8x10^{-5}$ above background. This is near the upper limit of the EPA risk management range. Doses from uranium isotopes in the drinking water in well B18W24S exceed 60 mrem per year, significantly above the 15 mrem per year threshold established in the New Jersey site remediation criteria at NJAC 7:28-12. Th-234 is a decay product of U-238, and its presence is dependent on that of U-238. U-235 is part of the natural uranium activity, and contributes a relatively small portion of the risk and dose. Based on the high risk potential and radiological doses, U-238 and U234 are considered COCs.

7.11 SUMMARY

The evaluation of the potential risks to human health resulting from exposure to groundwater contamination at MSP examined a Residential receptor (including a Child

Resident), and a Recreational Trespassing Child. The Residential scenario provides an estimate of health impacts that is protective in that it presumes complete household use of groundwater. Table 7-13 provides a summary of the exposure scenarios and pathway totals for risks and hazard indices. The risk assessment concludes that:

- The potential carcinogenic risks associated with groundwater are approximately 1×10^{-4}, which places the site at the upper limit of the target EPA risk management range.

- Hazard indices exceed unity for the Resident and Child Resident scenarios for groundwater exposure. This indicates that potential non-carcinogenic impacts are likely to be above acceptable levels.

- Radiation doses for drinking water (i.e., groundwater) in the residential RME and CTA scenarios exceed a 15 mrem annual dose for the well with the highest radiological contamination (B18W24S), but not for the RME analysis based on site-wide EPCs.

- Exposure to sediments and surface water at MSP do not pose unacceptable risk or hazard.

Based on the risks and hazards calculated for the COPCs, the following chemicals have been identified that pose potentially unacceptable risks or hazards, and are characterized as COCs:

- Uranium
- Manganese
- Carbon Tetrachloride
- U-238
- U-234.

7.12 EVALUATION OF POTENTIAL OFF-SITE IMPACTS

The above baseline risk assessment indicates that the risk and hazard from potential exposure to groundwater at the site exceed EPA risk management guidelines. To consider the potential for future off site impacts from the current contamination, the transport of contaminants modeled in Section 6 were compared to the concentrations used in the risk assessment.

The most significant contaminants in the MSP groundwater are the radionuclides U-238 and U-234; the metals manganese and uranium; and the organics TCE and carbon tetrachloride. The nuclides and organics have different source terms on the site, and behave differently in the groundwater. The transport model developed in Section 6 is intended to be protective of human health, to allow for an evaluation of the potential for offsite concentrations above regulatory compliance limits. It is not intended to provide a realistic prediction of the actual movement of the contaminants in the groundwater or to predict the future concentrations at particular locations. The following sections discuss the potential for unacceptable impacts from the site contaminants.

7.12.1 Radionuclides

The transport model, as seen in Table 6-3, conservatively estimates that the uranium isotope concentration will be reduced by about a factor of 50 approximately 0.3 km (1,070 ft) south of the source, which is thought to be in the vicinity of Well B18W24S. The site boundary is about 0.27 km (880 ft) south of that well. This indicates that the concentration drops by a factor of about 50 from the well to a potential nearby groundwater user. Total risk from U-238, U-235, and U-234 at the on-site well B18W24S concentrations is 5.7×10^{-4}, with an annual dose of 66 mrem from the drinking water pathway. A reduction by a factor of 50 would result in a risk of 1.1×10^{-5} and a dose of 1.3 mrem/yr.

7.12.2 Metals

Uranium and manganese are the only metals of concern in the MSP groundwater. The model indicates a reduction in uranium concentration from a maximum of 761 μg/L to 30 μg/L in a distance of approximately 0.35 km (1,145 ft) from Well B18W24S, or a factor of 25. The HI drops from 1.7 at the 95% UCL of 60 μg/L to about 0.1. This is well below unity, which is the EPA-accepted risk management level. Manganese is to behave similarly in the groundwater.

7.12.3 Organics

Carbon tetrachloride has been reported with a maximum concentration on site of 46.2 μg/L, which relates to a risk of 1.4×10^{-4} and an HI of 2. The model indicates that the concentration reduces to 2 μg/L within 0.05 km (170 ft). This is less than the 0.06 km (200 ft) to the site boundary from the source location near the garage with a corresponding risk of 6.1×10^{-6} and the HI would be 0.09.

7.12.4 Summary

Modeling indicates that the transport of the uranium isotopes, TCE, and carbon tetrachloride, would not result in unacceptable risk off the MSP site. Uranium metal would have an HI above unity at an off site location, exceeding the EPA risk management threshold of unity.

8.0 SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT

The Screening-Level Ecological Risk Assessment (SERA) for the MSP Groundwater OU is presented in this section. The analysis compares surface water and sediment contaminant concentrations to Ecological Screening Values (ESVs) as a means of evaluating the potential risk posed by the MSP to ecological receptors. A previous assessment of the ecological risk posed by the site was conducted and may be found in *"Remedial Investigation Report for the Soils Operable Unit at the Middlesex Sampling Plant"* (USACE, 1999).

8.1 METHODOLOGY

The SERA evaluates the potential present-day risks posed by contaminated surface water and sediments to ecological receptors in the vicinity of MSP. Risks were estimated using maximum detected surface water and sediment concentrations of chemicals (i.e., metals and organic compounds) and radionuclides. These concentrations were derived from sampling conducted between 2000 and 2002.

The SERA follows guidance found in *"Ecological Risk Assessment for Superfund, Process for Designing and Conducting Ecological Risk Assessments"* (EPA, 1997). The SERA is also consistent with the NJDEP guidance for conducting a Tier I, baseline ecological evaluation, as specified in *"Technical Requirement for Site Remediation"* (NJDEP, 1997) and *"Ecological Risk Assessment in NJDEP's Site Remediation Program: Conducting a Baseline Ecological Evaluation"* (Hamill and Demarest, 1997).

Risk is the likelihood of experiencing adverse effects. The risk assessment for ecological receptors exposed to surface water and sediments potentially contaminated by releases from MSP focuses on identifying and evaluating the potential for harmful effects resulting from the exposure to chemicals (i.e., metals and organic compounds) and radionuclides. The EPA (EPA, 1997c) outlines an eight-step process for conducting an ecological risk assessment (ERA), a process that includes five Scientific/Management Decision Points (SMDPs). The eight steps include:

Step 1: Screening-Level Problem Formulation and Ecological Effects Evaluation;

Step 2: Screening-Level Preliminary Exposure Estimate and Risk Calculation (followed by SMDP);

Step 3: Baseline Risk Assessment Problem Formulation (followed by SMDP);

Step 4: Study Design and Data Quality Objectives (followed by SMDP);

Step 5: Field Verification of Sampling Design (followed by SMDP);

Step 6: Site Investigation and Analysis of Exposure and Effects (possibly followed by SMDP, if change to the sampling and analysis plan is necessary);

Step 7: Risk Characterization; and

Step 8: Risk Management (followed by SMDP).

The SERA for the MSP consists of Steps 1 and 2, and a portion of Step 3. As required by guidance (NJDEP, 1997), the SERA report describes the ecological setting, including environmentally sensitive areas and contaminant migration pathways to environmentally sensitive areas, and identifies substances that pose a potential hazard to ecological receptors. These substances are referred to as contaminants of potential ecological concern (COPECs). COPECs are identified by comparing concentrations of chemicals in surface water and sediments to contaminant-specific ESVs, and by comparing radiation exposures to a dose-based ESV. The remainder of this chapter summarizes the results of Steps 1 and 2 and the COPEC re-evaluation portion of Step 3.

According to EPA guidance (EPA, 1997c), the risk assessment process may terminate after the initial screening stage if there is no potential hazard or risk to ecological receptors. If contaminants are found to be potential hazards in the SERA, an ERA including additional investigation and evaluation may be required. Only the COPECs identified in the SERA are evaluated in the ERA.

The need for an ERA (EPA Steps 3-7) is based on the nature and magnitude of the risk to ecological receptors in the environmental setting as estimated in the SERA. If risk managers decide an ERA for the MSP Groundwater OU is unnecessary, then data collection efforts in support of the risk analysis are stopped. Should an ERA be required for MSP, additional site-specific data will be collected to quantify exposures and evaluate potential effects. Appropriate site-specific data for ERAs include concentrations of COPECs in the tissues of plants and animals, and the results of site-specific toxicity tests (EPA, 1997c).

8.2 SCREENING-LEVEL PROBLEM FORMULATION AND ECOLOGICAL EFFECTS EVALUATION

Step 1 of the eight-step EPA ERA process includes site characterization and preliminary identification of the nature and extent of contamination. In conjunction with the preliminary risk calculation (Step 2), this information is used in the first SMDP to decide if further investigations are warranted.

8.2.1 Screening-Level Problem Formulation

The screening-level problem formulation for MSP addresses four subject areas:

- Environmental setting and contaminants known to exist at the site;
- Contaminant fate and transport mechanisms that might exist at the site;
- Mechanisms of ecotoxicity associated with the contaminants and likely categories of receptors that could be affected; and
- Complete exposure pathways likely to exist at the site.

Each of these areas is discussed below in the context of environmentally sensitive areas at MSP.

8.2.1.1 Environmental Setting and Contaminants at the Site

MSP is a 3.9 ha (9.6 acre) fenced, industrial site established in 1943 for sampling, storing, and shipping uranium, thorium, and beryllium ores. A grass lawn is maintained around the administration building and garage. The lawn represents less than 5 percent of the total area of MSP site. The remainder of the property is covered with asphalt, concrete pads, and buildings. No environmentally sensitive areas have been identified within the fenced borders of MSP.

The east side of MSP borders small businesses, homes, and fields; to the west lies a vehicle salvage yard. The salvage yard supports several narrow, linear areas of herbaceous old-field habitat among parallel rows of scrap material and gravel access roads. The property south of MSP consists of woodlots, old-field habitat, and State-designated wetlands. The South Drainage Ditch flows through this area, transporting surface runoff to a mosquito-control ditch and Main Stream. Animal and plant species observed, directly or indirectly (scat, song, trails, etc), that may rely on the South Drainage Ditch are presented in Appendix E – Site Ecology. Wooded areas south of Main Stream have been cleared and undergone residential development in recent years, clearing of wooded areas north of the stream has taken place more recently. The stream flows into Ambrose Brook within a mile of MSP; Ambrose Brook ultimately empties into the Raritan River.

Surface runoff from MSP has resulted in the contamination of surface water and sediments south of the site. Contaminated sediments have been removed from the drainage ditch on two occasions, most recently in 1996. Surface water and sediment sampling conducted between 2000 and 2002 indicates that contaminants continue to be present in the ditch. Contamination has also been observed along Main Stream. Contamination detected in groundwater beneath MSP and in site soils may act as a source of future contamination for surface water and sediments.

Table 8-1 lists the chemicals (i.e., metals and organic compounds) and radionuclides that have been detected in surface water and sediments near MSP, along with their background and maximum concentrations. The concentrations listed in the table are based on measurements conducted between 2000 and 2002. The background concentrations are based on surface water and sediment samples collected in Main Stream at location SWSD004. This sampling location occurs upstream of the confluence of Main Stream and the South Drainage Ditch. The concentrations listed represent the 95% Upper Threshold Limits (UTLs) of the background concentrations or the maximum background concentrations if insufficient data were available to calculate the UTLs. The maximum concentrations listed in Table 8-1 were identified using the entire data set, less the information for location SWSD004. Additional information about the surface water and sediment data used in the SERA are provided in Section 5.4 and 5.5 of this report.

8.2.1.2 Contaminant Fate and Transport

Surface runoff and the discharge of contaminated groundwater to the drainage ditch has led to the contamination of surface water and sediments south of MSP. Releases of this type may also result in future contamination of these media. Chemicals and radionuclides discharged to the drainage ditch may be transported to Main Stream and, subsequently, to Ambrose Brook. Contaminants reaching either of these streams will partition between the water column and the stream sediments.

8.2.1.3 Ecotoxicity and Potential Receptors

The chemicals and radionuclides that are the subject of the SERA are potentially toxic to benthic (i.e., sediment-dwelling) and aquatic organisms inhabiting the drainage ditch and the streams south of MSP. The nature and extent of toxic effects will depend upon several factors including the characteristics of the contaminants themselves, the biota present at the points of exposure, and the physical and chemical properties of the exposure environment.

The animals and plants likely to occur in the vicinity of MSP are described in Section 3.5 of this RI. The ecological receptors for the Groundwater OU SERA are aquatic plants inhabiting the wetlands and surface streams; sediment-dwelling animals; and aquatic animals. These receptors occur, or potentially occur, in the vicinity of MSP and may be susceptible to observed levels of contamination. Terrestrial organisms may also be exposed to contamination, but the risk posed to sediment-dwelling and aquatic organisms is expected to be greater. No threatened or endangered species are expected to occur at MSP (USACE, 1999b).

8.2.1.4 <u>Potential Exposure Pathways</u>

The primary exposure pathways include direct radiation from radionuclides in the water and sediments, dermal exposure to contaminated media, and the ingestion of contaminated food items. Plants and sediment-dwelling animals may receive direct radiation from the contaminated sediments, while aquatic organisms may be exposed to external radiation from suspended or dissolved contaminants. A number of contaminants may be absorbed across the skin and respiratory organs of biota. Animals may also receive internal exposures after consuming contaminated vegetation and prey. Other potential pathways include the exposure of terrestrial organisms through dermal contact with surface water and sediments, and the ingestion of contaminated water and food items by these animals. Exposures from dermal exposure and the ingestion of surface water are expected to be small relative to exposures received by sediment-dwelling and aquatic biota; the general lack of contaminants that biomagnify limits the potential risk associated with the consumption of aquatic prey.

8.2.2 Screening-Level Ecological Effects Evaluation

ESVs are conservative toxicity benchmarks for animals and plants. The ESVs used to identify chemical COPECs in surface water and sediments near MSP come from several sources. The primary source of surface water ESVs for metals and organic compounds is the U.S. EPA's national water quality criteria (NWQC; EPA, 1999). ESVs for several contaminants that were not included in the EPA reference were taken from Suter and Tsao (1996). Surface water ESVs were unavailable for some of the chemicals found near MSP. The surface water ESVs adopted for the SERA are listed in Table 8-2.

Sediment ESVs for metals and organic compounds were taken from *"Guidance for Sediment Quality Evaluations"*, published by the NJDEP (NJDEP, 1998). These ESVs represent concentrations at which adverse benthic impacts may begin to occur, or at which adverse effects are found in approximately 10 percent of the supporting studies. Alternate sources of sediment screening values were used for contaminants that were not addressed by this report, including work published by the Oak Ridge National Laboratory (Jones et al., 1997). Sediment ESVs were unavailable for some of the contaminants detected in the vicinity of MSP. The sediment ESVs used to conduct the SERA are included in Table 8-2.

The discharge of radioactive waste into the environment may result in long-term, low-dose exposures to organisms. The recommended acceptable dose rate to natural populations of aquatic biota and terrestrial plants is 1 rad/d (NCRP, 1991). The screening threshold dose level was set at 10 percent of this dose rate, or 0.1 rad/d, and used as the radionuclide ESV for surface water and sediment. This ESV is compared to the dose summed over the radionuclides present in the contaminated media.

8.3 SCREENING-LEVEL EXPOSURE ESTIMATE AND RISK CALCULATION

Exposures and potential risks are estimated in Step 2 of the eight-step EPA ERA process. Present-day exposure concentrations were estimated for the SERA using the maximum surface water and sediment concentrations measured south of MSP. In terms of the chemical contaminants, the risks posed by contaminated media were assessed through a direct comparison of the maximum exposure concentrations to the ESVs. The ratio of the exposure concentration and the corresponding ESV is called the hazard quotient; a hazard quotient greater than 1 indicates a potentially unacceptable risk. Table 8-3 lists the maximum measured concentrations of metals and organic compounds, the corresponding ESVs, and the calculated hazard quotients.

The exposure concentrations for the radionuclides were used to estimate the doses that may be received by benthic and aquatic organisms. These organisms may receive external or direct radiation from radionuclides in the sediments and those suspended or dissolved in the water column, and may receive internal doses from contamination taken up by the receptors. External doses received by benthic organisms from contaminated sediments were estimated using

$$D_{i,ext,sed} = C_{i,sed} * DF_{i,sed} * CF_{sed} \qquad (1)$$

where:

$D_{i,ext,sed}$ = external dose rate for radionuclide i from contaminated sediments (rad/d),
$C_{i,sed}$ = concentration of radionuclide i in sediments (pCi/g),
$DF_{i,sed}$ = dose conversion factor for radionuclide i in sediments (Sv m^3/Bq s), and
CF_{sed} = conversion factor (rad/d per pCi/g / Sv/s per Bq/m^3).

The radionuclide dose conversion factors used in the analysis are the coefficients listed by Eckerman and Ryman (1993) for soil contaminated to a depth of 15 cm, these dose factors are listed in Table 8-4. The conversion factor for sediments, CF_{sed}, is 5.1E+11 rad/d per pCi/g / Sv/s per Bq/m^3.

External doses received by aquatic organisms as a result of water immersion were calculated using

$$D_{i,ext,wat} = C_{i,wat} * DF_{i,wat} * \frac{CF_{wat}}{\rho_{wat}} \qquad (2)$$

where:

$D_{i,ext,wat}$ = external dose rate for radionuclide i from water immersion (rad/d),
$C_{i,wat}$ = concentration of radionuclide i in surface water (pCi/L),
$DF_{i,wat}$ = dose conversion factor for radionuclide i in water (Sv m^3/Bq s),
CF_{wat} = conversion factor (rad/d per pCi/g / Sv/s per Bq/m^3), and
$?_{wat}$ = density of water (g/L).

The dose conversion factors for water immersion were taken from Eckerman and Ryman (1993) and are listed in Table 8-4. The conversion factor for water, CF_{wat}, is 3.2E+11 rad/d per pCi/g / Sv/s per Bq/m^3, while the density of water is 1000 g/L.

Internal doses were estimated using (Blaylock et al., 1993)

$$D_{i,int} = C_{i,tis} * E_{i,x} * n_{i,x} * \Phi_x * CF_{int} \qquad (3)$$

where:

$D_{i,int}$ = internal dose rate for radionuclide i (rad/d),

C_{tis} = concentration of radionuclide i in tissue (pCi/g),

$E_{i,x}$ = energy for type x (a, ß, or ?) emissions by radionuclide i (MeV/dis),

$n_{i,x}$ = proportion of disintegrations of type x (a, ß, or ?) emissions for radionuclide i,

F_x = absorption fraction for emitted energy $E_{i,x}$, and

CF_{int} = conversion factor (rad/d per pCi/g per MeV/dis).

The product of $E_{i,x}$ * $n_{i,x}$ * F_x was summed over the radionuclide emissions; the products of $E_{i,x}$ and $n_{i,x}$ are listed in Table 8-4 for the radionuclides included in the SERA. An absorption factor of 1 was assumed for all alpha and beta emissions. The absorption factor for gamma emissions will be strongly affected by the size of the organism for which exposures are being estimated. Doses were calculated for small and large aquatic organisms and small benthic organisms, the gamma absorption factors used in these calculations are provided in Table 8-4. The conversion factor, CF_{int}, is 5.1E-05 rad/d per pCi/g per MeV/dis.

Radionuclide concentrations in the tissues of benthic and aquatic organisms must be estimated for Equation (3). Tissue concentrations in sediment-dwelling organisms were calculated using

$$C_{i,tis,sed} = C_{i,sed} * \frac{BCF_i}{K_{d,i}} \qquad (4)$$

where:

$C_{i,tis,sed}$ = concentration of radionuclide i in the tissues of benthic organisms (pCi/g),

$C_{i,sed}$ = concentration of radionuclide i in sediments (pCi/g),

BCF_i = bioconcentration factor for radionuclide i (L/kg), and

$K_{d,i}$ = soil-to-water partitioning coefficient for radionuclide i (L/kg).

Radionuclide concentrations in the tissues of aquatic organisms were estimated using

$$C_{i,tis,wat} = C_{i,wat} * \frac{BCF_i}{1000} \qquad (5)$$

where:

$C_{i,tis,wat}$ = concentration of radionuclide i in the tissues of aquatic organisms (pCi/g),

$C_{i,wat}$ = concentration of radionuclide i in surface water (pCi/L),

BCF_i = bioconcentration factor for radionuclide i (L/kg), and
1000 = conversion factor (g/kg).

The values of BCF_i and $K_{d,i}$ used in Equations (4) and (5) are included in Table 8-5.

External and internal doses for benthic and aquatic organisms were summed to measure the total dose for each radionuclide; these doses were summed over the contaminants to yield the total dose for each class of organisms. Table 8-6 lists the maximum measured radionuclide concentrations in surface water and sediments, and the dose rates calculated on the basis of these exposure concentrations. The total doses shown in this table were compared to the ESV of 0.1 rad/d to identify whether radionuclides released from MSP pose a potential risk to biota.

The identity of some of the radionuclides detected in surface water and sediments is ambiguous, examples include the results listed for gross alpha, gross beta, Uranium-233/234, Uranium-235/236 and total uranium. It was necessary to assign the concentrations of these constituents to specific isotopes in order to estimate the exposures and risks. Towards this end, the gross alpha and beta measurements were not evaluated, as it was unclear what combination of radionuclides yielded the detected activities. The measured concentrations of Uranium-233/234 were assigned to Uranium-234, while the sample concentrations of Uranium-235/236 were assumed to be Uranium-235. Total uranium concentrations corresponded to the sum of uranium isotopic activities based on these assignments.

The radionuclides detected in surface water and sediments near MSP undergo decay to form radioactive daughter products. The observed concentrations of parents and their short-lived daughters (i.e., daughter products with half-lives less than 1 yr) are a complex function of the dynamics of radioactive decay and the partitioning behavior of the various radionuclides. The activities of short-lived daughters within a given environmental medium will be similar to those of their parents if all members of the decay chain demonstrate similar partitioning behavior. This situation is exemplified by the sediment data, which indicate similar concentrations of parent and daughter radionuclides at most sampling locations. In contrast to this situation, the maximum concentrations of short-lived daughters in surface water are much greater than those of their long-lived parents. However, the short-lived daughters were detected on a single sampling date while parent radionuclides were generally detected on several occasions. The disparity in the amount of data for the daughters and parents limits the ability to draw conclusions about radionuclide equilibrium and partitioning behavior in surface water.

The state of equilibrium that exists between members of the radioactive decay chains must be known in order to calculate radionuclide doses. Lacking the information necessary to establish these conditions, it was assumed that secular equilibrium exists between the parent radionuclides and their short-lived daughters (i.e., daughter products with half-lives less than 1 yr). The concentrations of the short-lived daughters were set equal to the maximum concentrations of their parents, adjusting for branching within decay chains where appropriate. This approach captures potential exposures from all short-lived daughter products of Cesium-137, Radium-226, Radium-228, Thorium-228, Uranium-235, and Uranium-238.

8.4 SCREENING-LEVEL ERA RESULTS

The results of the risk calculations are presented in Table 8-3 for metals and organic compounds, and in Table 8-6 for radionuclides. These results are used in the following sections to identify COPECs for the MSP Groundwater OU RI.

8.4.1 Chemicals

The hazard quotients for 12 of the metals detected in surface water exceed a value of 1 (Table 8-3), suggesting a potential risk to the aquatic organisms inhabiting those waters. The ESV for chromium was exceeded if the metal was assumed to be in either the trivalent or hexavalent form. The maximum concentrations of eight of the 12 metals with hazard quotients greater than 1 (i.e., aluminum, barium, beryllium, copper, iron, lead, manganese and silver) are less than the background concentrations summarized in Table 1. The ESVs for all metals with hazard quotients greater than 1 are less than the background concentrations; this finding suggests the screening values for these contaminants are overly conservative. The maximum measured concentration of a single semi-volatile organic compound, benzo(a)anthracene, exceeds the surface water ESV. ESVs were unavailable for an additional three organic compounds.

Maximum contaminant concentrations and conservative ESVs are purposefully used in the SERA to provide assurance that aquatic organisms living in the vicinity of the MSP are adequately protected. Nevertheless, insight into the severity of the risk posed by surface water contaminants may be gained by comparing more moderate estimates of exposure concentrations to the ESVs. As an example, if hazard quotients for all contaminants are less than 1 when estimates of the mean concentrations are used it would suggest that the overall exposure conditions do not pose a serious risk to aquatic organisms. On the other hand, if the hazard quotients calculated using estimates of the mean concentrations all exceeded 1 it would suggest that widespread adverse impacts might occur.

The hazard quotients for the metals in surface water were calculated using 95% Upper Confidence Limits (UCLs) of the mean concentrations. These quantities were not estimated for six metals (i.e., beryllium, cadmium, cobalt, copper, silver, and vanadium) because UCLs that were less than the maximum concentrations of these contaminants could not be calculated. The hazard quotients based on the UCLs of the mean concentrations are less than 1 for three of the metals that yielded hazard quotients greater than 1 when maximum concentrations are used. These include the trivalent form of chromium, manganese, and nickel. The lack of additional data prevented the calculation of hazard quotients for the organic compounds using UCLs of the mean concentrations.

The hazard quotients for 12 of the metals detected in sediments are greater than 10 (Table 8-3), signifying they may pose a risk to benthic organisms. The maximum concentration of one of these metals (i.e., iron) is less than its background concentration. The ESVs for all but one of these contaminants are less than the background concentrations listed in Table 1, however, suggesting the potential risk may be overstated. The ESV for silver could not be compared to the contaminant's background concentration because that metal was not detected at the background location. Sediment-based ESVs were unavailable for 10 of the metals included in the SERA. Substituting the UCLs of the mean concentrations causes the hazard quotient of mercury to fall below 1. The other metals are unaffected.

Table 8-7 summarizes the chemicals retained as COPECs and provides the rationale for their inclusion as such. In terms of surface water, four metals were retained as COPECs. Although the hazard quotients for aluminum, barium, beryllium, copper, iron, lead, manganese, and silver exceeded 1 for surface water, they were excluded as COPECs. The maximum concentrations and ESVs for these metals are less than their background concentrations, suggesting the contaminants pose little risk to aquatic biota. While the ESVs for chromium, nickel, uranium, and zinc were also less than background, the hazard quotients for these contaminants were greater than 1 and the maximum concentrations of these metals were greater than background. Consequently, they were retained as COPECs. A single organic compound was retained as a COPEC on the basis of potential risk to aquatic organisms. Three additional compounds were retained because ESVs for these contaminants were unavailable.

Twenty-one metals were retained as COPECs based on their concentrations in sediments (Table 8-7). The hazard quotients were greater than 1 for 11 of these contaminants. While the ESVs for these contaminants were less than background, the maximum concentrations of the metals were greater than background. Consequently, they were retained as COPECs. Although iron had a hazard quotient greater than 1, it was excluded as a COPEC because its maximum concentration and ESV were both less than background. ESVs were unavailable for the 10 constituents. NJDEP guidance (NJDEP, 1998) requires that all contaminants for which ESVs are unavailable be retained as COPECs.

8.4.2 Radionuclides

The total radiation dose estimated for the maximum radionuclide concentrations is 1.7E-03 rad/d for aquatic organisms and 9.6E-03 rad/d for benthic organisms (Table 8-6). These doses are less than 10 percent of the ESV adopted for the MSP SERA, or 0.1 rad/d. On the basis of these comparisons, no radionuclides are retained as COPECs.

8.4.3 Summary

Several metals and organic compounds included in the MSP Groundwater OU RI SERA were retained as COPECS. These chemicals are listed in Table 8-7. Contaminants were identified as COPECs either because their maximum measured concentrations exceeded background concentrations and ESVs, or because ESVs were unavailable. The former contaminants may pose a significant risk to biota, although refinement of the risk analysis under the ERA may find otherwise (Section 8.5). Further insight into the potential toxicity of the chemicals lacking ESVs will be required in order to identify whether these contaminants pose a significant risk to aquatic and benthic organisms. The metals and organic compounds listed in Table 8-7 are evaluated as COPECs in the initial part of Step 3 of the EPA's ERA process.

8.5 PROBLEM FORMULATION

Step 3 of the EPA's ERA process initiates the problem formulation phase of the baseline ecological risk assessment. Activities conducted under this step include refinement of the COPECs, further characterization of the ecological impacts of the COPECs, reviewing and refining information on contaminant fate and transport for the site under consideration, selecting assessment endpoints for the baseline assessment, and refinement of a conceptual model of the site. The MSP Groundwater OU RI SERA discusses the first activity, refinement of the COPECs.

Four metals and one organic compound were identified as COPECs on the basis of the hazard quotients calculated using maximum surface water concentrations. A number of activities may be undertaken to refine this list of COPECs, thereby limiting the scope of the baseline ecological risk assessment if one is required. These activities are discussed in the following paragraphs.

A more accurate representation of the exposure conditions encountered by aquatic organisms is expected to reduce the number of COPECs. As discussed earlier, hazard quotients for trivalent chromium and nickel fall below 1 when the UCLs of the mean concentrations are used instead of maximum concentrations. Furthermore, the UCLs of the mean concentrations of both metals fall below their respective background concentrations. These findings suggest that these contaminants may be eliminated from further consideration early in the ERA process.

The metal concentrations used in the SERA represent total concentrations in surface water, including particulate and dissolved phases. In contrast, the surface water ESVs used to assess potential risk represent dissolved concentrations. Dissolved concentrations of the metals detected in the drainage ditch and Main Stream may be less than the total concentrations. Filtered samples usually contain metals concentrations much lower than unfiltered samples.

Surface water sampling data for chromium do not establish whether the metal is present in the trivalent or hexavalent form. Lacking this information, the maximum concentration was assigned to each chemical form and used to calculate hazard quotients. A more accurate assessment of the potential risk posed by chromium may be possible if the chemical form of the contaminant is established.

The surface water ESVs for three COPECs (i.e., chromium III, nickel, and zinc) are a function of the hardness of the water. Lacking site-specific hardness data for the drainage ditch and Main

Stream, a hardness of 50 mg/L was assumed for the SERA. The use of site-specific hardness data will help improve the risk estimates for these metals.

Benzo(a)anthracene is the only organic compound that was retained as a COPEC on the basis of the risk it poses to aquatic organisms. This compound occurs primarily in products of incomplete combustion and has been found in emissions from automobiles and some industrial plants (HSDB, 2002). As such, the compound does not appear to be related to the processing activities that occurred at MSP. Combined with the fact that the compound has been detected in only a single sample, it is quite likely that this contaminant can be eliminated as a COPEC. Surface water ESVs were unavailable for three organic compounds; a review of the toxicological literature for these contaminants may allow some of those chemicals to be eliminated as COPECs.

An evaluation of the magnitudes of the HQs calculated for the surface water COPECs provides insight into the likelihood that using the refinements discussed above will allow further reduction in the number of contaminants that would need to be carried through an ERA. Table 8-8 lists the surface water COPECs ranked by the HQs calculated using the maximum contaminant concentrations; the HQs estimated using the UCLs of the mean concentrations are also included. The HQs based on the maximum concentrations of nickel, zinc, and chromium are modestly greater than 1, and fall below or close to 1 when more realistic exposure conditions are considered. Combined with the fact that total concentrations of these metals were compared to ESVs that are based on dissolved concentrations, this finding suggests these metals may not have to be carried through the ERA. In contrast, the HQ for uranium remains high even when more realistic exposure conditions are considered. It is less clear that this contaminant would be able to be excluded from an ERA. The organic contaminants for which ESVs were unavailable are not included in Table 8-8; these constituents will still require consideration in the initial steps of any ERA.

A total of 21 metals were identified as COPECs on the basis of the sediment concentration data. Eleven of the contaminants have been found at concentrations in excess of the sediment ESVs, 10 of the metals were retained as COPECs because no ESVs were available.

Calculating the hazard quotients using the UCLs of the mean concentrations instead of maximum concentrations has relatively little effect in terms of COPEC identification. Mercury is the only metal whose hazard quotient drops below 1 when this substitution is made. Furthermore, given the sedentary nature of many benthic organisms, it is not clear that using estimates of mean exposure conditions is necessarily appropriate.

Refinement of the sediment-based COPECs should include additional research into the ecological toxicity of the metals for which ESVs were found. The fact that the ESVs for the metals with hazard quotients greater than 1 are less than their respective background concentrations suggests that the ESVs used in the SERA may be overly conservative.

The likelihood of being able to reduce the number of contaminants that may need to be considered in an ERA is unclear. As indicated above and shown in Table 8-9, the HQ for only one contaminant falls below 1 when more reasonable exposure conditions are assumed. Perhaps the greatest opportunity for reducing the number of COPECs lies in the fact that the ESVs adopted for these metals appear unduly conservative insofar as they all fall below background levels. Insight into the potential impacts of adopting less conservative ESVs may be gained if it is assumed that the sediment screening values are equal to background concentrations. Under these conditions, the HQs calculated for antimony, arsenic, chromium, and nickel using the UCLs of the mean concentrations fall below 1. While the HQs for cadmium, copper, manganese, lead, and zinc remain above 1 these quotients decrease 25 to 80 percent when less conservative ESVs are adopted. Based on these results, the refinement of the ESVs is expected to have a significant impact on the number of contaminants that would need to be carried through an ERA. The metals for which ESVs were unavailable are not included in Table 8-9; these contaminants will still require consideration in the initial steps of any ERA.

The sediment samples collected in the vicinity of MSP were not analyzed for organic compounds, preventing an assessment of the risk these contaminants pose to benthic organisms. Depending upon the remedial planning process, it may be necessary to collect and analyze additional sediment samples to establish whether these chemicals do, in fact, threaten sediment-dwelling organisms.

8.6 SUMMARY AND CONCLUSION

The MSP Groundwater OU RI SERA evaluated the potential for harmful effects to ecological receptors exposed to chemicals and radionuclides released from the facility to surface water and sediments. Potential ecological receptors are aquatic plants inhabiting the wetlands and surface streams, sediment-dwelling animals, and aquatic animals. Maximum concentrations of metals, organic compounds, and radionuclides were used to assess potential risk to these receptors.

Four metals were identified as COPECs on the basis of surface water concentrations, including:

- Chromium
- Nickel
- Uranium
- Zinc

Twenty-one metals were identified as COPECs on the basis of measured sediment concentrations. The maximum concentrations of 11 of these contaminants exceeded the sediment ESVs, including:

- Antimony
- Arsenic

- Cadmium
- Chromium
- Copper
- Lead
- Manganese
- Mercury
- Nickel
- Silver
- Zinc

An additional 10 metals were identified as COPECs because ESVs were unavailable; these metals include:

- Barium
- Beryllium
- Calcium
- Cobalt
- Magnesium
- Potassium
- Selenium
- Sodium
- Uranium
- Vanadium

Four organic compounds were identified as COPECs for surface water. The maximum concentration of benzo(a)anthracene exceeded the ESV adopted for the SERA. Three of the COPECs were identified as such because ESVs were unavailable, these include:

- Benzo(b)fluoranthene
- Chrysene
- Pyrene

Radionuclide doses were projected for aquatic and benthic organisms, taking into account external and internal exposure routes. The total doses projected for these receptors were less than 0.1 rad/d, the ESV adopted for the SERA. On the basis of these calculations, no radionuclides were identified as COPECs.

The results of the SERA indicate further evaluation may be necessary. The first step in this assessment is the refinement of the COPECs to be included in the evaluation. Several options for narrowing the list of COPECs for the ERA are discussed in the report. These options include representing exposure conditions more accurately and adopting ESVs that address conditions at the site.

9.0 FINDINGS AND RECOMMENDATIONS

The objectives of the MSP GWOU RI were to define the nature and extent of radiological and chemical contaminant in groundwater, evaluate the fate and transport of those contaminants, and assess potential human health and ecological risk. Each of these objectives has been accomplished. The information presented in the RI adequately characterizes and delineates radionuclides, metals and organic compounds present in the groundwater, sediment, and surface water so that the remedial planning process may continue on to the FS. However, additional investigations are recommended to complete characterization of the site groundwater to allow the remedial planning process to move forward.

9.1 Summary of Findings

The RI has reviewed and assessed site history and operational data from previously published reports prepared for AEC, DOE and other governmental agencies. It has also evaluated data from soil and groundwater sampling activities in 1976, 1980, 1983, 1991, 1996, and 2000, as well as annual environmental surveillance monitoring (ongoing since 1986). These data allowed the RI field program to focus on those areas and contaminants at MSP where information was needed for the identification and assessment of remedial alternatives. Based on this information, it has been found that:

- There are no ongoing commercial or industrial activities at MSP. The site is secure, access is controlled and monitored, and there are no above ground sources of contamination present.

- Land use in the vicinity of MSP is a mix of commercial and residential activities. There is a growing need to address environmental issues at the site, especially as the pace of property development to the south increases.

- Residual amounts of radioactivity are present in soil and groundwater at MSP. Other, non-radiological contaminants, primarily metals and synthetic organic compounds (VOCs and SVOCs) are also present in soil and groundwater, but at low levels.

- Groundwater at MSP is currently being monitored as part of an Environmental Surveillance Program (ongoing since 1986). Off-site migration of contaminated groundwater has not been detected. However, residual amounts of radioactive and non-radioactive constituents (primarily metals) continue to be found in surface water and sediment on and around MSP.

- Air quality is also being monitored as part of the Environmental Surveillance Program. Data from 2000 and 2001 indicate that the population in the immediate vicinity of the site (i.e., 75 m or 246 ft) was not adversely affected by airborne emissions from MSP and no additional engineering controls (other than maintenance of the asphalt cover) is required.

- A groundwater sampling program conducted by ATSDR in 2000 concluded that no exposures to the contaminated groundwater present beneath the site are occurring or are expected to occur in the future.

MSP's overall physiographic setting must be included as part of any evaluation of contaminant behavior. To do so, a site conceptual model was developed that incorporates both regional hydrogeologic data as well as site specific groundwater and surface water characteristics. The use of this model illustrates that:

- Infiltration of rainwater, as a mechanism of contaminant transport, has been significantly reduced since the site was paved in 1946. Prior to paving, infiltration was probably the primary way that potential contaminants were introduced to the subsurface.

- Currently, the primary pathway that precipitation uses to reach the subsurface is by entering catch basins and breaks in the (now inactive) subsurface drainage system. Backfill surrounding those drain lines may act as a preferential flow path for precipitation to reach shallow groundwater. Additionally, soil sample analysis for select pipe chase locations indicate the presence of SVOC, metal, and radionuclide constituents. Of lesser importance is the migration of precipitation to the subsurface through cracks in the asphalt.

- Two subsurface flow systems are present at MSP – overburden and shallow bedrock. Groundwater in the overburden in the northern third of the site flows north to northwest, towards a drainage ditch adjacent to a set of railroad tracks. This flow pattern is the same for groundwater in the shallow bedrock. Groundwater in the overburden in the southern two-thirds of the site generally flows south-southeast. Groundwater in the shallow bedrock flows generally eastward.

- The current MSP monitoring well network accurately reflects local overburden and shallow bedrock flow patterns across the site. However, it may not capture regional effects due to topography or large-scale structural features (e.g., fractures patterns in deeper bedrock). For this reason, the installation of additional monitoring wells may be necessary (see Section 9.2).

- Groundwater in the overburden discharges to the surface south of the site, in the area of the wetlands and Main Stream. Once at the surface, it can move via overland flow to Ambrose Creek, which in turn discharges to Raritan River.

- Groundwater from the overburden is not used as a source of drinking water near MSP. Some local area residents do use groundwater from the deeper bedrock aquifer. However, these supply wells are many hundreds of feet deep and are not likely to be influenced by the shallow bedrock groundwater present at MSP. Results of off-site groundwater sampling (i.e., South Drainage Ditch and background wells), support this statement. Additionally, the 2002 ATSDR report, in which groundwater from several downgradient homeowner wells were sampled, states no exceedances of drinking water standards were detected.

The RI describes those environmental characteristics of the site (climate, demography, local groundwater usage, etc.) that are relevant to identifying and evaluating potential transport pathways, mechanisms and receptors. This information has been compiled into a conceptual site model that provides a framework for an understanding on the nature and extent of groundwater contamination. The site specific information needed to support that conceptual mode was developed from an RI data collection program that has been carried out in accordance with work plans reviewed and approved by EPA Region II and NJDEP. It included the following:

Installation of 17 monitoring wells in the overburden water bearing zone and seven monitoring wells into the shallow bedrock. Subsequent sampling of these wells indicated that they yielded representative samples of groundwater and were providing information needed to move the remedial planning process forward (e.g., data on water quality downgradient of potential source areas and at property boundaries).

Geophysical logging (temperature/conductivity, gamma, and caliper) and television inspection of six bedrock bore-holes. Logging and television inspection results agreed closely with observations on fracture spacing and density made during diamond coring of the bore-holes.

Hydraulic conductivity testing of selected overburden and bedrock monitoring wells. Testing results fell with the ranges expected for silty soil and fractured mudstone.

Collection of 20 sediment samples along two transects of the South Drainage Ditch (four samples within the ditch and three samples on either side of the ditch). This was done to identify whether the sediment and floodplains soils had been impacted by runoff or groundwater discharges from MSP and were acting as a continuing source of contamination to surface water. Analytical results indicated they are not.

Installation and sampling of two (HydroPunch®) well points into the streambed of the South Drainage Ditch. Groundwater sampling results from these well points were to be used to evaluate potential impacts on overburden groundwater quality from surface water in the South Drainage Ditch. However, turbidity levels in the samples were too high for the results to be considered representative and these data were used for screening purposes only.

Measurement of stream flow at two locations – one downgradient of MSP headwall discharge and one upgradient of the confluence of the South Drainage Ditch and Main Stream. Flow measurements were to be used in calculations of mass loading rates. However, data indicated that flows were essentially stagnant, except during and shortly after precipitation events. Flow measurements taken during these times would not be representative of typical site conditions and so mass loading calculations were not done.

Validated analytical data have been used to identify the nature and extent of groundwater, surface water, and sediment contamination at MSP. These data were evaluated against comparison criteria (the most stringent of SDWA MCLs, NJ SDWA MCLs or NJ Class IIA Groundwater Quality Criteria). The results demonstrate that:

- Of the seven VOCs detected in overburden and bedrock groundwater, two are common laboratory contaminants (acetone and methylene chloride), two are not related to MSP operations (MTBE and TBA) and are from an off-site source, and two (chlorobenzene and carbon disulfide) are present at concentrations below comparison criteria values. The remaining VOC (cis 1,2-dichlorbenzene) is found at levels above the comparison criterion and was included in subsequent risk assessment calculations.

- Two SVOCs (bis(2-ethylhexyl)phthalate and 1,2,4-trichlorobenzene) have been regularly detected in overburden groundwater. Bis(2-ethylhexyl)phthalate, which is also the only SVOC found in bedrock groundwater, is a common laboratory contaminant and has been detected in off-site monitoring wells. 1,2,4-trichlorobenzene is present at concentrations above the comparison criterion and was included in subsequent risk assessment calculations.

- Eight metals (arsenic, antimony, aluminum, chromium, iron, lead, manganese, and nickel) have been found in MSP overburden ground water. Two metals (iron and manganese) have been reported in bedrock ground water samples above comparison criteria. Aluminum, iron and manganese are widespread, naturally occurring metals that are detected in groundwater throughout the Newark Basin and their presence is likely not related to past MSP operations. Iron was detected below background levels. Aluminum and manganese were addressed in the risk assessment. Arsenic and antimony, also metals that are commonly found in Newark Basin ground water, are present at concentrations just above comparison criteria. Antimony was not included in the risk assessement based on frequency of detection and below the criteria. Arsenic was not included in the groundwater risk assessment based on local background information presented in the NJDEP document "*A Homeowner's Guide to Arsenic in Drinking Water*" and its presence below Drinking Water Standards. The document identifies high levels of naturally occurring arsenic in the physiographic province in which MSP is situated. Chromium, nickel and lead are present above comparison criteria and were included in subsequent risk assessment calculations.

- Net alpha, total uranium and radium have been reported in ground water samples from both overburden and bedrock monitoring wells at concentrations above comparison criteria. These radionuclides are clearly related to former MSP operations and were included in subsequent risk assessment calculations.

The concentrations of VOCs, SVOCs, and metals that are found in overburden and bedrock groundwater at concentrations above comparison criteria are not indicative of a separate phase (i.e., free product). Additionally, their distribution does not suggest the presence of a plume or an active/ongoing source (e.g., leaking underground storage tank).

To assess the mobility and behavior of the contaminants present in the groundwater at MSP, a simple, one-dimensional computer model was used. The modeling effort had two objectives: (a) to estimate the attenuation time of contaminant concentrations from presumed source areas, and (b) to estimate the distance that the contaminant will travel downgradient in the groundwater before degrading below groundwater quality comparison criteria.

Modeling indicates that if remedial action is not implemented on the groundwater at MSP, radionuclides and VOCs will eventually migrate off-site. The time frame estimated by the model for impacted groundwater to move more than 0.4 km (0.25 mi.) beyond the site boundary (10+ years) is well beyond the 2005 anticipated cleanup schedule for MSP.

A baseline human health risk assessment was performed to estimate potential risks to humans from exposure to contaminated groundwater, surface water, and sediment at MSP. These risks include both radiological and non-radiological constituents. The assessment concluded that potential carcinogenic risks and hazards associated with radionuclides (U-238 and U-234), metals (uranium and manganese) and VOC carbon tetrachloride for a residential groundwater use scenario are unacceptable. Even with an unrestricted use scenario, it is not likely groundwater will be used for drinking water purposes. Surface water and sediment exposure scenarios do not exceed risk management guidelines and modeling indicates that transport of uranium isotopes, and carbon tetrachloride in the groundwater would not result in unacceptable risks to off-site receptors.

A screening level ecological risk assessment was carried out to evaluate the potential risk posed by MSP to ecological receptors. Potential ecological receptors are aquatic plants in the wetlands and surface water, sediment-dwelling animals, and aquatic animals. Four metals found in surface water, 21 metals present in sediment and four SVOC compounds detected in surface water were identified as chemicals of potential ecological concern. These compounds need to be included in remedial planning activities. No radionuclides were identified as posing an unacceptable risk to potential ecological receptors. Contaminants of potential ecological concern identified in sediment and surface water during the ecological risk assessment will be addressed in the soils feasibility study.

9.2 Recommendations

To continue to move the remedial planning process forward for MSP, it is recommended that:

- Since the existing buildings and structures (e.g., settling basin) do not pose an unusual or special risk to environmental quality, they can be demolished as part of the overall site remedial process.

- Where additional data are needed (e.g., groundwater samples near the railroad ditch), those data should be gathered as part of the overall remedial planning process.

- A feasibility study to evaluate remedial alternatives is necessary.

10.0 REFERENCES

AEC (U.S. Atomic Energy Commission) 1974. *Radiation Survey Report of the Middlesex Landfill Site*, USAEC-NRN-7406, Washington, DC, June.

American Water Works Asociation, 1975, Standard methods for the examination of water and wastewater (14^{th} ed.) – corrosivity, method 203 and oxygen (dissolved), method 422: Washington, D.C., American Water Works Association, 1193 p.

ATSDR. 2000. Toxicological Profile for Arsenic. Update. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. PB/2000/10821.

ATSDR. 2002. Public Health Assessment for Middlesex Sampling Plant. U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry.

Baes, C.F., et al., 1984. "*A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture*." Oak Ridge National Laboratory report ORNL-5786, September 1984.

BJ, 1998. "*Radiological Benchmarks for Screening Contaminants of Potential Concern for Effects on Aquatic Biota at Oak Ridge National Laboratory, Oak Ridge, Tennessee,*" Bechtel Jacobs Company report BJC/OR-80, July 1998.

Blaylock, B.G., M.L. Frank, and B.R. O'Neal 1993. *Methodology for Estimating Radiation Dose Rates to Freshwater Biota Exposed to Radionuclides in the Environment*. ES/ER/TM-78. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

BNI 1985a. *Final Report on Phase II Remedial Action at the Former Middlesex Sampling Plant Site and Associated Properties*, DOE/OR/20722-27, Volumes 1-3, April.

BNI 1985b. *Radiological Survey Report for the Former Middlesex Sampling Plant*, DOE/OR/20722-20, March.

BNI 1985c (Bechtel National, Inc.). *Radiological Survey Report for the Former Middlesex Sampling Plant Middlesex, New Jersey*, DOE/OR/20722-20, Bechtel National, Inc. March.

BNI 1991a. *Field Sampling Plan for the Middlesex Sampling Plant*, DOE/OR/20722-274, Revision 1, May.

BNI 1991b. *Characterization Report for the Interim Storage Piles at the Middlesex Sampling Plant*, Volume 1 and 2, DOE/OR/21949-297, December.

BNI 1993a. *Middlesex Sediment Sampling Onsite and Within the Drainage Ditch*, FUSRAP Technical Bulletin No. 118-93-003, December 30.

BNI 1993b. *Quality Assurance Document for Site Environmental Reports*, DOE/OR/21949-362, March.

BNI 1993c. *FUSRAP Technical Bulletin*, 118-93-003, December 30.

BNI 1993d. *FUSRAP Technical Bulletin*, No. 118-93-003, December 30.

BNI 1993e. *FUSRAP Technical Bulletin*, No. 118-93-000, June 25.

BNI 1996a. *Environmental Surveillance Plan*, Appendix B2 (Middlesex Sampling Plant), 118-ESP, Rev. 0, March.

BNI 1996b. *Shallow Groundwater Investigation and Drainage Ditch Recontamination Assessment*, CCN 147446, October.

BNI 1996c. Shallow Groundwater Investigation and Drainage Ditch Assessment, FUSRAP Technical Memorandum No. 118-97-001, Rev. 0, Oak Ridge, TN, October 24.

BNI 1997a. *Removal of Contaminated Water and Sediment from MSP Process Building Sump*, CCN 149682, January.

BNI 1997b. *Environmental Surveillance Technical Memorandum for 1996 for the Middlesex Sampling Plant*, No. 118-97-007, April.

BNI 1997c. *Shallow Groundwater Investigation and Drainage Ditch Recontamination Assessment, Technical Memorandum*, 118-07-001, October.

BNI 1998. *Environmental Surveillance Technical Memorandum for 1997 for the Middlesex Sampling Plant*, No. 118-98-007, May.

Boch, W., 1959, New eastern American Triassic fishes and Triassic correlations: Geol. Center Res. Ser., v. 1, 184 p.

Bouwer, H. and R.C. Rice, 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers With Completely or Partially Penetrating Wells. Water Resources Research, v. 12, No. 3 pp. 423-428.

Bouwer, H., 1989. The Bouwer and Rice Slug Test – An Update. Ground Water v. 27, No. 3. Pp. 304-309.

Boyle, J.T. 1993. *Well Interference and Evidence of Fracture Flow in the Passaic Formation near Pennington, Mercer County, New Jersey*, New Jersey Geological Survey, Open File Report OFR 93-1.

Cahalane, R.W. 1958. *The History of the Middlesex Sampling Plant,* National Lead Company of Ohio, February.

Carswell, L.D. 1976. *Appraisal of Water Resources in the Hackensack River Basin, New Jersey*, U.S. Department of the Interior, U.S. Geological Survey Water Resources Investigations 76-74.

Conner, J.A., C.J. Newell, J.P. Nevin, and H.S. Rifai, 1994. Guidelines for Use of Groundwater Spreadsheet Models in Risk-Based Corrective Action Design. National Ground Water Association, Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water Conference, Houston, Texas, November 1994, PP. 43-55.

DOE 1996. *Engineering Evaluation/Cost Analysis for the Removal of the Process Building and Contaminated Sediments at the Middlesex Sampling Plant*, Oak Ridge, Tennessee, June.

DOE 1997. *Middlesex Sampling Plant Historic District, Historic American Engineering Record*, Final, CCN 149375, Oak Ridge, Tennessee, January.

Domenico, P.A., 1987. An Analytical Model for Multidimensional Transport of a Decaying Contaminant Species. Journal of Hydrology, v. 91, pp. 49-58.

Domenico, P.A. and F.W. Schwartz. 1990. Physical and Chemical Hydrogeology. John Wily & Sons, Inc. 824 pp.

Drake, A.A., Jr., Volkert, Richard A., Monteverde, Donald H., Herman, Gregory C., Houghton, Hugh F., Parker, Ronald A., and Dalton, Richard F., 1996. *U.S. Geological Survey*: Bedrock Geologic Map of Northern New Jersey, Map I-2540-A.

Eberline 1981. *Radiological/Environmental Support Program Report. Phase I Middlesex Sampling Plant and Vicinity Properties.* Submitted to Bechtel Library, Oak Ridge, Tennessee, September 24, 1994.

Eckerman, K.F. and J.C. Ryman, 1993. "External Exposure to Radionuclides in Air, Water, and Soil." U.S. Environmental Protection Agency report EPA-402-R-93-081, Federal Guidance Report No. 12.

EPA 1989a. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERLCA*, EPA 540 G-89 004, October.

EPA 1989b. "Risk Assessment Guidance for Superfund: Human Health Evaluation Manual, Part A, Interim Final," EPA/540/1-89/002, EPA, Office of Emergency and Remedial Response, Washington, DC.

EPA 1992. *Statistical Analysis of Groundwater Data at RCRA Facilities, Addendum to Interim Final Guidance.*

EPA 1992a. "Dermal Exposure Assessment: Principles and Applications," EPA/600/8-91/011b, Office of Health and Environmental Assessment, Washington, DC.

EPA 1996a. *Soil Screening Guidance: Technical Background*, EPA/540/R-95/R8, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC, May.

EPA 1997a. "Technology Support Center Issue: The Lognormal Distribution in Environmental Applications", Office of Solid Waste and Emergency Response, EPA/600/R-97/006, Washington, DC.

EPA 1997b. *Exposure Factors Handbook*, Volumes I, II, and III, EPA/600/P-95/002Fa-c, EPA, Office of Research and Development, Washington, DC.

EPA 1997c. *Ecological Risk Assessment Guidance For Superfund: Process for Designing and Conducting Ecological Risk Assessments.* EPA 540-R-97-006. Office of Solid Waste and Emergency Response, Washington, DC.

EPA 1998a. Integrated Risk Information System (IRIS), National Center for Environmental Assessment, U.S. Environmental Protection Agency, 26 West Martin Luther King Drive, MS-190, Cincinnati, OH 45268. (513) 569-7254.

EPA 1998b. *"Risk Assessment Guidance for Superfund: Volume I Human Health Evaluation manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments) Interim Guidance,"* OSWER Directive 9285.7-01D, EPA, Office of Emergency and Remedial Response, Washington, DC.

EPA 1998c. *"Risk Assessment Guidance for Superfund" Volume I: Human Health Evaluation Manual*, Supplemental Guidance, Dermal Risk Assessment Interim Guidance, NCEA-W0364, External Review Draft, EPA, Office of Emergency and Remedial Response, Washington, DC.

EPA 1999. "National Recommended Water Quality Criteria – Correction," U.S. Environmental Protection Agency report EPA 822-Z-99-001.

EPA 2001. *"Health Effects Assessment Summary Tables – Radionuclides,"* April 2001.

EPA 2001. *"Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual"*,(Part E, Supplemental Guidance for Dermal Risk Assessment), Interium.

EPA 1999. "National Recommended Water Quality Criteria – Correction," U.S. Environmental Protection Agency report EPA 822-Z-99-001.

EPA 2000. EPA's Recommended Consensus Based TEC for Freshwater Systems, (MacDonald et al. 2000) D.D. MacDonald, C.G. Ingersoll, and T.A. Berger, "Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems," Archives of Environmental Contamination and Toxicology, January 2000.

EPA 2002, *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*, OSWER 9285.6-10, December 2002

Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion,* EPA-520/1-88-020, September 1988.

Federal Guidance Report No. 12, *External Exposure to Radionuclides in Air, Water, and Soil*, EPA-402-R-93-081, September 1988

Federal Guidance Report No. 13, *Cancer Coefficients for Environmental Exposure to Radionuclides*, EPA-402-R-99-001, September 1999

Fetter, C.W., 1999. *Contaminant Hydrogeology*, 2nd Edition. Prentice Hall, New Jersey. 500 pp.

Ford, Bacon, & Davis Utah, Inc. 1979a. *Engineering Evaluation of the Former Middlesex Sampling Plant and Associated Properties, Middlesex, New Jersey* (FBDU230-001), July.

Ford, Bacon, & Davis Utah, Inc. 1979b. *Environmental Analysis of the Former Middlesex Sampling Plant and Associated Properties, Middlesex, New Jersey*, (FBDU 230-005) July.

Freeze, R.A. and J.A.Cherry, 1979. *Groundwater*. Prentice-Hall, Inc. 604 pp.

French, M.A. 1996. *Ground-Water Recharge and Aquifer Recharge Potential for Middlesex County, New Jersey*, New Jersey Geological Survey, Open-File Map OFM 21. *Geological Survey*, Geological Survey Report GSR 35.

Hamill, N. and E. Demarest 1997. Ecological Risk Assessment in NJDEP's Site Remediation Program: Conducting a Baseline Ecological Evaluation. *Site Remediation News* (Vol. 9 No. 1) - Article 05, NJDEP, Bureau of Environmental Evaluation and Risk Assessment, http://www.state. nj.us/dep/srp/news/1997/9701_05.htm (2/18/099).

HSDB, 2002. "Hazardous Substances Data Bank." U.S. National Library of Medicine, Specialized Information Services, http://toxnet.nlm.nih.gov/.

Jones, D.S., et al., 1997. "Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Dwelling Biota: 1997 Revision." Oak Ridge National Laboratory report ES/ER/TM-95/R4.

Knox R.C., D.A. Sabatini, and L.W. Cantor, 1993. *Subsurface Transport and Fate Processes*. Lewis Publishers.

Kricher, John C., et al. 1988. *Ecology of Eastern Forests.* Houghton Mifflin Company, New York.

McCarthy, J.F. and J.M. Zachara, 1989. Subsurface Transport of Contaminants. Environmental Science and Technology, v. 23, no. 5, pp. 496-502.

McCarty, P.L.; M. Reinhard, and B.E. Rittmann, 1981. Environmental Science and Technology, v. 15, pp. 40-51

McKelvey, V.E., D.L. Everhart, and R.M. Garrels, 1955. Origin of uranium deposits. Economic Geology, 50th Anniversary Volume, pp. 464–533.

Michalski, A. 1990. *Hydrogeology of the Brunswick (Passaic) Formation and Implications for Groundwater Monitoring Practice*, Groundwater Monitoring Review, (10) no.4, p. 134-143.

Michalski, A. and Britton, R. 1997. *The Role of Bedding Fractures in the Hydrogeology of Sedimentary Bedrock-Evidence from the Newark Basin, New Jersey*, Groundwater, v. 35, no. 2, pp. 318-327.

Montgomery & Welkom, 1989. *Groundwater Chemicals, Desk Reference.* Lewis Publishers Inc.

Morin, R.H., Carlton, G.B., and Poirier, S. 1997. *Fractured - Aquifer Hydrogeology from Geophysical Logs; The Passaic Formation, New Jersey*. Groundwater. v. 35, no. 2, pp. 328-338.

National Atmospheric Deposition Program, 1991. Annual and seasonal data summary of precipitation chemistry collected during 1990 in Washington Crossing State Park, Mercer County, New Jersey – update to the Directory of Precitpitation Monitoring Sites (1988), *for* National Atmospheric Deposition Program/National Trends Network, National Resource Ecology Laboratory, Colorado State University, Fort Collins, Colorado, p. 284-285.

NCRP, 1991. “Effects of Ionizing Radiation on Aquatic Organisms.” NCRP Report No. 109, National Council on Radiation Protection and Measurements, Bethesda, Md.

Newell, C.J., R.K. McLeod, and J.R. Gonzales, 1997. BIOSCREEN, Natural Attenuation Decision Support System User’s Manual Versions 1.3 and 1.4. National Risk Management Research Laboratory Office of Research and development, U.S. Environmental Protection Agency. 64 pp.

NJDEP 1998. NJDEP’s Lowest Observed Effect Level, (Persaud et al. 1993) D. Persaud, R Jaagumagi, and A. Hayton, Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario, Ontario Ministry of the Environment, 1993.

Nininger, R.D. 1956. *Minerals for Atomic Energy: A Guide to Exploration for Uranium, Thorium, and Beryllium*, D. Van Nostrand Company, Inc., New York.

NJAC (New Jersey Administrative Code) 7:26E 1997. *New Jersey Technical Requirements for Site Remediation.*

NJDEP (New Jersey Department of Environmental Protection) 1993. *A Summary of Selected Soil Constituents and Contaminants at Background Locations in New Jersey*, Site Remediation Program and Division of Science and Research, Trenton, New Jersey, September.

NJDEP 1997. *Technical Requirements for Site Remediation* (NJAC 7:26E), New Jersey Department of Environmental Protection Site Remediation Program, Trenton, New Jersey, May.

NJDEP, 1998. "Guidance for Sediment Quality Evaluations." New Jersey Department of Environmental Protection, November 1998.

NJDEP, 2002, "Surface Water Quality Standards." N.J.A.C 7:9B, January 2002.

NLO (National Lead Company of Ohio) 1981. *Environmental Monitoring Program for DOE Middlesex, New Jersey Site,* NLCO-0010EV, October.

NOAA (National Oceanic and Atmosphere Administration) 2002. Local Climatological Data, Newark Airport, Newark, New Jersey.

NRC, 1992. "*Residual Radioactive Contamination from Decommissioning, Technical Basis for Translating Contamination Levels to Animal Total Effective Dose Equivalent*, Vol. 1." U.S. Nuclear Regulatory Commission report NUREG/CR-5512.

Olsen, P.E. 1980. "Triassic and Jurassic Formations of the Newark Basin," in *Field Studies of New Jersey Geology and Guide Field Trips: 52nd Annual Meeting of the New York State Geological Association*.

ORNL 1977. *Radiological Survey of the Middlesex Sampling Plant,* Final Report (DOE/EV-005/1) Oak Ridge National Laboratory, Oak Ridge, Tennessee, November.

ORNL 1980. *Radiological Survey of the Middlesex Municipal Landfill Site, Middlesex, New Jersey,* DOE/EV-005/20, Oak Ridge, Tennessee, April.

Osmond, J.K. and J. B. Cowart,2000. *Ground Wate*r. In: Uranium Series Disequilibrium: Applications to Earth, Marine, and Environmental Sciences. (M. Ivanovich and R. S. Harmon (eds.)) 3rd Ed. Clarendon Press, Oxford.

Parker, R.A. 1993. Stratigraphic relations of the sedimentary rocks below the Lower Jurassic Orange Mountain Basalt, Northern Newark Basin, New Jersey and New York. U.S. Geological Survey Misc. Field Studies Map MF-2208.

SAIC (Science Applications International Corporation) 1995. *Characterization Report for the Middlesex Sampling Plant, Middlesex, New Jersey, Volumes I and II*, DOE/OR/21950-1007 (Final), August.

SAIC 1999. *Remedial Investigation and Baseline Risk Assessment at Middlesex Sampling Plant*, (Draft), Middlesex, New Jersey, USACE.

Serfes, M. E., 1994, Natural Ground-Water Quality in Bedrock of the Newark Basin, New Jersey, New Jersey Geological Survey, Geological Survey Report GSR 35, 29 p.

Serfes, M.E. 1994. *Natural Ground-Water Quality in Bedrock of the Newark Basin, New Jersey*

Schaum, J., Hoang, K., Kinerson, R., Moya, J., and R. G. M. Wang, *Estimating Dermal and Inhalation Exposure to Volatile Chemicals in Domestic Water* in Water Contamination and Health: Integration of Exposure Assessment, Toxicology, and Risk Assessment, Edited by R. G. M. Wang, Marcel Dekker, Inc. New York, 1994

Sturm, Edward, 1956, Mineralogy and petrology of the Newark Group sediments of New Jersey: Ph.D. thesis, Rutgers Univ.

Suter, G.W., II, and C.L. Tsao, 1996. "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision." Oak Ridge National Laboratory report ES/ER/TM-96/R2.

Tedrow, J.C.F. 1986. *Soils Of New Jersey*. Robert E. Kreiger Publishing Company, Florida.

TMA (Thermo Analytical, Inc.) 1995. *Case Narrative for Sediment Sample 118RS030A*, Letter to Jim McCagne (Bechtel National, Inc.), Oak Ridge, Tennessee, October 27.

URS 2000. *Contractor Quality Control Plan for the Middlesex Sampling Plant*

USACE 1997. *Engineering Evaluation/Cost Analysis for the Removal of the Middlesex Municipal Landfill Waste Pile at the Middlesex Sampling Plant*, CCN 160071, November.

USACE 1999a. *Engineering Evaluation/Costs Analysis for the Removal of the Vicinity Property Interim Storage Pile at the Middlesex Sampling Plant*.

USACE 1999b. *Baseline Human Health Risk Assessment and Screening-Level Ecological Risk Assessment for the Middlesex Sampling Plant, Middlesex, New Jersey* (First USACE-Kansas City District Review Draft), September.

USACE, 1999c. *Data Quality Guidance, July*

USACE 2000a. *Environmental Surveillance Work Plan for the Middlesex Sampling* (First USACE-Kansas City District Review Draft), August

USACE 2000b. *Quality Assurance Project Plan for the Middlesex Sampling Plant*, August

USACE 2000c. *Soil Operable Unit Remedial Investigation Work Plan for the Middlesex Sampling Plant*

USACE 2000d. *Groundwater Operable Unit Remedial Investigation Work Plan for the Middlesex Sampling Plant*

USACE, 2001. *Data Quality Guidance*, *July*

USACE 2003. *Remedial Investigation Report of the Soil Operable Unit for the Middlesex Sampling Plant*

USDA 1997. *Ecological Subregions of the United States, Chapter 16*, http://www.fs.fed.us/land/pubs/ecoregions/ch16.html (2/7/01).

USDA 1999. *Chapter 16 Ecological Subregions of the United States, Section 221D-Northern Appalachian Piedmont*, March 19, http://www.fs.fed.us/land/pubs/ecoregions/ch16.html.

USDA SCS (United States Department of Agriculture Soil Conservation Service) 1987. *Soil Survey of Middlesex County New Jersey.*

USGS (United States Geological Survey) 1999. *Aquifer and Well Characteristics in New Jersey*, March 2., http://nj.usgs.gov/gw/table_1.html.

Van Houten, F.B., 1969, Late Triassic Newark Group, north-central New Jersey and adjacent Pennsylvania and New York, *in* Subitzky, Seymour, ed., Geology of selected areas in New Jersey and Pennsylvania and guidebook of excursions: New Brunswick, Rutgers University Press, p. 314-347.

Vecchioli, J. and Miller, E.G. 1974, *Water Resources of the New Jersey Part of the Ramapo River Basin*, U.S. Geological Survey Water-Supply Paper 1974, pp. 77.

Vecchioli, J., Carswell, L.D., and Kasabach, H.F. 1969, *Occurrence and Movement of Groundwater in the Brunswick Shale at a Site Near Trenton, New Jersey*, U.S. Geological Survey Professional Paper 650-B, pp. B154-B157.

Weston, Inc., Roy F. 1980. *Final Report – Hydrogeology of the Former Middlesex Sampling Plant Site, Middlesex, New Jersey*, prepared for the Oak Ridge National Laboratory, October.

Xu, M. and Y. Eckstein, 1995. Use of Weighted Least-Squares Method in Evaluation of the Relationship Between Dispersivity and Scale. Journal of Ground Water, v. 33, no. 6, pp. 905-908.

Yu and others, 1993. *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5*.0, Draft, ANL/EAD/LD-2, Argonne National Laboratory, Argonne, Ill., Sept.

TABLE 2-1

Summary of Historical Site Investigations Significant Results
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

DATE	FIELD ACTIVITIES	TECHNIQUE	SIGNIFICANT FINDINGS	NOTES
1976	Alpha contamination measurements in buildings on site	Direct readings for fixed contamination Smear techniques for removable contamination	Buildings had areas with fixed contamination above NRC limits for Ra-226, with some areas of the Process Building having removable contamination above NRC limits but in general removable levels were low.	
	Beta contamination measurements in buildings on site	Direct readings for fixed Smear techniques for removable	Beta-gamma dose rates measured on some building surfaces were above NRC limits. Beta-gamma removable contamination levels were below NRC limits.	
	External gamma radiation levels			
	On site	Direct readings and TLDs	Direct ranged from 22 to 147 uR/hr one meter above the ground. Background measurements were 5 to 10 uR/hr. TLD readings ranged from 14 to 342 uR/hr.	Elevated readings correlate with elevated readings from direct measurements.

TABLE 2-1

Summary of Historical Site Investigations Significant Results
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

DATE	FIELD ACTIVITIES	TECHNIQUE	SIGNIFICANT FINDINGS	NOTES
	Off site	Direct readings	Along the streams and drainage areas the gamma radiation levels were as high as 235 uR/hr at three feet from the surface. Direct gamma radiation levels measured from occupied properties ranged from 11 to 67 uR/hr.	
	Air sampling			
	On site buildings	Radon and daughters through grab samples and continuous monitoring.	Radon and radon daughter measurements in the buildings were above background and non-occupational maximum permissible levels.	
	Off site private dwellings	Radon and daughters through grab samples and continuous monitoring.	Radon and radon daughter level measurements were below guidelines.	
	Surface and subsurface soil sampling	Ge(Li) detector		Elevated results mostly in 0-2ft bgs

TABLE 2-1

Summary of Historical Site Investigations Significant Results
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

DATE	FIELD ACTIVITIES	TECHNIQUE	SIGNIFICANT FINDINGS	NOTES
	On site • at 46 locations/and approx. 114 samples	Radium	Radium-226 levels in soil/fill ranged from 0.8 pCi/g to 577 pCi/g	18 locations had results > 5 pCi/g 4 locations had results > 5 pCi/g at depths > 2-ft bgs Deepest contamination was detected at 4.8 ft On site contamination most prevalent near the surface and in the vicinity of the Process Building

TABLE 2-1

Summary of Historical Site Investigations Significant Results
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

DATE	FIELD ACTIVITIES	TECHNIQUE	SIGNIFICANT FINDINGS	NOTES
	Vicinity property • Approx. 54 locations/approx. 95 samples from the drainage area • Approx. 21 locations/approx. 27 samples from Main stream • Approx. 54 locations/ approx. 82 samples from vicinity properties	Radium	Radium-226 levels in drainage area ranged from 0.8 to 2,401 pCi/g. Radium-226 levels in Main Stream ranged from 1.7 to 317 pCi/g. Radium-226 levels in vicinity properties ranged from 0.7 to 408 pCi/g.	Clean up of the vicinity properties began in 1980 and were completed in 1981.
		Uranium	Uranium levels in select samples from the drainage are and Main Stream ranged from 26.5 to 5,280 ppm U. Uranium levels in select samples from vicinity properties ranged from 4.2 to 126 ppm U.	
	Background (2 locations)	Radium	Radium-226 results ranged from 1.0 pCi/g to 1.7 pCi/g.	

TABLE 2-1

Summary of Historical Site Investigations Significant Results
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

DATE	FIELD ACTIVITIES	TECHNIQUE	SIGNIFICANT FINDINGS	NOTES
1980	Surface & subsurface soil sampling (during MW installation) • From 14 locations/ 29 samples	Radium	Radium-226 levels measured from 0.6 to 793 pCi/g	Highest levels were in pavement sub base material. Most of the radiological contamination was identified in 2-3ft bgs.
		Uranium	Uranium-238 results ranged from 0.5 to 285 pCi/g	Highest levels were in pavement sub base material.
	Bedrock sampling	Radium	Radium-226 levels consistent with background (1.3 pCi/g).	
	Downhole gamma logging	Direct readings	Only two boreholes logged indicated levels that may be above 5 pCi/g of Radium-226 in concentration.	A correlation between cpm and pCi/g was developed.

TABLE 2-1

Summary of Historical Site Investigations Significant Results
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

DATE	FIELD ACTIVITIES	TECHNIQUE	SIGNIFICANT FINDINGS	NOTES
	Groundwater (15 MW to bedrock, and 5 in bedrock)	Radium	Radium-226 levels ranged from 0.1 to 1.94 pCi/g and one result of 474 pCi/l.	Shallow groundwater has been contaminated through contact with localized accumulations of radionuclides in soil. However, no gradient could be determined.
		Uranium	Most Uranium-234 levels ranged from 0.7 to 38.6 pCi/g, with 1,420 pCi/g in the same well as the elevated Ra-226 result. Most Uranium-238 levels ranged from 0.9 to 41.3 pCi/g, with 1,430 pCi/g in the same well as the elevated Ra-226 result.	Due the questionable integrity of these wells, all but one well (MSP-12) were subsequently abandoned.
1983	Alpha contamination measurements in buildings on site	Direct readings for fixed contamination Smear techniques for removable contamination	Levels of fixed alpha contamination were identified above limits. No removable contamination in excess of the limits was identified.	

TABLE 2-1

Summary of Historical Site Investigations Significant Results
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

DATE	FIELD ACTIVITIES	TECHNIQUE	SIGNIFICANT FINDINGS	NOTES
	Beta contamination measurements in buildings on site	Direct readings for fixed Smear techniques for removable	Limited areas with levels of fixed beta contamination were identified above limits. No removable contamination in excess of the limits was identified.	
	External gamma radiation levels on site	Direct readings	Gamma radiation dose rates ranged from 16 to 371 uR/hr, and the beta-gamma dose rates measurements of the ground surface ranged from 0.01 to 7.25 mrad/hr.	
	Surface and subsurface soil sampling • Samples collected on 50-ft grid in all areas except those covered by buildings and the VP Pile.	Radium	The maxim level of Radium-226 in the asphalt/soil interface was 736 pCi/g. The maxim levels of Radium-226 in the subsurface soil was 208 pCi/g.	Highest levels were in the area of the former Process Building and the area where the MML was to be located.
		Uranium	The maxim levels of Uranium-238 in the asphalt/soil interface was 961 pCi/g. The maxim levels of Uranium-238 in the subsurface soil was 398 pCi/g.	
	Groundwater from borings	Radium	Radium-226 levels measured in water ranged from 0.1 to 71 pCi/l.	

TABLE 2-1

Summary of Historical Site Investigations Significant Results
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

DATE	FIELD ACTIVITIES	TECHNIQUE	SIGNIFICANT FINDINGS	NOTES
	• From 22 locations	Uranium	Uranium-238 levels in water ranged from 1.5 to 1,288 pCi/l.	
1991	Surface and subsurface site soil sampling • At 33 locations to 8-ft depth	TAL Metals		Prior to 1991 limited or no chemical characterization of in-situ soils was performed.
		Beryllium	0.23 to 1.70 mg/kg	Detected in most boreholes
		Cadmium	0.65 to 3.10 mg/kg	In two boreholes at depths of 5-ft
		Cobalt	2.50 to 26.10 mg/kg	Detected in most boreholes
		Chromium	4.80 to 70.20 mg/kg	Detected in every borehole
		Iron	5,710 to 38,000 mg/kg	Detected in every borehole
		Nickel	4.80 to 63.90 mg/kg	Detected in every borehole
		Lanthanides		
		Thulium	73.40 to 2,680 mg/kg	Detected frequently
		Erbium	56.70 to 2,570 mg/kg	Detected frequently
		Neodymium	50.20 to 88.70 mg/kg	Detected twice

TABLE 2-1

Summary of Historical Site Investigations Significant Results
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

DATE	FIELD ACTIVITIES	TECHNIQUE	SIGNIFICANT FINDINGS	NOTES
		Lanthanum	88.40 mg/kg	Detected once
		Cerium	50.50 to 962 mg/kg	Detected in 4 boreholes
		PCBs		
		Aroclor-1254	0.11 mg/kg	Detected in 2 boreholes
		Aroclor-1260	0.03 mg/kg	Detected in one borehole
		VOCs		VOCs primarily detected in surface soils
		Acetone	1,800 ug/kg max	In 24 boreholes
		Methylene chloride	130 ug/kg max	In 22 boreholes
		Toluene	2,300 ug/kg max	In 14 boreholes
		Benzene	8 mg/kg	In 3 boreholes
		Carbon disulfide	2 mg/kg	In 3 boreholes
		Xylenes	540 ug/kg	In 2 boreholes
		Tetrachloroethene	2 ug/kg	In 2 borehole
		SVOCs		Highest levels were in the area between the two storage piles and the area north of the VP pile

TABLE 2-1

Summary of Historical Site Investigations Significant Results
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

DATE	FIELD ACTIVITIES	TECHNIQUE	SIGNIFICANT FINDINGS	NOTES
		Pesticides		
		Lindane	0.76 ug/kg	In 1 borehole
		heptachlor	1.30 ug/kg	In 1 borehole
	Gamma logging of boreholes	Direct readings	Elevated levels were encountered in localized areas typically less than 3ft bgs. Areas of highest activities were encountered in the area of the Process Building and in the area in and around the Pipe Chase (Storm Sewer).	
1995-1996	Storm Water discharge headwall areas; surface and subsurface soil sampling (1995) • Four locations and 3 samples	Radium	Radium-226 results were 32.07, 9.68, and 13.05 ug/g.	
		Uranium	Total Uranium results were 87.96, 29.90, and <7.62 ug/g .	
	Gamma logging of accessible portions of the storm drain pipes (1995)	Direct readings	Results indicated that there is contamination in the pipes and/or in the fill around the pipe.	Limited to a short distance up the pipes (due to plugs in line).

TABLE 2-1

Summary of Historical Site Investigations Significant Results
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

DATE	FIELD ACTIVITIES	TECHNIQUE	SIGNIFICANT FINDINGS	NOTES
	Sediment Sampling (1995)	Radium	Radium-226 levels in the ranged from 0.25 to 17.63 pCi/g.	Highest level of Radium-226 at the same location as the highest level of Total Uranium.
		Uranium	Total Uranium levels ranged from <0.78 to 306.13 pCi/g.	
	Catch Basin Sampling (1995)	Radium	Radium-226 results were 7.8, 18.4, and 8.06 pCi/g (three samples).	
		Uranium	Total Uranium results were 18.95, 45.66, and 34.16 pCi/g (three samples)	
	Gamma Logging of well boreholes (1996)		Elevated levels in three boreholes.	(in the fill material)
	Soil samples from nine groundwater monitoring wells (1996)	Radium	Radium-226 results ranged from 0.6 to 21.4 pCi/g.	Highest level in B18W31D – north of the headwall.
		Uranium	Total Uranium results range from 1.93 to 18.55 pCi/g.	Highest level in B18W31D – north of the headwall.

TABLE 2-1

Summary of Historical Site Investigations Significant Results
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

DATE	FIELD ACTIVITIES	TECHNIQUE	SIGNIFICANT FINDINGS	NOTES
	Groundwater sampling (1996)	Radium	Radium-226 unfiltered results ranged from 0.09 to 2.12 pCi/l. Radium-226 filtered results ranged from 0.08 to 1.86 pCi/l.	Highest level in B18W32S – in Pipe Chase material.
		Uranium	Total Uranium unfiltered results ranged from 1.24 to 63.42 pCi/l. Total Uranium filtered results ranged from 1.13 to 44.95 pCi/l.	Highest levels in wells behind the headwall.
2000 ATSDR public health assessment	On site groundwater sampling • 2 locations	Radium	Maximum Radium-226 results of 4.0 pCi/l	Information taken from summary of results contained in ATSDR 2002.
		Uranium	Maximum total Uranium results of 391 pCi/l	
		Arsenic	Maximum Arsenic result of 13 ppb	
		Lead	Maximum Lead result of 17 ppb	
		Trivalent Chromium	Maximum Trivalent Chromium result of 25,700 ppb	
		Radium	Maximum Radium-226 result of 0.3 pCi/l	

TABLE 2-1

Summary of Historical Site Investigations Significant Results
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

DATE	FIELD ACTIVITIES	TECHNIQUE	SIGNIFICANT FINDINGS	NOTES
	Off Site groundwater sampling • 1 location	Uranium	Maximum Total Uranium result of 19.7 pCi/l in February, that detected at 6.8 pCi/l in April 2000.	Review of historical data indicate that the sediment removal actions in the drainage area resulted in a decrease in uranium levels in the groundwater in this area.
		Arsenic	Maximum Arsenic result of 2.2 ppb	
		Lead	Non-detect	
		Total Chromium	Non-detect	
		Hex Chromium	Non-detect	
				ATSDR concluded that the groundwater beneath MSP is contaminated, however, no exposures from the contamination are now or expected to occur.
	Off site private wells	Radium	Maximum Radium-226 result of 2.0 pCi/l	

TABLE 2-1

Summary of Historical Site Investigations Significant Results
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

DATE	FIELD ACTIVITIES	TECHNIQUE	SIGNIFICANT FINDINGS	NOTES
	• 14 private wells	Uranium	Maximum Total Uranium result of 2.9 pCi/l	
		Arsenic	Maximum Arsenic result of 8.1 ppb	
		Total Chromium	Maximum Total Chromium result of 19 ppb	
		Hex Chromium	Non-detect	
		Lead	Maximum Lead result of 16 ppb	
	Off site surface water	Radium	Maximum Radium-226 result of 0.3 pCi/l	
		Uranium	Non-detect	
		Arsenic	Non-detect	
		Total Chromium	Maximum Total Chromium result of 45 ppb	
		Lead	Maximum Lead result of 6.7 ppb	

Table 3-1

Summary of Meteorological Data[1]
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Rainfall*	mm	88.39	74.16	103.12	92.96	98.04	84.07	102.11	103.12	96.27	76.71	90.17	84.33	1095.22
	in	3.48	2.92	4.06	3.66	3.86	3.31	4.02	4.06	3.79	3.02	3.55	3.32	43.04
Average Temperature**	°C	-0.2	0.7	5.2	10.9	16.9	22.0	24.3	23.9	19.9	13.8	7.9	2.0	12.3
	°F	31.7	33.3	41.3	51.7	62.4	71.6	75.7	75.1	67.8	56.9	46.3	35.6	54.1
Average Minimum Temperature***	°C	-4.3	-3.4	0.7	5.9	11.5	16.8	19.4	19.1	14.9	8.8	3.7	-1.9	7.6
	°F	24.3	25.8	33.2	42.7	52.8	62.3	67.0	66.5	58.8	47.9	38.6	28.6	45.7
Average Maximum Temperature***	°C	3.7	4.5	9.9	16.2	22.2	27.2	29.2	28.9	24.8	19.1	12.3	5.9	17.0
	°F	38.6	40.1	49.9	61.2	72.0	81.0	84.6	84.0	76.7	66.4	54.2	42.7	62.7

Notes:

[1] Data obtained from the National Weather Service at the Newark International Airport collection station.

* Period of Record: 69 Years (1932-2000)

** Period of Record: 70 Years (1931-2000)

*** Period of Record: 65 Years (1936-2000)

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W24S* 2000/06/29 REG WATER µg/L		B18W24S* 2000/07/07 REG WATER µg/L		B18W24S* 2000/09/19 REG WATER µg/L		B18W24S* 2000/12/19 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	145000		NA		171000		113000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	1000	U	NA		1000	U	1000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	145000		NA		171000		113000	
CHLORIDE	250000	NE	NE	NA		NA		4800		3860	
PHOSPHORUS (TOTAL)	NE	NE	NE	NA		144		238		172	
SETTLEABLE SOLIDS	NE	NE	NE	NA		100	U	100	U	100	U
SULFATE	250000	NE	NE	191000		NA		150000		42600	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	**531000**		NA		416000		192000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.

Boxed results

* denotes groundwater samples associated with the En - indicate an exceedance in applicable standards.

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W24S* 2001/03/23 REG WATER µg/L		B18W24S* 2001/05/31 REG WATER µg/L		B18W24S* 2001/10/03 REG WATER µg/L		B18W24S* 2001/12/12 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	78800		150000		170000		140000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	1000	U	10000	U	10000	U	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	78800		NA		NA		NA	
CHLORIDE	250000	NE	NE	5070		2340	J	2400		3680	R
PHOSPHORUS (TOTAL)	NE	NE	NE	140		176	J	200		192	
SETTLEABLE SOLIDS	NE	NE	NE	100	U	0.1	U	0.1	U	0.1	U
SULFATE	250000	NE	NE	38300		52200	J	101000		87000	R
TOTAL DISSOLVED SOLIDS	500000	NE	NE	175000		260000		370000		231000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.

Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the En

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W24S* 2002/04/01 REG WATER µg/L		B18W24S* 2002/09/26 REG WATER µg/L		B18W25S* 2000/06/27 DUP WATER µg/L		B18W25S* 2000/06/27 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	104000		170000		192000		190000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	1000	U	1000	U	1000	U	1000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	104000		170000		192000		190000	
CHLORIDE	250000	NE	NE	2200		3200		9090		9090	
PHOSPHORUS (TOTAL)	NE	NE	NE	80		1200		NA		NA	
SETTLEABLE SOLIDS	NE	NE	NE	100	U	0.1	U	NA		NA	
SULFATE	250000	NE	NE	31000		100000		41800		41500	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	160000		NA		256000		237000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the En

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W25S* 2000/07/05 REG WATER µg/L		B18W25S* 2000/07/06 DUP WATER µg/L		B18W25S* 2000/09/18 REG WATER µg/L		B18W25S* 2000/12/18 DUP WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	NA		NA		188000		190000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	NA		NA		1000	U	1000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		188000		190000	
CHLORIDE	250000	NE	NE	NA		NA		9000		6750	
PHOSPHORUS (TOTAL)	NE	NE	NE	109		88		131		418	
SETTLEABLE SOLIDS	NE	NE	NE	100	U	100	U	100	U	100	U
SULFATE	250000	NE	NE	NA		NA		43900		34800	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	NA		NA		212000	J	244000	

Notes:

U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.

Boxed results - indicate an exceedance in applicable standards.

* denotes groundwater samples associated with the En

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W25S* 2000/12/18 REG WATER µg/L		B18W25S* 2001/03/22 REG WATER µg/L		B18W25S* 2001/05/24 REG WATER µg/L		B18W25S* 2001/10/02 DUP WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	188000		103000		140000		130000	UJ
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	1000	U	1000	U	10000	U	10000	UJ
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	188000		103000		NA		NA	
CHLORIDE	250000	NE	NE	7230		26400		9700		9200	UJ
PHOSPHORUS (TOTAL)	NE	NE	NE	83		138		94		110	UJ
SETTLEABLE SOLIDS	NE	NE	NE	100	U	808		0.1	U	0.1	UJ
SULFATE	250000	NE	NE	34300		37000		29200		28900	UJ
TOTAL DISSOLVED SOLIDS	500000	NE	NE	223000		262000		200000		170000	UJ

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the En

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W25S* 2001/10/02 REG WATER µg/L		B18W25S* 2001/12/11 DUP WATER µg/L		B18W25S* 2001/12/11 REG WATER µg/L		B18W25S* 2002/03/28 DUP WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	130000	UJ	91400		93600		110000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	UJ	10000	U	10000	U	1000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		NA		110000	
CHLORIDE	250000	NE	NE	9200	UJ	5750	R	5900	R	8000	
PHOSPHORUS (TOTAL)	NE	NE	NE	110	UJ	107		35		170	
SETTLEABLE SOLIDS	NE	NE	NE	0.11	UJ	0.1	U	0.1	U	100	U
SULFATE	250000	NE	NE	28700	UJ	31800	R	31200	R	25300	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	150000	UJ	160000		166000		200000	

Notes:

U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.

Boxed results - indicate an exceedance in applicable standards.

* denotes groundwater samples associated with the En

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W25S* 2002/03/28 REG WATER µg/L		B18W25S* 2002/09/30 DUP WATER µg/L		B18W25S* 2002/09/30 REG WATER µg/L		B18W26S* 2000/06/28 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	110000		130000		130000		177000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	1000	U	1000	U	1000	U	1000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	110000		130000		130000		177000	
CHLORIDE	250000	NE	NE	8000		8900		8900		NA	
PHOSPHORUS (TOTAL)	NE	NE	NE	73		160		160		NA	
SETTLEABLE SOLIDS	NE	NE	NE	100	U	0.1	U	0.1	U	NA	
SULFATE	250000	NE	NE	26000		29000		28000		2880	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	190000		NA		NA		209000	

Notes:

U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.

Boxed results - indicate an exceedance in applicable standards.

* denotes groundwater samples associated with the En

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W26S* 2000/07/07 REG WATER µg/L		B18W26S* 2000/09/21 REG WATER µg/L		B18W26S* 2000/12/21 REG WATER µg/L		B18W26S* 2001/03/22 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	NA		180000		133000		98500	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	NA		1000	U	133000		1000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		180000		133000		98500	
CHLORIDE	250000	NE	NE	NA		7100		2410		17200	
PHOSPHORUS (TOTAL)	NE	NE	NE	28		34		21		45	
SETTLEABLE SOLIDS	NE	NE	NE	100	U	100	U	100	U	104	J
SULFATE	250000	NE	NE	NA		16000		3140		3270	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	NA		213000		162000		143000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.

Boxed results

* denotes groundwater samples associated with the En - indicate an exceedance in applicable standards.

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W26S* 2001/05/25 DUP WATER µg/L		B18W26S* 2001/05/25 REG WATER µg/L		B18W26S* 2001/10/03 REG WATER µg/L		B18W26S* 2001/12/13 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	120000		120000		170000		120000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U	10000	U	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		NA		NA	
CHLORIDE	250000	NE	NE	17200		16700		10000		7450	
PHOSPHORUS (TOTAL)	NE	NE	NE	28	J	41	J	32		20	U
SETTLEABLE SOLIDS	NE	NE	NE	0.1	U	0.1	U	0.1	U	0.1	U
SULFATE	250000	NE	NE	4900		5000		1900	U	2680	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	161000		153000		230000		165000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the En

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type / Matrix: / Units: / Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W26S* 2002/04/03 REG WATER µg/L		B18W26S* 2002/09/24 REG WATER µg/L		B18W27S* 2000/06/28 REG WATER µg/L		B18W27S* 2000/07/05 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	110000		160000		138000		NA	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	1000	U	1000	U	1000	U	NA	
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	110000		160000		138000		NA	
CHLORIDE	250000	NE	NE	6700		6800		NA		NA	
PHOSPHORUS (TOTAL)	NE	NE	NE	50		70		NA		264	
SETTLEABLE SOLIDS	NE	NE	NE	100	J	0.1	U	NA		100	U
SULFATE	250000	NE	NE	2800		420		32100		NA	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	110000		180000		10000	U	NA	

Notes:

U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.

Boxed results

* denotes groundwater samples associated with the En - indicate an exceedance in applicable standards.

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W27S* 2000/09/20 REG WATER µg/L		B18W27S* 2000/12/21 REG WATER µg/L		B18W27S* 2001/03/21 DUP WATER µg/L		B18W27S* 2001/03/21 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	132000		127000		109000		107000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	1000	U	1000	U	1000	U	1000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	132000		127000		109000		107000	
CHLORIDE	250000	NE	NE	28500		30400		28400		28900	
PHOSPHORUS (TOTAL)	NE	NE	NE	340		275		330		226	
SETTLEABLE SOLIDS	NE	NE	NE	100	U	100	U	100	J	100	U
SULFATE	250000	NE	NE	29400		28200		26200		25900	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	258000		240000		224000		223000	

Notes:

U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.

Boxed results

* denotes groundwater samples associated with the En - indicate an exceedance in applicable standards.

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W27S* 2001/05/30 REG WATER µg/L		B18W27S* 2001/10/04 REG WATER µg/L		B18W27S* 2001/10/09 REG WATER µg/L		B18W27S* 2001/12/13 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	130000		140000	UJ	NA		130000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	UJ	NA		10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		NA		NA	
CHLORIDE	250000	NE	NE	26200		32200	UJ	NA		36600	
PHOSPHORUS (TOTAL)	NE	NE	NE	316		380	UJ	NA		295	
SETTLEABLE SOLIDS	NE	NE	NE	0.1	U	0.1	UJ	0.1	U	0.1	U
SULFATE	250000	NE	NE	18900		23800	UJ	NA		19400	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	220000	J	260000	UJ	NA		266000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results
* denotes groundwater samples associated with the En - indicate an exceedance in applicable standards.

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W27S* 2002/04/03 REG WATER µg/L		B18W27S* 2002/09/25 REG WATER µg/L		B18W28S* 2000/06/29 REG WATER µg/L		B18W28S* 2000/07/07 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	110000		130000		175000		NA	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	1000	U	1000	U	1000	U	NA	
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	110000		130000		175000		NA	
CHLORIDE	250000	NE	NE	35000		39000		NA		NA	
PHOSPHORUS (TOTAL)	NE	NE	NE	350		570		NA		115	
SETTLEABLE SOLIDS	NE	NE	NE	100	U	0.1	U	NA		100	U
SULFATE	250000	NE	NE	26000		23000		23500		NA	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	220000		230000		218000		NA	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the En

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type / Matrix: / Units: / Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W28S* 2000/09/21 REG WATER µg/L		B18W28S* 2000/12/20 REG WATER µg/L		B18W28S* 2001/03/20 REG WATER µg/L		B18W28S* 2001/05/31 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	109000		127000		97600		90000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	1000	U	1000	U	1000	U	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	109000		127000		97600		NA	
CHLORIDE	250000	NE	NE	20900		23100		27400		23700	J
PHOSPHORUS (TOTAL)	NE	NE	NE	470		142		251		147	J
SETTLEABLE SOLIDS	NE	NE	NE	100	U	100	U	600		0.1	U
SULFATE	250000	NE	NE	38700		39900		26600		20500	J
TOTAL DISSOLVED SOLIDS	500000	NE	NE	450000		236000		195000		220000	

Notes:

U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.

Boxed results - indicate an exceedance in applicable standards.

* denotes groundwater samples associated with the En

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W28SR* 2001/10/05 REG WATER µg/L		B18W28SR* 2001/12/14 REG WATER µg/L		B18W28SR* 2002/04/02 REG WATER µg/L		B18W28SR* 2002/09/25 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	97000		130000		1000	U	110000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U	1000	U	1000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		1000	U	110000	
CHLORIDE	250000	NE	NE	7400		15500		100	U	16000	
PHOSPHORUS (TOTAL)	NE	NE	NE	69	UJ	34		20	U	110	
SETTLEABLE SOLIDS	NE	NE	NE	0.11	U	0.1	U	100	J	0.1	U
SULFATE	250000	NE	NE	9400		19000		100	U	13000	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	110000		201000		10000	U	180000	

Notes:

U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.

Boxed results

* denotes groundwater samples associated with the En - indicate an exceedance in applicable standards.

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W29S* 2000/06/30 REG WATER µg/L		B18W29S* 2000/07/06 REG WATER µg/L		B18W29S* 2000/09/20 REG WATER µg/L		B18W29S* 2000/09/21 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	129000		NA		NA		96000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	1000	U	NA		NA		1000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	129000		NA		NA		96000	
CHLORIDE	250000	NE	NE	NA		NA		NA		51300	
PHOSPHORUS (TOTAL)	NE	NE	NE	NA		102		135		NA	
SETTLEABLE SOLIDS	NE	NE	NE	NA		100	B	NA		100	U
SULFATE	250000	NE	NE	56000		NA		NA		34700	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	386000		NA		NA		262000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results
* denotes groundwater samples associated with the En - indicate an exceedance in applicable standards.

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type / Matrix: / Units: / Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W29S* 2000/12/20 REG WATER µg/L		B18W29S* 2000/12/21 REG WATER µg/L		B18W29S* 2001/03/20 REG WATER µg/L		B18W29S* 2001/06/05 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	78000		NA		68000		110000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	1000	U	NA		1000	U	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	78000		NA		68000		NA	
CHLORIDE	250000	NE	NE	59300		NA		**253000**		176000	
PHOSPHORUS (TOTAL)	NE	NE	NE	29		NA		430		147	
SETTLEABLE SOLIDS	NE	NE	NE	NA		100	U	15000		0.1	U
SULFATE	250000	NE	NE	46200		NA		38400		106000	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	284000		NA		**525000**		**615000**	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the En

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W29SR* 2001/10/08 REG WATER µg/L		B18W29SR* 2001/12/14 REG WATER µg/L		B18W29SR* 2002/04/01 REG WATER µg/L		B18W29SR* 2002/09/26 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	89300		140000		91000		97000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U	1000	U	96000	
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		91000		NA	
CHLORIDE	250000	NE	NE	**276000**		218000		181000		180000	
PHOSPHORUS (TOTAL)	NE	NE	NE	100	U	20	U	20	U	30	
SETTLEABLE SOLIDS	NE	NE	NE	0.1	U	0.1	U	100	U	0.1	U
SULFATE	250000	NE	NE	40300		33400		41000		45000	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	**931000**		**724000**		**570000**		NA	

Notes:

U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.

Boxed results - indicate an exceedance in applicable standards.

* denotes groundwater samples associated with the En

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW10S 2001/05/15 REG WATER µg/L		URSMW10S 2002/01/03 REG WATER µg/L		URSMW11S 2001/05/16 DUP WATER µg/L		URSMW11S 2001/05/18 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	130000		134000		29000		NA	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U	10000	U	NA	
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		NA		NA	
CHLORIDE	250000	NE	NE	12000		11900		NA		NA	
PHOSPHORUS (TOTAL)	NE	NE	NE	23		20	U	NA		23	
SETTLEABLE SOLIDS	NE	NE	NE	0.1	U	0.1	U	NA		NA	
SULFATE	250000	NE	NE	3580		3000		NA		NA	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	170000		171000		333000		NA	

Notes:

U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.

Boxed results - indicate an exceedance in applicable standards.

* denotes groundwater samples associated with the En

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW11S 2001/05/21 REG WATER µg/L		URSMW11S 2002/01/08 REG WATER µg/L		URSMW11S 2002/01/09 REG WATER µg/L		URSMW1S 2001/05/14 DUP WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	NA		NA		17800		46000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	NA		NA		10000	U	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		NA		NA	
CHLORIDE	250000	NE	NE	NA		85500		NA		5750	
PHOSPHORUS (TOTAL)	NE	NE	NE	NA		20	U	NA		82	
SETTLEABLE SOLIDS	NE	NE	NE	0.1	U	0.11	U	NA		0.1	U
SULFATE	250000	NE	NE	38800		35000		NA		21700	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	NA		NA		228000		100000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re·
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results
* denotes groundwater samples associated with the En - indicate an exceedance in applicable standards.

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW1S 2001/05/14 REG WATER µg/L		URSMW1S 2001/12/19 REG WATER µg/L		URSMW20S 2002/04/04 REG WATER µg/L		URSMW2S 2001/05/15 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	42000		49000		60500		130000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U	1000	U	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		NA		NA	
CHLORIDE	250000	NE	NE	5900		7000		16400		41500	
PHOSPHORUS (TOTAL)	NE	NE	NE	101		99		20		20	U
SETTLEABLE SOLIDS	NE	NE	NE	0.1	U	0.1	U	100	U	0.1	U
SULFATE	250000	NE	NE	22300		20300		37500		31500	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	99000		114000		200000		270000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results
* denotes groundwater samples associated with the En - indicate an exceedance in applicable standards.

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW2S 2001/12/20 REG WATER µg/L		URSMW4S 2001/05/16 REG WATER µg/L		URSMW4S 2002/01/02 DUP WATER µg/L		URSMW4S 2002/01/02 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	126000		70900		127000		129000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U	10000	U	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		NA		NA	
CHLORIDE	250000	NE	NE	33800		18900		25000		25000	
PHOSPHORUS (TOTAL)	NE	NE	NE	20	U	193		484		161	
SETTLEABLE SOLIDS	NE	NE	NE	0.1	U	0.1	U	0.1		0.1	U
SULFATE	250000	NE	NE	49400		32300		39000		39200	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	242000		192000		217000		219000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results
* denotes groundwater samples associated with the En - indicate an exceedance in applicable standards.

Table 3-2

Summary of Overburden Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW5S 2001/05/16 REG WATER µg/L		URSMW5S 2002/01/07 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	216000		156000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA	
CHLORIDE	250000	NE	NE	23300		26800	
PHOSPHORUS (TOTAL)	NE	NE	NE	25		20	U
SETTLEABLE SOLIDS	NE	NE	NE	0.1	U	0.11	U
SULFATE	250000	NE	NE	32900		38200	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	343000		267000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results
* denotes groundwater samples associated with the En - indicate an exceedance in applicable standards.

Table 3-3

Summary of South Drainage Ditch Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W30S* 2000/07/05 REG WATER µg/L		B18W30S* 2000/09/19 DUP WATER µg/L		B18W30S* 2000/09/19 REG WATER µg/L		B18W30S* 2000/12/19 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	37400		227000		211000		176000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	1000	U	1000	U	1000	U	1000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	37400		227000		211000		176000	
CHLORIDE	250000	NE	NE	12300		12400		12400		7230	
PHOSPHORUS (TOTAL)	NE	NE	NE	160		159		161		20	U
SETTLEABLE SOLIDS	NE	NE	NE	100	U	100	U	100	U	100	U
SULFATE	250000	NE	NE	2930		4000		4000		10100	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	146000		254000		237000		197000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 3-3

Summary of South Drainage Ditch Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: / Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W30S* 2001/03/23 REG WATER µg/L		B18W30S* 2001/05/25 REG WATER µg/L		B18W30S* 2001/10/04 REG WATER µg/L		B18W30S* 2001/12/17 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	135000		180000		190000	UJ	177000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	1000	U	10000	U	10000	UJ	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	135000		NA		NA		NA	
CHLORIDE	250000	NE	NE	3500		16400		25400	UJ	23600	
PHOSPHORUS (TOTAL)	NE	NE	NE	60		156	J	180	UJ	97	
SETTLEABLE SOLIDS	NE	NE	NE	100	U	0.1	U	0.11	UJ	0.1	U
SULFATE	250000	NE	NE	12100		5400		4800	UJ	64000	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	182000		223000		250000	UJ	255000	

Notes:

U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 3-3

Summary of South Drainage Ditch Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type / Matrix: / Units: / Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W30S* 2002/04/04 REG WATER µg/L		B18W30S* 2002/10/03 REG WATER µg/L		URSHP1 2001/04/20 REG WATER µg/L		URSHP2 2001/04/23 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	200000		NA		240000		100000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	1000	U	210000		10000	U	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	200000		NA		NA		NA	
CHLORIDE	250000	NE	NE	8500		27000		21800		22000	R
PHOSPHORUS (TOTAL)	NE	NE	NE	100		210		20	U	436	
SETTLEABLE SOLIDS	NE	NE	NE	100	U	0.1	U	0.7		4	
SULFATE	250000	NE	NE	12000		6100		17200		15800	R
TOTAL DISSOLVED SOLIDS	500000	NE	NE	240000		230000		350000		170000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 3-3

Summary of South Drainage Ditch Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW12S 2001/05/22 REG WATER µg/L		URSMW12S 2001/07/05 REG WATER µg/L		URSMW12S 2002/01/04 REG WATER µg/L		URSMW13S 2001/05/24 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	170000		200000		172000		380000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U	10000	U	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		NA		NA	
CHLORIDE	250000	NE	NE	13700		6820		14300		NA	
PHOSPHORUS (TOTAL)	NE	NE	NE	27		214		20	U	36	
SETTLEABLE SOLIDS	NE	NE	NE	0.1	U	0.1	U	0.11	U	0.1	U
SULFATE	250000	NE	NE	20800		12500		14400		NA	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	260000		260000		209000		NA	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 3-3

Summary of South Drainage Ditch Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type / Matrix: / Units: / Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW13S 2001/05/25 REG WATER µg/L		URSMW13S 2001/07/10 REG WATER µg/L		URSMW13S 2002/01/09 REG WATER µg/L		URSMW13S 2002/01/10 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	NA		380000		NA		348000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	NA		10000	U	NA		10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		NA		NA	
CHLORIDE	250000	NE	NE	10300		NA		14200		NA	
PHOSPHORUS (TOTAL)	NE	NE	NE	NA		NA		39	U	NA	
SETTLEABLE SOLIDS	NE	NE	NE	NA		0.1	U	NA		1.32	
SULFATE	250000	NE	NE	76500		NA		98000		NA	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	**540000**		**530000**		NA		**528000**	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 3-3

Summary of South Drainage Ditch Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type / Matrix: / Units: / Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW14S 2001/05/22 REG WATER µg/L		URSMW14S 2001/07/06 REG WATER µg/L		URSMW14S 2002/01/08 REG WATER µg/L		URSMW15S 2001/05/24 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	240000		240000		210000		210000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U	10000	U	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		NA		NA	
CHLORIDE	250000	NE	NE	16900		17800		21200		NA	
PHOSPHORUS (TOTAL)	NE	NE	NE	20	U	20	U	20	U	31	
SETTLEABLE SOLIDS	NE	NE	NE	0.1	U	0.1	U	0.11	U	NA	
SULFATE	250000	NE	NE	27000		38500		21400		NA	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	350000		340000		266000		NA	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 3-3

Summary of South Drainage Ditch Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW15S 2001/05/25 REG WATER µg/L		URSMW15S 2001/07/11 REG WATER µg/L		URSMW15S 2002/01/07 REG WATER µg/L		URSMW16S 2001/05/21 DUP WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	NA		260000		221000		160000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	NA		10000	U	10000	U	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		NA		NA	
CHLORIDE	250000	NE	NE	23800		NA		11400		19700	
PHOSPHORUS (TOTAL)	NE	NE	NE	NA		NA		20	U	180	
SETTLEABLE SOLIDS	NE	NE	NE	0.1	U	0.1	U	0.14	U	0.1	U
SULFATE	250000	NE	NE	30400		NA		44600		4480	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	310000		380000		342000		210000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 3-3

Summary of South Drainage Ditch Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW16S 2001/05/21 REG WATER µg/L		URSMW16S 2001/07/05 REG WATER µg/L		URSMW16S 2002/01/03 REG WATER µg/L		URSMW17S 2001/05/21 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	160000		200000		183000		100000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U	10000	U	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		NA		NA	
CHLORIDE	250000	NE	NE	19600		9300		23300		25800	
PHOSPHORUS (TOTAL)	NE	NE	NE	96		105		20	U	2080	
SETTLEABLE SOLIDS	NE	NE	NE	0.1	U	0.1	U	0.1	U	0.1	U
SULFATE	250000	NE	NE	4460		5120		13500		30900	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	220000		250000		236000		240000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 3-3

Summary of South Drainage Ditch Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type / Matrix: / Units: / Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW17S 2001/07/09 REG WATER µg/L		URSMW18S 2001/05/17 REG WATER µg/L		URSMW18S 2001/07/03 DUP WATER µg/L		URSMW18S 2001/07/03 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	106000		49000		73000		72000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U	10000	U	10000	U
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA		NA		NA	
CHLORIDE	250000	NE	NE	31800		51600		54400		52700	
PHOSPHORUS (TOTAL)	NE	NE	NE	20	U	53		43		61	
SETTLEABLE SOLIDS	NE	NE	NE	0.1	U	0.1	U	NA		NA	
SULFATE	250000	NE	NE	32400		15800		10900		11000	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	297000		220000		200000		210000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 3-3

Summary of South Drainage Ditch Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: **Sample Date:** **Analysis Type** **Matrix:** **Units:** **Analyte**	**NJDEP CLASS IIA GW QUALITY STANDARDS** **µg/L**	**NJ STATE PRIMARY DRINKING WATER STANDARDS** **µg/L**	**USEPA NATIONAL PRIMARY DRINKING WATER REGS** **µg/L**	**URSMW18S** **2001/07/05** **DUP** **WATER** **µg/L**		**URSMW18S** **2001/07/05** **REG** **WATER** **µg/L**	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	NA		NA	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	NA		NA	
ALKALINITY, TOTAL (AS CACO3)	NE	NE	NE	NA		NA	
CHLORIDE	250000	NE	NE	NA		NA	
PHOSPHORUS (TOTAL)	NE	NE	NE	NA		NA	
SETTLEABLE SOLIDS	NE	NE	NE	0.1	U	0.1	U
SULFATE	250000	NE	NE	NA		NA	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	NA		NA	

Notes:
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance re
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 3-4

Summary of Bedrock Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW11D 2001/05/18 REG WATER µg/L		URSMW11D 2002/01/02 DUP WATER µg/L		URSMW11D 2002/01/02 REG WATER µg/L		URSMW1D 2001/05/14 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	250000		272000		270000		120000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U	10000	U	10000	U
CHLORIDE	250000	NE	NE	18000		30200		31400		6350	
PHOSPHORUS (TOTAL)	NE	NE	NE	30		83		72		103	
SULFATE	250000	NE	NE	32200		37600		36600		23100	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	370000		329000		383000		200000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.

Table 3-4

Summary of Bedrock Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW1D 2001/12/19 REG WATER µg/L		URSMW20D 2002/01/04 REG WATER µg/L		URSMW20D 2002/10/03 REG WATER µg/L		URSMW2D 2001/05/15 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	138000		312000		NA		130000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U	340000		10000	U
CHLORIDE	250000	NE	NE	7350		54000		48000		21400	
PHOSPHORUS (TOTAL)	NE	NE	NE	97		626		30		48	
SULFATE	250000	NE	NE	41000		29200		14000		37400	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	190000		458000		420000		250000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
$\boxed{\textbf{Boxed results}}$ - indicate an exceedance in applicable standards.

Table 3-4

Summary of Bedrock Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW2D 2001/12/20 REG WATER µg/L		URSMW3D 2001/05/17 REG WATER µg/L		URSMW3D 2001/12/21 REG WATER µg/L		URSMW5D 2001/05/21 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	131000		130000		200000		220000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U	10000	U	10000	U
CHLORIDE	250000	NE	NE	27200		15900		19300		73900	
PHOSPHORUS (TOTAL)	NE	NE	NE	63		20	U	20	U	22	
SULFATE	250000	NE	NE	44800		27600		24100		19300	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	249000		220000		264000		490000	

Notes:

U - The compound was not detected above the laboratory method detection limit.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.

Table 3-4

Summary of Bedrock Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type / Matrix: / Units: — Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW5D 2001/12/20 DUP WATER µg/L		URSMW5D 2001/12/20 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	214000		215000	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	10000	U
CHLORIDE	250000	NE	NE	95500		97000	
PHOSPHORUS (TOTAL)	NE	NE	NE	20	U	20	U
SULFATE	250000	NE	NE	24400		22400	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	416000		420000	

Notes:
U - The compound was not detected above the laboratory method detection limit.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.

Table 3-5

Summary of Pipechase Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW6S 2001/05/16 REG WATER µg/L		URSMW6S 2002/01/07 REG WATER µg/L		URSMW7SR 2002/01/08 REG WATER µg/L		URSMW8S 2001/05/23 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	24000		158000		107000		NA	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	131000		10000	U	10000	U	NA	
CHLORIDE	250000	NE	NE	10800		19400		6600		NA	
PHOSPHORUS (TOTAL)	NE	NE	NE	213		20	U	20	U	53	
SULFATE	250000	NE	NE	15600		2300		19400		NA	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	271000		198000		127000		NA	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.

Table 3-5

Summary of Pipechase Analytical Results - Anions
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW8S 2001/05/24 REG WATER µg/L		URSMW8S 2002/01/09 REG WATER µg/L		URSMW8S 2002/01/11 REG WATER µg/L	
ALKALINITY, BICARBONATE (AS CACO3)	NE	NE	NE	71000		NA		60200	
ALKALINITY, CARBONATE (AS CACO3)	NE	NE	NE	10000	U	NA		10000	U
CHLORIDE	250000	NE	NE	31800		142000		NA	
PHOSPHORUS (TOTAL)	NE	NE	NE	NA		209	U	NA	
SULFATE	250000	NE	NE	18000		26000		NA	
TOTAL DISSOLVED SOLIDS	500000	NE	NE	190000		NA		217000	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards

Table 3-6

Summary of Site Parameters
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CATEGORY	PARAMETER	VALUE
TOPOGRAPHY	SLOPE	1%
WEATHER	AV. TEMP.	12.3C (54F)
	AV. ANNUAL WIND SPEED (m/sec)	2.00E+00
	PRECIPITATION (m/y)	9.00E-01
CONTAMINATED ZONE	AREA OF CONTAMINATED ZONE (m^2)	3.89E+04*
	THICKNESS OF ZONE (m)	2.00E+00*
	LENGTH PARALLEL TO AQUIFER FLOW (m)	1.00E+02*
	RADIATION DOSE LIMIT (mrem/y)	2.50E+01*
HYDROLOGICAL DATA (COVER ZONE)	DENSITY OF COVER (g/cm^3)	1.50E+00*
	COVER DEPTH EROSION RATE (m/y)	1.00E-03*
HYDROLOGICAL DATA (CONTAMINATED ZONE)	DENSITY OF CONTAMINATED ZONE (g/cm^3)	1.50E+00*
	CONTAMINATED ZONE EROSION RATE (m/y)	1.00E-03*
	CONTAMINATED ZONE TOTAL POROSITY	4.00E-01*
	CONTAMINATED ZONE FIELD CAPACITY	2.00E-01*
	CONTAMINATED ZONE HYDRAULIC CONDUCTIVITY (m/y)	1.00E+01*
	CONTAMINATED ZONE b PARAMETER	5.30E+00*
	HUMIDITY IN AIR (g/m^3)	8.00E+00*
	EVAPOTRANSPIRATION COEFFICIENT	5.00E-01*
	RUNOFF COEFFICIENT	2.00E-01*
HYDROLOGICAL DATA (SATURATED ZONE)	DENSITY OF SATURATED ZONE (g/cm^3)	1.50E+00*
	SATURATED ZONE TOTAL POROSITY	4.00E-01*
	SATURATED ZONE EFFECT POROSITY	2.00E-01*
	SATURATED ZONE FIELD CAPACITY	2.00E-01*
	SATURATED ZONE HYDRAULIC CONDUCTIVITY (m/y)	1.00E+02*
	SATURATED ZONE HYDRAULIC GRADIENT	2.00E-02*
	SATURATED ZONE b PARAMETER	5.30E+00*
	WATER TABLE DROP RATE (m/y)	1.00E-03*

*RESRAD computer code default value.

Table 3-7

Overburden Groundwater Elevation Measurements - 2001
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Well Identification	PVC Casing Elevation	Q2-2001		Q3-2001		Q4-2001	
		Depth to Groundwater	Groundwater Elevation	Depth to Groundwater	Groundwater Elevation	Depth to Groundwater	Groundwater Elevation
URSMW1S	61.68	8.61	53.07	11.17	50.51	10.82	50.86
URSMW2S	59.63	5.56	54.07	6.38	53.25	7.05	52.58
URSMW4S	57.38	3.97	53.41	4.79	52.59	5.41	51.97
URSMW5S	57.42	8.93	48.49	9.81	47.61	9.98	47.44
URSMW6S	54.37	3.59	50.78	4.41	49.96	4.39	49.98
URSMW7SR	54.57	WLBP	N/A	4.63	49.94	4.77	49.80
URSMW8S	54.52	6.71	47.81	6.76	47.76	6.85	47.67
URSMW10S	53.80	4.88	48.92	5.34	48.46	5.24	48.56
URSMW11S	55.09	9.94	45.15	9.87	45.22	10.24	44.85
URSMW12S	49.39	2.76	46.63	2.97	46.42	3.06	46.33
URSMW13S	51.48	9.25	42.23	7.43	44.05	7.35	44.13
URSMW14S	49.20	3.87	45.33	4.09	45.11	3.85	45.35
URSMW15S	51.11	10.41	40.70	6.52	44.59	6.52	44.59
URSMW16S	49.03	2.67	46.36	2.77	46.26	2.83	46.20
URSMW17S	48.25	5.20	43.05	4.91	43.34	4.17	44.08
URSMW18S	48.47	7.71	40.76	9.68	38.79	7.86	40.61
B18W24S	60.48	7.28	53.20	WLBP	N/A	WLBP	N/A
B18W25S	56.86	4.32	52.54	4.87	51.99	5.14	51.72
B18W26S	54.67	WLBP	N/A	4.65	50.02	4.47	50.20
B18W27S	52.42	WLBP	N/A	5.29	47.13	5.58	46.84
B18W28S	51.68	6.78	44.90	Abandoned	Abandoned	Abandoned	Abandoned
B18W29S	53.02	WLBP	N/A	Abandoned	Abandoned	Abandoned	Abandoned
B18W28SR	51.86	Not Installed	Not Installed	6.28	45.58	7.79	44.07
B18W29SR	53.51	Not Installed	Not Installed	9.83	43.68	9.18	44.33
B18W30S	49.11	2.81	46.30	2.94	46.17	3.00	46.11

Notes:
1. Groundwater elevation given in feet above mean sea level.
2. Data not collected for Q1-2001 as wells the Groundwater RI wells were not yet installed.
3. WLBP - Water Level Below Pump. Unable to measure water level as the groundwater was below the top of the installed pump.

Table 3-8

Overburden Groundwater Elevation Measurements - 2002
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Well Identification	PVC Casing Elevation	Q1-2002		Q3-2002		Q4-2002	
		Depth to Groundwater	Groundwater Elevation	Depth to Groundwater	Groundwater Elevation	Depth to Groundwater	Groundwater Elevation
URSMW1S	61.68	8.72	52.96	11.46	50.22	10.33	51.35
URSMW2S	59.63	5.89	53.74	7.06	52.57	6.22	53.41
URSMW4S	57.38	4.51	52.87	5.25	52.13	4.94	52.44
URSMW5S	57.42	9.06	48.36	10.36	47.06	9.53	47.89
URSMW6S	54.37	3.87	50.50	4.69	49.68	4.05	50.32
URSMW7SR	54.57	3.90	50.67	5.12	49.45	4.31	50.26
URSMW8S	54.52	6.71	47.81	6.87	47.65	6.77	47.75
URSMW10S	53.80	4.92	48.88	5.46	48.34	4.99	48.81
URSMW11S	55.09	8.81	46.28	9.76	45.33	9.09	46.00
URSMW12S	49.39	2.95	46.44	3.74	45.65	3.08	46.31
URSMW13S	51.48	5.60	45.88	7.48	44.00	6.04	45.44
URSMW14S	49.20	3.65	45.55	4.38	44.82	3.68	45.52
URSMW15S	51.11	5.15	45.96	6.57	44.54	5.76	45.35
URSMW16S	49.03	2.74	46.29	2.87	46.16	2.71	46.32
URSMW17S	48.25	3.25	45.00	Well	Well	Well	Well
URSMW18S	48.47	7.02	41.45	Abandoned	Abandoned	Abandoned	Abandoned
B18W24S	60.48	7.11	53.37	11.6	48.88	7.72	52.76
B18W25S	56.86	4.70	52.16	5.11	51.75	4.92	51.94
B18W26S	54.67	3.93	50.74	5.97	48.70	4.07	50.60
B18W27S	52.42	5.65	46.77	5.48	46.94	5.41	47.01
B18W28SR	51.86	5.11	46.75	7.38	44.48	6.22	45.64
B18W29SR	53.51	8.39	45.12	10.82	42.69	8.31	45.20
B18W30S	49.11	2.91	46.20	3.17	45.94	3.00	46.11

1. Groundwater elevation given in feet above mean sea level.
2. Data not collected for Q2-2002. Environmental Surveillance suspended by USEPA pending review of sampling frequency reduction request by USACE.
3. Monitoring wells URSMW17S and URSMW18S abandoned in March 2002 due to right-of-entry expiration.

Table 3-9

Bedrock Groundwater Elevation Measurements - 2001
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Well Identification	PVC Casing Elevation	Q2-2001		Q3-2001		Q4-2001	
		Depth to Groundwater	Groundwater Elevation	Depth to Groundwater	Groundwater Elevation	Depth to Groundwater	Groundwater Elevation
URSMW1D	61.72	23.40	38.32	24.42	37.30	24.97	36.75
URSMW2D	59.91	21.15	38.76	21.83	38.08	21.56	38.35
URSMW3D	57.07	18.91	38.16	20.34	36.73	20.21	36.86
URSMW5D	57.59	19.29	38.30	20.68	36.91	20.32	37.27
URSMW9D	53.10	12.45	40.65	13.33	39.77	13.37	39.73
URSMW11D	55.13	17.98	37.15	19.52	35.61	19.08	36.05

Notes:
1. Groundwater elevation given in feet above mean sea level.
2. Data not collected for Q1-2001 as wells the Groundwater RI wells were not yet installed.

Table 3-10

Bedrock Groundwater Elevation Measurements - 2002
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Well Identification	PVC Casing Elevation	Q1-2002		Q3-2002		Q4-2002	
		Depth to Groundwater	Groundwater Elevation	Depth to Groundwater	Groundwater Elevation	Depth to Groundwater	Groundwater Elevation
URSMW1D	61.72	24.49	37.23	26.08	35.64	24.36	37.36
URSMW2D	59.91	20.39	39.52	21.65	38.26	19.62	40.29
URSMW3D	57.07	19.48	37.59	21.12	35.95	19.04	38.03
URSMW5D	57.59	19.74	37.85	21.68	35.91	19.18	38.41
URSMW9D	53.10	12.96	40.14	13.9	39.20	12.51	40.59
URSMW11D	55.13	18.51	36.62	20.61	34.52	17.96	37.17

Notes:
1. Groundwater elevation given in feet above mean sea level.
2. Data not collected for Q2-2002. Environmental Surveillance suspended by USEPA pending review of sampling frequency reduction request by USACE.

Table 4-1

Summary of Monitoring Well Construction and Pump Installation Information
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Monitoring Well Identification	NJDEP Permit Number	Well Completion Date	Most Recent Well Survey Date	Ground Surface Elevation (famsl)	Top of Casing Elevation (famsl)	Total Depth (fbg)	Well Bottom Elevation (famsl)	Depth to Top of Screen (fbg)	Top of Screen Elevation (famsl)	Bottom of Steel Casing (fbg)	Screen Length (feet)	Screen Slot Size (inches)	Screen Material	Riser or Casing Material	Casing Diameter (inches)
Overburden															
URSMW1S	25-57649	2/21/2001	5/2001	59.06	61.68	15.0	44.06	5.0	54.06	N/A	10.0	0.010	PVC	PVC	4
URSMW2S	25-57651	3/2/2001	5/2001	57.03	59.63	10.0	47.03	5.0	52.03	N/A	5.0	0.010	PVC	PVC	4
URSMW4S	25-57654	3/22/2001	5/2001	54.78	57.38	9.0	48.38	4.0	50.78	N/A	5.0	0.010	PVC	PVC	4
URSMW5S	25-57655	3/13/2001	5/2001	54.85	57.42	10.0	47.42	5.0	49.85	N/A	5.0	0.010	PVC	PVC	4
URSMW6S	25-57641	3/23/2001	5/2001	52.22	54.37	5.0	49.37	3.0	49.22	N/A	2.0	0.010	PVC	PVC	4
URSMW7SR	25-58625	8/30/2001	1/2002	52.30	54.57	5.0	49.57	3.0	49.30	N/A	2.0	0.010	PVC	PVC	4
URSMW8S	25-57643	3/23/2001	5/2001	51.98	54.52	5.0	49.52	3.0	48.98	N/A	2.0	0.010	PVC	PVC	4
URSMW10S	25-57644	3/23/2001	5/2001	51.55	53.80	9.0	44.80	4.0	47.55	N/A	5.0	0.010	PVC	PVC	4
URSMW11S	25-57657	3/22/2001	5/2001	52.42	55.09	9.0	46.09	4.0	48.42	N/A	5.0	0.010	PVC	PVC	4
URSMW12S	25-57659	4/16/2001	5/2001	47.39	49.39	8.0	41.39	3.0	44.39	N/A	5.0	0.010	PVC	PVC	2
URSMW13S	25-57660	4/18/2001	5/2001	49.41	51.48	10.0	41.48	3.0	46.41	N/A	7.0	0.010	PVC	PVC	2
URSMW14S	25-57661	4/16/2001	5/2001	47.16	49.20	10.0	39.20	3.0	44.16	N/A	7.0	0.010	PVC	PVC	2
URSMW15S	25-57662	4/18/2001	5/2001	49.03	51.11	10.0	41.11	3.0	46.03	N/A	7.0	0.010	PVC	PVC	2
URSMW16S	25-57663	4/17/2001	5/2001	47.32	49.03	8.0	41.03	3.0	44.32	N/A	5.0	0.010	PVC	PVC	2
URSMW17S(1)	25-57664	4/17/2001	5/2001	46.03	48.25	10.0	38.25	3.0	43.03	N/A	7.0	0.010	PVC	PVC	2
URSMW18S(1)	25-57665	4/17/2001	5/2001	46.88	48.47	10.0	38.47	4.0	42.88	N/A	6.0	0.010	PVC	PVC	2
URSMW20S	25-57565	9/4/2001	1/2002	52.72	54.79	15.0	39.79	5.0	47.72	N/A	10.0	0.010	PVC	PVC	4
Bedrock															
URSMW1D	25-57650	2/20/2001	5/2001	59.16	61.72	55.0	6.72	N/A	N/A	30.0	N/A	N/A	N/A	Steel	8
URSMW2D	25-57652	3/1/2001	5/2001	57.09	59.91	47.0	12.91	N/A	N/A	22.0	N/A	N/A	N/A	Steel	6
URSMW3D	25-57653	3/7/2001	5/2001	54.74	57.07	50.0	7.07	N/A	N/A	25.0	N/A	N/A	N/A	Steel	6
URSMW5D	25-57656	3/12/2001	5/2001	54.93	57.59	47.0	10.59	N/A	N/A	22.0	N/A	N/A	N/A	Steel	6
URSMW9D	25-57645	3/19/2001	5/2001	50.39	53.10	50.0	3.10	N/A	N/A	25.0	N/A	N/A	N/A	Steel	6
URSMW11D	25-57658	3/20/2001	1/2002	52.48	55.13	47.0	8.13	N/A	N/A	22.0	N/A	N/A	N/A	Steel	6
URSMW20D	25-57566	9/4/2001	1/2002	52.71	55.46	60.0	-4.54	N/A	N/A	35.0	N/A	N/A	N/A	Steel	6

Notes:
NJDEP - New Jersey Department of Environmental Protection
famsl - Feet above mean sea level.
fbg - Feet below grade.
(1) - Monitoring well abandoned March 2002 due to expiration of right-of-entry permit.

Table 4-1

Summary of Monitoring Well Construction and Pump Installation Information
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Monitoring Well Identification	T.O.C Elevation	Depth to Pump Intake	Elevation of Pump Intake	Depth to Pump Top	Elevation of Pump Top
Overburden					
URSMW1S	61.68	19.39	42.29	15.99	45.69
URSMW2S	59.63	15.15	44.48	11.75	47.88
URSMW4S	57.38	14.31	43.07	10.91	46.47
URSMW5S	57.42	15.2	42.22	11.80	45.62
URSMW6S	54.37	9.15	48.62	5.75	48.62
URSMW7SR	54.57	9.54	45.03	6.14	48.43
URSMW8S	54.52	9.52	45.00	6.12	48.40
URSMW10S	53.80	13.84	39.96	10.44	43.36
URSMW11S	55.09	14.29	40.80	10.89	44.20
URSMW12S	49.39	11.14	38.25	7.74	41.65
URSMW13S	51.48	13.8	37.68	10.40	41.08
URSMW14S	49.20	14.16	35.04	10.76	38.44
URSMW15S	51.11	13.76	37.35	10.36	40.75
URSMW16S	49.03	11.89	37.14	8.49	40.54
URSMW17S (1)	48.25	14.04	34.21	10.64	37.61
URSMW18S (1)	48.47	14.13	34.34	10.73	37.74
URSMW20S	54.79	19.84	34.95	16.44	38.35
B18W24S	60.48	14.47	46.01	11.07	49.41
B18W25S	56.86	15.29	41.57	11.89	44.97
B18W26S	54.67	15.29	39.38	11.89	42.78
B18W27S	52.42	16.32	36.10	12.92	39.50
B18W28SR	51.86	17.94	33.92	14.54	37.32
B18W29SR	53.51	18.39	35.12	14.99	38.52
B18W30S	49.11	12.26	36.85	8.86	40.25
Bedrock					
URSMW1D	61.72	44.74	16.98	41.34	20.38
URSMW2D	59.91	43.74	16.17	40.34	19.57
URSMW3D	57.07	47.74	9.33	44.34	12.73
URSMW5D	57.59	45.74	11.85	42.34	15.25
URSMW9D	53.10	46.74	6.36	43.34	9.76
URSMW11D	55.13	48.7	6.43	45.30	9.83
URSMW20D	55.46	49.74	5.72	46.34	9.12

Notes:

(1) - Monitoring well abandoned March 2002 due to expiration of right-of-entry permit.

Table 4-2

Summary of Drilling/Potable Water Analytical Results - Detections Only
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: **Date Collected:** **Analysis Type:** **Matrix:** **Unit:**	**MSP-POTWATER** **2001/02/21** **REG** **WATER** **µg/L**	**NJDEP CLASS IIA GW QUALITY STANDARDS** **µg/L**	**NJ STATE PRIMARY DRINKING WATER STANDARDS** **µg/L**	**USEPA NATIONAL PRIMARY DRINKING WATER REGS** **µg/L**
VOCs				
CHLOROFORM	9.2	6	6	NE
SVOCs				
BIS(2-ETHYLHEXYL)PHTHALATE	5.5 JB	30	30	6
DIMETHYL PHTHALATE	6.3 J	NE	10	NE
METALS				
BARIUM	45.5	2000	2000	2000
CALCIUM	27800	NE	NE	NE
COPPER	50.8	1000	1300	1300
LEAD	9.85	10	15	15
MAGNESIUM	8530	NE	NE	NE
NICKEL	11.2	100	NE	NE
POTASSIUM	1780	NE	NE	NE
SODIUM	23800	50000	NE	NE
ZINC	210	5000	NE	NE
WETCHEM				
ALKALINITY (mg $CaCO_3$/L)	41	NE	NE	NE
CHLORIDE	35400	250000	NE	NE
M-ALKALINITY	42000	NE	NE	NE
PHOSPHORUS (TOTAL)	23	NE	NE	NE
SULFATE	34300	250000	NE	NE
TOTAL DISSOLVED SOLIDS	140000	500000	NE	NE
Location ID: **Date Collected:** **Analysis Type:** **Matrix:** **Unit:**	**MSP-POTWATER** **2001/02/21** **REG** **WATER** **pCi/L**	**NJDEP CLASS IIA GW QUALITY STANDARDS** **pCi/L**	**NJ STATE PRIMARY DRINKING WATER STANDARDS** **pCi/L**	**USEPA NATIONAL PRIMARY DRINKING WATER REGS** **pCi/L**
RADIONUCLIDES				
RADIUM-226	0.576	NE	NE	NE
THORIUM-230	0.0826	NE	NE	NE
TOTAL URANIUM (µg/L)	0.183	NE	30	30
URANIUM-233/234	0.0583	NE	NE	NE
URANIUM-238	0.0583	NE	NE	NE

Table 4-3

Summary of Rock Quality Designation Values
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Well Identification	Run Number	Depth (fbg)	Recovery (%)	Rock Quality Designation (%)
URSMW1D	1	20 - 25	100	40
	2	25 - 30	100	31
	3	30 - 35	73	50
	4	35 - 40	94	87
	5	40 - 40'8"	100	*
	6	40'8" - 45	90	49
	7	45 - 50	97	75
	8	50 - 55	100	55
	EOB	55	---	---
URSMW2D	1	12 -17	97.5	31
	2	17 - 22	98	80
	3	22 - 27	97.5	52.5
	4	27 -32	100	47
	5	32 - 37	99	45
	6	37 - 42	100	98
	7	42 -47	98	45
	EOB	47	---	---
URSMW3D	1	10 - 13	75	11
	2	13 -15	100	0
	3	15 - 20	100	18
	4	20 - 21	29	0
	5	21 - 25	100	55
	6	25 - 30	100	74
	7	30 - 35	100	73
	8	35 - 40	100	70
	9	40 - 45	98	58
	10	45 - 50	100	77
	EOB	50	---	---
URSMW5D	1	12 - 14	30	96
	2	14 - 17	97	56
	3	17 - 22	98	85
	4	22 - 27	100	55
	5	27 - 32	100	75
	6	32 - 37	100	65
	7	37 - 42	100	75
	8	42 - 47	100	65
	EOB	47	---	---
URSMW9D	1	10 - 15	93	8
	2	15 - 20	92	38
	3	20 - 25	90	40
	4	25 - 30	48	68
	5	30 - 35	100	62
	6	35 - 40	97	53
	7	40 - 45	100	85
	8	45 - 50	97	78
	EOB	50	---	---
URSMW11D	1	12 - 16		Not Recorded
	2	16 - 21		Not Recorded
	3	21 - 22		Not Recorded
	4	22 - 27	95	52
	5	27 - 32	100	75
	6	32 - 37	93	Not Recorded
	7	37 - 42	100	83
	8	42 - 47	100	45
	EOB	47	---	---

Notes:
EOB - End of Boring
fbg - Feet below grade
* - Short run due to mechanical problems with fracture barrel

Table 4-4

Summary of Monitoring Well Development Information
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Monitoring Well ID	Installation Completion Date	Development Completion Date	Development Method	Groundwater Removed (1) (Gallons)	Parameters Monitored During Development: Temperature (C^o)	Turbidity (NTU)	pH (S.U.)	Conductivity (mS/cm)
Overburden								
URSMW1S	2/21/2001	3/21/2001	Submersible Pump	125	11.3	222	8.46	0.078
URSMW2S	3/2/2001	3/13/2001	Submersible Pump	55	10.7	18.6	7.25	0.265
URSMW4S	3/22/2001	3/26/2001	Submersible Pump	50	20.1	19.8	7.30	0.134
URSMW5S	3/13/2001	3/23/2001	Submersible Pump	30	12.5	81.1	8.01	0.285
URSMW6S	3/23/2001	3/28/2001	Submersible Pump	35	9.9	132	8.78	0.169
URSMW7SR	8/30/2001	9/14/2001	Submersible Pump	27.5	22.6	9.5	6.92	0.299
URSMW8S	3/23/2001	3/30/2001	Bailer	7	6.1	999	8.92	0.061
URSMW10S	3/23/2001	3/27/2001	Submersible Pump	50	12.1	520	7.85	0.159
URSMW11S	3/22/2001	4/5/2001	Bailer (2)	18	10.0	59.7	7.59	0.218
URSMW12S	4/16/2001	4/24/2001	Submersible Pump	32	13.2	18.5	7.19	0.403
URSMW13S	4/18/2001	5/9/2001	Bailer	28	10.7	68	7.24	0.857
URSMW14S	4/16/2001	4/27/2001	Submersible Pump	40.5	22.8	18.2	6.76	0.532
URSMW15S	4/18/2001	5/22/2001	Bailer (2)	20	11.6	71.1	6.92	0.593
URSMW16S	4/17/2001	4/26/2001	Submersible Pump	33	12.8	20.9	7.11	0.340
URSMW17S	4/17/2001	5/4/2001	Submersible Pump	46	11.0	31.9	6.22	0.430
URSMW18S	4/17/2001	4/23/2001	Submersible Pump	38	13.0	197	6.22	0.155
URSMW20S	Monitoring Well Dry							
Bedrock								
URSMW1D	2/21/2001	3/21/2001	Submersible Pump	795	13.9	35.7	7.55	0.170
URSMW2D	3/1/2001	3/13/2001	Submersible Pump	245	17.2	3.3	8.18	0.201
URSMW3D	3/7/2001	3/16/2001	Submersible Pump	285	23.2	42.7	8.40	0.210
URSMW5D	3/12/2001	3/19/2001	Submersible Pump	265	20.5	0.9	8.30	0.250
URSMW9D	3/19/2001	3/23/2001	Submersible Pump	303	13.6	3.5	7.85	0.281
URSMW11D	3/20/2001	3/23/2001	Submersible Pump	258	15.1	80.2	8.01	0.261
URSMW20D	9/4/2001	9/7/2001	Submersible Pump	405	17.5	8.8	7.68	0.762

Notes:

(1) - Purge volume includes: five times the standing water volume and well screen/casing plus saturated annulus (assuming 30% porosity).
Purge volume also includes five times the amount of water lost, if any, during drilling.
(2) - Development began with a submersible pump. Due to low yields, development was completed via bailer.

Table 4-5

Bedrock Borehole Characterization Summary
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Well Number	Isolation Casing Interval (feet MSL)	Open Hole Interval (feet MSL)	Gamma Log Results (feet MSL)	Conductivity Log Results (feet MSL)	Temperature Log Results (feet MSL)	Caliper Log Results (feet MSL)	Television Survey Observations (feet MSL)	Rock Core Observations (feet MSL)	Pump Intake Depth (feet MSL)
URSMWID	62 - 29	29 - 4	Highs at 25-23 and 15-11; Lows at 20-18 and 14	Uniform throughout open borehole	Minor change in slope at 26	Minor restriction at 31 (casing joint)	Very small horizontal fractures at 25, 20.5, 20, and 14	Possible water bearing zones at 30-29, 24-22, 15-12, and 6-4; Low RQD at 29-24,18.5-14, and 9-4	20.5
URSMW2D	60 - 35	35 - 10	Highs at 33, 31, 24, 20, 17, and 15-14	Uniform throughout open borehole	Minor change in slope 30-27	Minor restriction at 28; Possible fractures at 26 and 19	Not Conducted	Possible water bearing zones at 27, 21, and 14; Low RQD at 30-20 and 15-10	19.5
URSMW3D	57.5 - 30	30 - 5	High at 10.5; Lows at 26.5, 19.5-15.5, and 13.5-11.5	Minor change in slope 29.5-25.5	Minor change in slope 29.5-25.5	Possible fractures at 19.5-17.5 and 12.5	Not Conducted	Possible water bearing zones at 19, 15.5, 13, and 7; Low RQD at 15-10	13
URSMW5D	58 - 33	33 - 8	High at 29, 26, and 17; Lows at 27, 25, 23, and 16	Uniform throughout open borehole	Minor change in slope at 25	Possible fractures at 26 and 15	Not Conducted	Possible water bearing zones at 39-37, 35-34, 32.5-31.5, 30-29, 22.5, 20, and 13-12; Low RQD at 26-21 and 16-11	15
URSMW9D	53.5 - 25.5	25.5 - 3.5	Highs at 24.5, 22.5, 17.5, and 6.5; Low at 19.5	Uniform throughout open borehole	Uniform slope throughout open borehole	Possible fractures at 15, 11.5, and 9.5	Very small horizontal fractures at 22.5, 18.5, 18, 15, 13.5, 11.5, and 5; Small horizontal fractures at 16.5 and 12; Medium vertical fracture at 9.5; Rough borehole at 15; White mineralization throughout borehole.	Possible water bearing zones at 19.5-18.5, 9.5, and 6.5; Low RQD at 18.5-13.5	10
URSMW11D	55.5 - 30.5	30.5 - 5.5	Highs at 24.5, 18.5, 14.5, 11.5, and 9.5; Lows at 23.5, 19.5, 17.5, and 8.5	Uniform throughout open borehole	Uniform slope throughout open borehole	Possible fractures at 30.5-25.5, 20.5, 18.5, and 6.5	Not Conducted	Possible water bearing zones at 11, and 8-7; Low RQD at 10.5-5.5	10

NOTE: All elevations have been rounded to the nearest 0.5 ft.

Table 4-6

Summary of Hydropunch Sampling Data
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Temporary Well Identification	Date	Stabilized Depth to Ground Water	Screened Interval	Depth of Water in Stream
HP-1	19-Apr-01	2.75	4.37 - 4.87	1.37
HP-2	23-Apr-01	0.33	3.54 - 4.04	1.42

NOTES: Top of temporary casing not surveyed.
Ground water elevation not determined.
All measurements in feet below surface of stream.

Table 4-7

Summary of Stream Gauge Measurements
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Stream Gauge Identification	2001/07/02		2001/09/14	
	Depth to Water (feet)	Flow (feet/second)	Depth to Water (feet)	Flow (feet/second)
SG - 1	0.52	< 0.0	0.66	NR
SG - 2	1.00	< 0.0	1.02	NR
	2002/01/14		**2002/03/27**	
	Depth to Water (feet)	**Flow (feet/second)**	**Depth to Water (feet)**	**Flow (feet/second)**
SG - 1	0.50	Very Slow	0.62	NR
SG - 2	0.84	Very Slow	0.90	NR
	2003/06/12		**2003/09/02**	
	Depth to Water (feet)	**Flow (feet/second)**	**Depth to Water (feet)**	**Flow (feet/second)**
SG - 1	0.62	NR	0.54	NR
SG - 2	2.12	NR	1.76	NR

Notes:
NR - Not Reported

Table 5-1

Summary of Previous Groundwater Analytical Data - Organic Compounds Reported Above Comparison Criteria (µg/L)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Well No.	Date Collected	Bis(2-Ethylhexyl)Phthalate	Dichloromethane
EPA National Primary Drinking Water Standards (MCL)[1]		6[4]	5
New Jersey ClassIIA Groundwater Quality Criteria[2]		30	NE
B18W24S	7/14/98		2.5
B18W25S	04/09/96	18	
	05/21/96		6[3]
	7/14/98		
B18W26S	05/21/97	33[3]	6[3]
B18W27S	05/21/97		6[3]
	7/14/98	12.5	
	7/13/98	5.0	
B18W28S	10/28/94	22.0	
B18W29S	05/08/97		10
	04/09/96	11.0	
B18W30S	05/21/97	7[3]	
	05/21/97		5[3]

Sources: BNI 1994b, 1996c, 1997a

Notes:
NE = not established
[1] MCL = Maximum Contaminant Level
[2] Higher of the PQLs and Groundwater Quality Criteria
[3] Chemical was not detected, detection limit is reported
[4] Reported in Class IIA Criteria as Di(2-Ethylhexyl)Phthalate.

Table 5-2

Summary of Previous Groundwater Analytical Data – Metals Reported above Comparison Criteria (µg/L)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Well No.	Date Collected	Aluminum	Antimony	Arsenic	Beryllium	Chromium	Iron	Lead	Manganese	Nickel
EPA National Primary Drinking Water Standards (MCL) [1]		NE	6	50	4	100[3]	NE	15	NE	NE
New Jersey Class IIA Groundwater Quality Criteria[6]		200	20	8	20	100[3]	300	10[4]	50	100[5]
B18W24S	10/28/94						70,200	16.9	1,410	
	05/23/95							33.9		
	07/14/98							18.1		
B18W25S	10/27/94									
	05/23/95							11.2		
	04/09/96									
	05/21/97									
	07/14/98									
B18W26S	05/21/97								857	
	07/14/98			12.8						
B18W27S	10/26/94								2,280	
	05/22/95								2,290	
	04/08/96								2,120	
	05/07/97								1,630	
B18W28S	10/28/94	71,000	38.5	11.9	8	324	131,000		4,030	
	05/23/95					102		18.9		
B18W29S	05/25/95					247	70,700	31.5	1,380	832
	04/10/96					170				
	05/08/97					591				
	07/13/98			21.0		45,500		23.3		836

Table 5-2

Summary of Previous Groundwater Analytical Data – Metals Reported above Comparison Criteria (µg/L)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Well No.	Date Collected	Aluminum	Antimony	Arsenic	Beryllium	Chromium	Iron	Lead	Manganese	Nickel
B18W30S	10/26/94						1,530		1,500	
	05/23/95								1,230	
	04/11/96						808		1,430	
	05/21/97			9.3						
	07/15/98			12.3						

Source: BNI 1994b, 1996c, 1997c
NE = not established
[1]Maximum Contaminant Level
[2] Total Arsenic
[3] Total Chromium
[4]Total Lead
[5]Nickel (soluble salts)
[6] Higher of the PQLs and Groundwater Quality Criteria

Table 5-3

Summary of Previous Groundwater Analytical Results - Radiological Constituents
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Well No.	Date Collected	Screen Depth bgs (ft)	Well Completed in	Ra-226 (pCi/L)	Ra-226 Dissolved (pCi/L)	Ra-228 (pCi/L)	Ra-228 Dissolved (pCi/L)	Th-230 (pCi/L)	Th-232 (pCi/L)	U-238[1] (µg/L)	U-238 Dissolved (µg/L)
B18P01[2]	4/15/96	3.3-6.3	pipe chase, gravel fill	1.49	1.86					22.37	21.98
B18P02[2]	4/15/96	3.0-6.0	weathered bedrock	0.21	<0.08					8.31	8.75
B18P03[2]	4/13/96	3.0-6.0	silty clay	0.19	0.12					3.48	1.11
B18P04[2]	4/13/96	1.8-5.0	silty clay and sand	<0.09	0.26					2.89	1.17
B18W24S	10/28/94	5.5-10.5	weathered bedrock	6.1	0.27	3.5	1.2	16.8	4.3	7.87	4.50
	5/23/95			<0.15		1.9		1.4	0.27	12.13	
	5/26/95				<0.06		3.1				12.67
	4/9/96			<0.07		-0.91		<0.63	<0.04	21.62	
	5/7/97			0.4		0.17		0.67	<0.08	199.13	
	7/14/98			0.89		0.54		1.49	0.82	148.96	
B18W25S	10/27/94	6.0-11.0	weathered bedrock	<0.19		0.7		<0.04	0.09	11.83	
	5/23/95			<0.05		2.1		<0.94	<0.02	0.01	
	4/9/96			0.14		1.59		<0.16	<0.12	3.99	
	5/21/97			0.19		0.06		1.17	<0.22	11.66	
	7/14/98			<0.18		<0.19		<0.27	<0.40	87.41	
B18W26S	10/27/94	6.6-11.6	weathered to unweathered bedrock	2.6		4.5		2.3	2.2	8.22	
	5/23/95			0.62		0.2		<0.99	<0.02	1.56	
	4/10/96			0.58		1.4		<0.38	<0.07	3.80	
	5/21/97			0.41		0.11		0.69	0.32	0.99	
	7/14/98			1.47		<0.24		0.14	<0.05	0.94	
B18W27S	10/26/94	6.9-11.9	weathered bedrock	<0.14		0.9		<0.16	<0.12	0.64	
	5/22/95			<0.05		2		<1.2	<0.03	0.05	
	4/8/96			<0.03		-0.02		<0.39	<0.04	0.07	
	5/7/97			0.12		0.05		1.1	<0.08	0.005	
	7/13/98			0.42		<0.04		<0.13	<0.09	<0.01	
B18W28S	10/28/94	4.9-9.9	weathered bedrock	4.7		5.4		3.9	3.7	11.88	
	5/23/95			1		-1.4		2	0.44	6.16	
	4/10/96			0.67		1.58		1.94	0.32	4.47	
	5/21/97			0.22		0.39		1.86	<0.21	7.86	
	7/13/98			3.67		1.64		8.47	2.38	23.62	

Table 5-3

Summary of Previous Groundwater Analytical Results - Radiological Constituents
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Well No.	Date Collected	Screen Depth bgs (ft)	Well Completed in	Ra-226 (pCi/L)	Ra-226 Dissolved (pCi/L)	Ra-228 (pCi/L)	Ra-228 Dissolved (pCi/L)	Th-230 (pCi/L)	Th-232 (pCi/L)	U-238[1] (µg/L)	U-238 Dissolved (µg/L)
B18W29S	5/25/95	4.4-9.4	weathered bedrock	5.6	0.08	1.1	-0.9	4.2	0.81	4.50	2.35
	4/10/96			0.33		0.94		<0.61	0.33	1.52	
	5/8/97			0.37		0.36		1.23	<0.25	1.57	
	7/13/98			<0.37		0.55		1.39	<0.20	1.94	
B18W30S	10/26/94	3.0-8.0	weathered bedrock	0.17		0.7		<0.25	<0.07	7.24	15.41
	5/23/95			0.2		1.7		<0.92	<0.03	11.64	16.99
	4/11/96			0.24		1.39		<0.45	<0.11	104.01	2.21
	5/23/96			0.42		0.12		0.43	<0.26	23.77	0.55
	10/14/96			0.46		0.27		0.59	<0.04	4.19	3.43
	5/21/97			0.55		0.15		0.72	0.24	30.75	
	7/15/98			<0.19		<0.36		<0.48	<0.10	52.07	
B18W31D	4/13/96	6.9-9.9	weathered bedrock	<0.15	<0.11					18.75	15.41
B18W31S	4/13/96	1.9-4.9	pipe chase, gravel fill and clay	<0.15	1.37					31.01	16.99
B18W32S	4/15/96	1.9-3.9	pipe chase, gravel fill and clay	2.12	0.9					4.76	2.21
B18W33S	4/15/96	2.5-5.5	fill	0.43	0.34					0.61	0.55
B18W34S	4/12/96	2.0-5.0	weathered bedrock	0.35	<0.13					3.23	3.43

[1] Concentrations of U-238 were calculated from measured Total Uranium concentrations (assuming equilibrium) [U-238 = U total × 0.489].
[2] These wells were installed for the 1996 shallow groundwater study and are not included in the annual environmental monitoring.
Source: BNI 1996a, BNI 1996c, BNI 1997a
Current EPA National Primary Drinking Water Standards (MCL) for gross alpha in groundwater is 15 pCi/L.Current EPA National Primary Drinking Water Standards (MCL) for Ra-226 and Ra-228 combined is 5 pCi/L.

Table 5-4

Previous Surface Water Analytical Data at Outfall SWSD001 (Location 1) – Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Analyte	Sample Date										
	NJ SWQC	4/11/96	8/19/96	10/14/96	5/6/97	11/11/97	7/14/97	9/16/97	3/5/98	10/13/98	2/16/99
Aluminum	NE		104	10000(J)	682	101	682		101	55.8	395
Antimony	12.2		1.6	2.6		2.6(J)			2.6	2.6	1
Arsenic	0.017		1.8	2.8	1.7	2.2	1.7		2.2	3.4	3.3
Barium	2,000	34.7	37.3	58.2	54.7	19.6	54.7	32	19.6	34.7	37.7
Beryllium	NE			0.41							
Boron	NE	233	299	200	228	314					
Cadmium	1.0				0.52		0.52	0.3			
Calcium	NE	26200	23700	19700	26300(J)	30400	26300	23800	30400	49900	33700
Chromium	160			14.4	3.6		3.6			0.68	
Cobalt	NE			7.4	1.2		1.2	0.72			0.64
Copper	NE		9.6	26.9	17.3	11.9	17.3	12.8	11.9	9.9	
Iron	NE	262	787	11500(J)	1290	195	1290	731	195	433	1070
Lead	5			15.8(J)	17.5	2.1(J)	17.5	11.9	2.1	3.1	
Magnesium	NE	6810	7520	8680	6800	7100	6800	5210	7100	10200	8070
Manganese	100	183	410	185	94.7	50.8	94.7	95	50.8	142	192
Molybdenum	NE	9.8			3.1	10.2	3.1	4.5	10.2	4.6	3.9
Nickel	516			7.3	4.3		4.3	3.8	1.9	4	
Potassium	NE	1490	2770	2860	2360	2670	2360	2470	2670	4530	2740
Selenium	10						2.1				
Sodium	NE	10800	12200	31000	35400(J)	17700	35400	1400	17700	24200	18200
Thallium	1.7										
Vanadium	NE			18.7	3	2.1	3	2.1	2.1	0.78	2.1
Zinc	NE		139	122		74.9	167	124	74.9	187	610

All values in µg/L
NE = Not Established
[1]New Jersey Surface Water Quality Criteria for FW2 Waters.

Table 5-5

Previous (1996-1999) Surface Water Analytical Data – Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Analyte	NJ SWQC[1]	Results > Detection Limit	Minimum Detect (mg/L)	Maximum Detect (mg/L)	Location Of Maximum Detect	Location 4 Value (mg/L)
Aluminum	NE	20/20	45.9	10,000	1	697
Antimony	12.2	7/11	0.65	2.6	1	NA
Arsenic	0.017	12/14	0.75	3.4	1	1.4
Barium	2,000	21/21	19.6	64.3	6	54.8
Beryllium	NE	1/7	0.41	0.41	1	NA
Boron	NE	21/21	64.6	434	1	146
Cadmium	1.0	1/7	0.52	0.52	1	NA
Calcium	NE	21/21	11,700	49,900	1	32,600
Chromium	160	6/11	0.68	14.4	1	1.4
Cobalt	NE	7/9	0.43	7.4	1	1.0
Copper	NE	13/16	4.0	28.0	3	17.7
Iron	NE	18/20	114	11,500	1	1,450
Lead	5	11/14	0.85	17.5	1	0.65
Magnesium	NE	21/21	3,140	10,200	1	8,800
Manganese	100	20/20	9.6	415	6	185
Molybdenum	NE	11/12	0.66	10.2	1	NA
Nickel	516	10/10	1.8	7.3	1	4.3
Potassium	NE	21/21	1,490	8,760	3	2,280
Silver	164	3/9	7.7	9.3	3	7.0
Sodium	NE	21/21	10,700	35,400	1	17,300
Vanadium	NE	12/12	0.78	18.7	1	2.5
Zinc	NE	11/13	19.5	610	1	29.2

NA = background value not available
NE = Not Established
[1]New Jersey Surface Water Quality Criteria for FW2 Waters.

Table 5-6

Average Concentrations of Total Uranium and Ra-226 in Surface Water in the Vicinity of MSP, 1982-1998
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Sample Location	Average Annual Concentration (pCi/L)																
	1982[1]	**1983[1]**	**1984[1]**	**1985[1]**	**1986[1]**	**1987[2]**	**1988[2]**	**1989[2]**	**1990[2]**	**1991[2]**	**1992[2]**	**1993[2]**	**1994[3]**	**1995[4]**	**1996[5]**	**1997[6]**	**1998**
Total Uranium																	
1	92.3	ND	103	80	56	54	47	34	60	39	53	81.8	NS	NS	46.4	46.2	110.1
6	6	ND	8	10	23	5	3	3	3	2	2	NS	NS	NS	4.3	8.65	1.91
3	3.9	ND	4	4	21	3	4	5	3	3	1	2.9	NS	NS	2.03	3.79	1.77
4 (background)	5	ND	3	3	<3	3	3	3	3	2	1	0.6	NS	NS	0.3	0.14[a]	0.13
Ra-226																	
1	3.8	ND	3.8	3.3	2.2	1.7	2	1.7	2.8	3.6	26.9	2.7	NS	NS	4.13	2.1	2.36
6	0.49	ND	0.3	0.3	1	0.7	0.3	0.6	0.3	0.6	1.6	NS	NS	NS	0.44[a]	1.28[a]	0.31
3	0.45	ND	0.1	0.2	1.1	0.6	0.2	0.6	0.5	0.6	1.3	<0.2	NS	NS	0.29	1.58[a]	0.14
4 (background)	1.16	ND	0.2	0.4	0.2	0.7	0.2	1	0.4	0.4	0.5	0.5	NS	NS	7.35[a]	0.6	0.48

ND = no data
NS = not sampled
[a] Single detection of all annual samples collected.

Sources: [1]BNI 1988, [2]BNI 1993b, [3]BNI 1994, [4]BNI 1996b, [5]BNI 1997b, [6]BNI 1998

Table 5-7

Average Concentrations of Ra-228, Th-230, and Th-232 in Surface Water in the Vicinity of MSP, 1991-1998
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Sample Locations	Average Annual Concentration (pCi/L)							
	1991	1992[2]	1993	1994	1995	1996[3]	1997[4]	1998
Ra-228								
1	NS	4.5	NS	NS	NS	1.81	U	0.46
6	NS	2.2	NS	NS	NS	U	0.37[1]	0.69
3	NS	2.3	NS	NS	NS	2.10[1]	U	0.17
4 (background)	NS	2.7	NS	NS	NS	6.95[1]	U	0.09
Th-230								
1	NS	2.9	0.6	NS	NS	1.77	0.74	0.65
6		0.8	NS	NS	NS	0.48	0.39	0.28
3		0.3	<0.2	NS	NS	0.31	0.65	0.35
4 (background)		0.5	<0.4	NS	NS	0.73[1]	0.54	0.62
Th-232								
1	NS	0.9	<0.8	NS	NS	0.42	0.21[1]	0.15
6	NS	0.6	NS	NS	NS	U	0.18[1]	0.13
3		0.2	<0.2	NS	NS	0.31	U	0.23
4 (background)		0.2	<0.2	NS	NS	U	0.20[1]	0.15

NS = not sampled
U = not detected
[1] Single detection of all annual samples collected.
[2] BNI 1993b
[3] BNI 1997b
[4] BNI

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W24S* 2000/06/29 REG 7012-008-01-1/3 WATER µg/L		B18W24S* 2000/09/19 REG 9121-004-01-1 WATER µg/L		B18W24S* 2000/12/19 REG 12065-002-01-1/3 WATER µg/L		B18W24S* 2001/03/23 REG 103239-001-01-1/3 WATER µg/L		B18W24S* 2001/05/31 REG AB34824 WATER µg/L	
1,1-DICHLOROETHANE	70	50	NE	5	U	1	U	1	U	1	U	5	U
1,2-DICHLOROBENZENE	600	600	600	5	U	1	U	1	U	1	U	NA	
1,3-DICHLOROBENZENE	600	600	NE	5	U	1	U	1	U	1	U	NA	
1,4-DICHLOROBENZENE	75	75	75	5	U	1	UJ	1	U	1	U	NA	
ACETONE	700	NE	NE	10	R	5	UJ	4	R	5	U	20	U
CARBON DISULFIDE	800	NE	NE	3	J	1	U	1	U	1	U	5	U
CHLOROBENZENE	4	50	100	5	U	1	U	1	U	1	U	5	U
CIS-1,2-DICHLOROETHENE	10	70	70	5	U	1	U	1	U	1	U	5	U
ISOPROPYL ETHER	NE	NE	NE	NA		NA		NA		1	U	5	U
METHYL-T-BUTYL ETHER	NE	70	NE	NA		NA		NA		1	U	1	U
TERT-BUTYL ALCOHOL	NE	NE	NE	NA		NA		NA		1	U	10	R
TRANS-1,2-DICHLOROETHENE	100	100	100	5	U	1	U	1	U	1	U	5	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W24S* 2001/10/03 REG AB43781 WATER µg/L		B18W24S* 2001/12/12 REG AB48499 WATER µg/L		B18W24S* 2002/04/01 REG 204011-001-01-1/3 WATER µg/L		B18W24S* 2002/09/26 REG 209170-001-017-1/3 WATER µg/L		B18W25S* 2000/06/27 DUP 6172-002-01-1/3 WATER µg/L	
1,1-DICHLOROETHANE	70	50	NE	5	U	5	U	1	U	1	U	5	U
1,2-DICHLOROBENZENE	600	600	600	NA		NA		1	U	1	U	5	U
1,3-DICHLOROBENZENE	600	600	NE	NA		NA		1	U	1	U	5	U
1,4-DICHLOROBENZENE	75	75	75	NA		NA		1	U	1	U	5	U
ACETONE	700	NE	NE	20	U	20	U	5	U	5	U	10	R
CARBON DISULFIDE	800	NE	NE	5	U	5	U	1.8	U	1	U	5	U
CHLOROBENZENE	4	50	100	5	U	5	U	1	U	1	U	5	U
CIS-1,2-DICHLOROETHENE	10	70	70	5	U	5	U	1	U	1	U	5	U
ISOPROPYL ETHER	NE	NE	NE	5	U	5	U	1	U	1	U	NA	
METHYL-T-BUTYL ETHER	NE	70	NE	1	U	1	U	1	U	1	U	NA	
TERT-BUTYL ALCOHOL	NE	NE	NE	10	U	10	U	1	R	3.7	U	NA	
TRANS-1,2-DICHLOROETHENE	100	100	100	5	U	5	U	1	U	1	U	5	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W25S* 2000/06/27 REG 6172-001-01-1/3 WATER µg/L		B18W25S* 2000/09/18 REG 9110-001-01-1 WATER µg/L		B18W25S* 2000/12/18 DUP 12060-002-01-1/3 WATER µg/L		B18W25S* 2000/12/18 REG 12060-001-01-1/3 WATER µg/L		B18W25S* 2001/03/22 REG 103223-002-01-1/3 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
1,1-DICHLOROETHANE	70	50	NE	5	U	1	U	1	U	1	U	5	U
1,2-DICHLOROBENZENE	600	600	600	5	U	1	U	1	U	1	U	5	U
1,3-DICHLOROBENZENE	600	600	NE	5	U	1	U	1	U	1	U	5	U
1,4-DICHLOROBENZENE	75	75	75	5	U	1	U	1	U	1	U	5	U
ACETONE	700	NE	NE	10	R	5	UJ	5	R	5	R	10	U
CARBON DISULFIDE	800	NE	NE	5	U	1	U	0.6	J	1	U	5	U
CHLOROBENZENE	4	50	100	5	U	1	U	1	U	1	U	5	U
CIS-1,2-DICHLOROETHENE	10	70	70	5	U	1	U	1	U	1	U	5	U
ISOPROPYL ETHER	NE	NE	NE	NA		NA		NA		NA		5	U
METHYL-T-BUTYL ETHER	NE	70	NE	NA		NA		NA		NA		5	U
TERT-BUTYL ALCOHOL	NE	NE	NE	NA		NA		NA		NA		5	U
TRANS-1,2-DICHLOROETHENE	100	100	100	5	U	1	U	1	U	1	U	1	J

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W25S* 2001/05/24 REG AB34409 WATER µg/L		B18W25S* 2001/10/02 DUP AB43776 WATER µg/L		B18W25S* 2001/10/02 REG AB43775 WATER µg/L		B18W25S* 2001/12/11 DUP AB48386 WATER µg/L		B18W25S* 2001/12/11 REG AB48385 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
1,1-DICHLOROETHANE	70	50	NE	5	U	5	U	5	U	5	U	5	U
1,2-DICHLOROBENZENE	600	600	600	NA		NA		NA		NA		NA	
1,3-DICHLOROBENZENE	600	600	NE	NA		NA		NA		NA		NA	
1,4-DICHLOROBENZENE	75	75	75	NA		NA		NA		NA		NA	
ACETONE	700	NE	NE	20	U	20	U	20	U	20	U	20	U
CARBON DISULFIDE	800	NE	NE	5	U	5	U	5	U	5	U	5	U
CHLOROBENZENE	4	50	100	5	U	5	U	5	U	5	U	5	U
CIS-1,2-DICHLOROETHENE	10	70	70	5	U	5	U	5	U	5	U	5	U
ISOPROPYL ETHER	NE	NE	NE	5	U	5	U	5	U	5	U	5	U
METHYL-T-BUTYL ETHER	NE	70	NE	6.63		8.12		8.44		1	U	1	U
TERT-BUTYL ALCOHOL	NE	NE	NE	10	R	10	U	10	U	10	U	10	U
TRANS-1,2-DICHLOROETHENE	100	100	100	5	U	5	U	5	U	5	U	5	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W25S* 2002/03/28 DUP 204001-003-01-1/3 WATER µg/L		B18W25S* 2002/03/28 REG 204001-001-01-1/3 WATER µg/L		B18W25S* 2002/09/30 DUP 210007-002-010-1/3 WATER µg/L		B18W25S* 2002/09/30 REG 210007-001-001-1/9 WATER µg/L		B18W26S* 2000/06/28 REG 7012-007-01-1/3 WATER µg/L	
1,1-DICHLOROETHANE	70	50	NE	1	U	1	U	1	U	1	U	5	U
1,2-DICHLOROBENZENE	600	600	600	1	U	1	U	1	U	1	U	5	U
1,3-DICHLOROBENZENE	600	600	NE	1	U	1	U	1	U	1	U	5	U
1,4-DICHLOROBENZENE	75	75	75	1	U	1	U	1	U	1	U	5	U
ACETONE	700	NE	NE	5	U	5	U	5	U	5	U	10	R
CARBON DISULFIDE	800	NE	NE	1	U	1	U	1	U	1	U	4.19	J
CHLOROBENZENE	4	50	100	1	U	1	U	1	U	1	U	5	U
CIS-1,2-DICHLOROETHENE	10	70	70	1	U	1	U	1	U	1	U	5	U
ISOPROPYL ETHER	NE	NE	NE	1	U	1	U	1	U	1	U	NA	
METHYL-T-BUTYL ETHER	NE	70	NE	2.3		2.1		3.3		4		NA	
TERT-BUTYL ALCOHOL	NE	NE	NE	1	R	1	R	20	U	20	U	NA	
TRANS-1,2-DICHLOROETHENE	100	100	100	1	U	1	U	1	U	1	U	5	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W26S* 2000/09/21 REG 9147-004-01-1 WATER µg/L		B18W26S* 2000/12/21 REG 12088-008-01-1/3 WATER µg/L		B18W26S* 2001/03/22 REG 103223-001-02-2/6 WATER µg/L		B18W26S* 2001/05/25 DUP AB34397 WATER µg/L		B18W26S* 2001/05/25 REG AB34396 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
1,1-DICHLOROETHANE	70	50	NE	1	U	1	U	5	U	5	U	5	U
1,2-DICHLOROBENZENE	600	600	600	1	U	1	U	5	U	NA		NA	
1,3-DICHLOROBENZENE	600	600	NE	1	U	1	U	5	U	NA		NA	
1,4-DICHLOROBENZENE	75	75	75	1	U	1	U	5	U	NA		NA	
ACETONE	700	NE	NE	5	UJ	5	UJ	10	U	20	U	20	U
CARBON DISULFIDE	800	NE	NE	1	U	2		5	U	5	U	5	U
CHLOROBENZENE	4	50	100	1	U	1	U	5	U	5	U	5	U
CIS-1,2-DICHLOROETHENE	10	70	70	1	U	1	U	5	U	5	U	5	U
ISOPROPYL ETHER	NE	NE	NE	NA		NA		5	U	5	U	5	U
METHYL-T-BUTYL ETHER	NE	70	NE	NA		NA		5	U	1.84		2.05	
TERT-BUTYL ALCOHOL	NE	NE	NE	NA		NA		5	U	10	R	10	R
TRANS-1,2-DICHLOROETHENE	100	100	100	1	U	1	U	5	U	5	U	5	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W26S* 2001/10/03 REG AB43782 WATER µg/L		B18W26S* 2001/12/13 REG AB48636 WATER µg/L		B18W26S* 2002/04/03 REG 204028-002-01-1/3 WATER µg/L		B18W26S* 2002/09/24 REG 209154-001-012-1/3 WATER µg/L		B18W27S* 2000/06/28 REG 7012-001-01-1/3 WATER µg/L	
1,1-DICHLOROETHANE	70	50	NE	5	U	5	U	1	R	1	U	5	U
1,2-DICHLOROBENZENE	600	600	600	NA		NA		1	R	1	U	5	U
1,3-DICHLOROBENZENE	600	600	NE	NA		NA		1	R	1	U	5	U
1,4-DICHLOROBENZENE	75	75	75	NA		NA		1	R	1	U	5	U
ACETONE	700	NE	NE	20	U	20	U	5	R	5	U	10	R
CARBON DISULFIDE	800	NE	NE	5	U	5	U	2.9	R	1	U	5	U
CHLOROBENZENE	4	50	100	5	U	5	U	1	R	1	U	4	J
CIS-1,2-DICHLOROETHENE	10	70	70	5	U	5	U	1	R	1	U	5	U
ISOPROPYL ETHER	NE	NE	NE	5	U	5	U	1	R	1	U	NA	
METHYL-T-BUTYL ETHER	NE	70	NE	1.58		1.5		1.6	R	2.9		NA	
TERT-BUTYL ALCOHOL	NE	NE	NE	10	U	10	U	1	R	20	U	NA	
TRANS-1,2-DICHLOROETHENE	100	100	100	5	U	5	U	1	R	1	U	5	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W27S* 2000/09/20 REG 9134-001-01-1 WATER µg/L		B18W27S* 2000/12/21 REG 12088-006-01-1/6 WATER µg/L		B18W27S* 2001/03/21 DUP 103208-002-01-1/3 DL 50X WATER µg/L		B18W27S* 2001/03/21 DUP 103208-002-01-1/3 WATER µg/L		B18W27S* 2001/03/21 REG 103208-001-01-1/3 DL 50X WATER µg/L	
1,1-DICHLOROETHANE	70	50	NE	1	U	1	UJ	NA		1	U	NA	
1,2-DICHLOROBENZENE	600	600	600	1	U	1	UJ	NA		1	U	NA	
1,3-DICHLOROBENZENE	600	600	NE	1	U	1	UJ	NA		1	U	NA	
1,4-DICHLOROBENZENE	75	75	75	1	U	1	UJ	NA		1	U	NA	
ACETONE	700	NE	NE	5	UJ	5	UJ	NA		5	U	NA	
CARBON DISULFIDE	800	NE	NE	1	J	1	UJ	NA		1	U	NA	
CHLOROBENZENE	4	50	100	0.7	J	1	UJ	NA		1		NA	
CIS-1,2-DICHLOROETHENE	10	70	70	1	U	1	UJ	NA		1	U	NA	
ISOPROPYL ETHER	NE	NE	NE	NA		NA		NA		1	U	NA	
METHYL-T-BUTYL ETHER	NE	70	NE	NA		NA		**908**		NA		**951**	
TERT-BUTYL ALCOHOL	NE	NE	NE	NA		NA		1530		NA		1480	
TRANS-1,2-DICHLOROETHENE	100	100	100	1	U	1	UJ	NA		1	U	NA	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W27S* 2001/03/21 REG 103208-001-01-1/3 WATER µg/L		B18W27S* 2001/05/30 REG AB34618 WATER µg/L		B18W27S* 2001/10/04 REG AB43983 WATER µg/L		B18W27S* 2001/12/13 REG AB48635 WATER µg/L		B18W27S* 2002/04/03 REG 204028-001-01-1/3 WATER µg/L	
1,1-DICHLOROETHANE	70	50	NE	1	U	25	U	5	UJ	5	U	5	R
1,2-DICHLOROBENZENE	600	600	600	1	U	NA		NA		NA		5	R
1,3-DICHLOROBENZENE	600	600	NE	1	U	NA		NA		NA		5	R
1,4-DICHLOROBENZENE	75	75	75	1	U	NA		NA		NA		5	R
ACETONE	700	NE	NE	5	U	100	U	20	UJ	20	U	25	R
CARBON DISULFIDE	800	NE	NE	1	U	25	U	5	UJ	5	U	5.3	R
CHLOROBENZENE	4	50	100	1		25	U	5	UJ	5	U	5	R
CIS-1,2-DICHLOROETHENE	10	70	70	1	U	25	U	5	UJ	5	U	5	R
ISOPROPYL ETHER	NE	NE	NE	1	U	25	U	5	UJ	1.15	J	5	R
METHYL-T-BUTYL ETHER	NE	70	NE	NA		**687**		29	J	45.8		130	R
TERT-BUTYL ALCOHOL	NE	NE	NE	NA		3170	J	2380	J	2130		5	R
TRANS-1,2-DICHLOROETHENE	100	100	100	1	U	25	U	5	UJ	5	U	5	R

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W27S* 2002/09/25 REG 209160-001-001-1/3 WATER µg/L		B18W27S* 2002/09/25 REG 209160-001-002-2/3DL WATER µg/L		B18W28S* 2000/06/29 REG 7012-005-01-1/3 WATER µg/L		B18W28S* 2000/09/21 REG 9147-002-09-1 WATER µg/L		B18W28S* 2000/12/20 REG 12088-003-01-1/3 WATER µg/L	
1,1-DICHLOROETHANE	70	50	NE	1	UJ	NA		5	U	1	U	1	U
1,2-DICHLOROBENZENE	600	600	600	1	UJ	NA		5	U	1	U	1	U
1,3-DICHLOROBENZENE	600	600	NE	1	UJ	NA		5	U	1	U	1	U
1,4-DICHLOROBENZENE	75	75	75	1	UJ	NA		5	U	1	U	1	U
ACETONE	700	NE	NE	5	UJ	NA		10	R	4	J	5	UJ
CARBON DISULFIDE	800	NE	NE	1	UJ	NA		5	U	1	U	1	U
CHLOROBENZENE	4	50	100	1	UJ	NA		5	U	1	U	1	U
CIS-1,2-DICHLOROETHENE	10	70	70	1	UJ	NA		5	U	1	U	1	U
ISOPROPYL ETHER	NE	NE	NE	1.1	J	NA		NA		NA		NA	
METHYL-T-BUTYL ETHER	NE	70	NE	20	J	NA		NA		NA		NA	
TERT-BUTYL ALCOHOL	NE	NE	NE	NA		1800	J	NA		NA		NA	
TRANS-1,2-DICHLOROETHENE	100	100	100	1	UJ	NA		5	U	1	U	1	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W28S* 2001/03/20 REG 103200-001-01-1/3 WATER µg/L		B18W28S* 2001/05/31 REG AB34821 WATER µg/L		B18W28SR* 2001/10/05 REG AB43987 WATER µg/L		B18W28SR* 2001/12/14 REG AB48691 WATER µg/L		B18W28SR* 2002/04/02 REG 204022-001-01-1/3 WATER µg/L	
1,1-DICHLOROETHANE	70	50	NE	1	U	5	U	5	UJ	5	UJ	1	UJ
1,2-DICHLOROBENZENE	600	600	600	1	U	NA		NA		NA		1	UJ
1,3-DICHLOROBENZENE	600	600	NE	0.7	J	NA		NA		NA		1	UJ
1,4-DICHLOROBENZENE	75	75	75	0.8	J	NA		NA		NA		1	UJ
ACETONE	700	NE	NE	5	U	20	U	20	UJ	20	UJ	5	UJ
CARBON DISULFIDE	800	NE	NE	1	U	5	U	5	UJ	5	UJ	1.8	UJ
CHLOROBENZENE	4	50	100	1	U	1.02	J	5	UJ	1.11	J	1	UJ
CIS-1,2-DICHLOROETHENE	10	70	70	1	U	5	U	5	UJ	5	UJ	1	UJ
ISOPROPYL ETHER	NE	NE	NE	1	U	5	U	5	UJ	5	UJ	1	UJ
METHYL-T-BUTYL ETHER	NE	70	NE	13		**74.6**		1	UJ	1.85	J	1	UJ
TERT-BUTYL ALCOHOL	NE	NE	NE	1	U	10	R	10	UJ	10	UJ	1	R
TRANS-1,2-DICHLOROETHENE	100	100	100	1	U	5	U	5	UJ	5	UJ	1	UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W28SR* 2002/09/25 REG 209160-002-005-2/3 WATER µg/L		B18W29S* 2000/06/30 REG 7012-004-01-1/3 WATER µg/L		B18W29S* 2000/09/20 REG 9134-004-01-1 WATER µg/L		B18W29S* 2000/12/20 REG 12088-001-01-1/3 WATER µg/L		B18W29S* 2001/03/20 REG 103200-002-01-1/3 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
1,1-DICHLOROETHANE	70	50	NE	1	UJ	5	U	1	U	1	U	1	U
1,2-DICHLOROBENZENE	600	600	600	0.51	J	5	U	1	U	1	U	1	U
1,3-DICHLOROBENZENE	600	600	NE	0.62	J	5	U	1	U	1	U	1	U
1,4-DICHLOROBENZENE	75	75	75	1	UJ	5	U	1	U	1	U	1	U
ACETONE	700	NE	NE	5	UJ	10	R	5	UJ	5	UJ	5	U
CARBON DISULFIDE	800	NE	NE	4.5	J	5	U	1	U	1	U	1	U
CHLOROBENZENE	4	50	100	1	UJ	5	U	1	U	1	U	1	U
CIS-1,2-DICHLOROETHENE	10	70	70	1	UJ	5	U	1	U	1	U	1	U
ISOPROPYL ETHER	NE	NE	NE	1	UJ	NA		NA		NA		1	U
METHYL-T-BUTYL ETHER	NE	70	NE	1	UJ	NA		NA		NA		6	
TERT-BUTYL ALCOHOL	NE	NE	NE	3.5	J	NA		NA		NA		1	U
TRANS-1,2-DICHLOROETHENE	100	100	100	1	UJ	5	U	1	U	1	U	1	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W29S* 2001/06/05 REG AB35173 WATER µg/L		B18W29SR* 2001/10/08 REG AB44188 WATER µg/L		B18W29SR* 2001/12/14 REG AB48690 WATER µg/L		B18W29SR* 2002/04/01 REG 204011-002-01-1/3 WATER µg/L		B18W29SR* 2002/09/26 REG 209170-003-023-1/3 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
1,1-DICHLOROETHANE	70	50	NE	5	U	5	U	5	UJ	1	U	1	U
1,2-DICHLOROBENZENE	600	600	600	NA		NA		NA		1	U	1	U
1,3-DICHLOROBENZENE	600	600	NE	NA		NA		NA		1	U	1	U
1,4-DICHLOROBENZENE	75	75	75	NA		NA		NA		1	U	1	U
ACETONE	700	NE	NE	20	U	20	U	20	UJ	5	U	5	U
CARBON DISULFIDE	800	NE	NE	5	U	5	U	5	UJ	1	U	1	U
CHLOROBENZENE	4	50	100	5	U	5	U	5	UJ	1	U	1	U
CIS-1,2-DICHLOROETHENE	10	70	70	5	U	5	U	5	UJ	1	U	1	U
ISOPROPYL ETHER	NE	NE	NE	5	U	5	U	5	UJ	1	U	1	U
METHYL-T-BUTYL ETHER	NE	70	NE	18.1		15.9		8.76	J	6.4		1.4	
TERT-BUTYL ALCOHOL	NE	NE	NE	10	R	10	U	10	UJ	1	R	4.1	U
TRANS-1,2-DICHLOROETHENE	100	100	100	5	U	5	U	5	UJ	1	U	1	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW10S 2001/05/15 REG AB33601 WATER µg/L		URSMW10S 2002/01/03 REG AB49494 WATER µg/L		URSMW11S 2001/05/16 REG AB33802 WATER µg/L		URSMW11S 2002/01/08 REG AB49706 WATER µg/L		URSMW1S 2001/05/14 DUP AB33489 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
1,1-DICHLOROETHANE	70	50	NE	5	UJ	5	U	5	U	5	U	5	R
1,2-DICHLOROBENZENE	600	600	600	NA		NA		NA		NA		NA	
1,3-DICHLOROBENZENE	600	600	NE	NA		NA		NA		NA		NA	
1,4-DICHLOROBENZENE	75	75	75	NA		NA		NA		NA		NA	
ACETONE	700	NE	NE	20	UJ	20	R	20	U	20	U	20	R
CARBON DISULFIDE	800	NE	NE	5	UJ	5	U	5	U	5	U	5	R
CHLOROBENZENE	4	50	100	5	UJ	5	U	5	U	5	U	5	R
CIS-1,2-DICHLOROETHENE	10	70	70	5	UJ	5	U	5	U	5	U	5	R
ISOPROPYL ETHER	NE	NE	NE	5	UJ	5	U	5	U	5	U	5	R
METHYL-T-BUTYL ETHER	NE	70	NE	6.79	J	5.8		15.2		1	U	1	R
TERT-BUTYL ALCOHOL	NE	NE	NE	3.42	J	1.41	J	10	U	10	U	10	R
TRANS-1,2-DICHLOROETHENE	100	100	100	5	UJ	5	U	5	U	5	U	5	R

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW1S 2001/05/14 REG AB33488 WATER µg/L		URSMW1S 2001/12/19 REG AB48979 WATER µg/L		URSMW20S 2002/04/04 REG 204043-001-01-1/3 WATER µg/L		URSMW2S 2001/05/15 REG AB33603 WATER µg/L		URSMW2S 2001/12/20 REG AB49084 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
1,1-DICHLOROETHANE	70	50	NE	5	R	5	UJ	1	U	5	UJ	5	U
1,2-DICHLOROBENZENE	600	600	600	NA		NA		1	U	NA		NA	
1,3-DICHLOROBENZENE	600	600	NE	NA		NA		1	U	NA		NA	
1,4-DICHLOROBENZENE	75	75	75	NA		NA		1	U	NA		NA	
ACETONE	700	NE	NE	20	R	20	UJ	5	U	20	UJ	20	U
CARBON DISULFIDE	800	NE	NE	5	R	5	UJ	1.7	U	5	UJ	5	U
CHLOROBENZENE	4	50	100	5	R	5	UJ	1	U	5	UJ	5	U
CIS-1,2-DICHLOROETHENE	10	70	70	5	R	5	UJ	1	U	5	UJ	5	U
ISOPROPYL ETHER	NE	NE	NE	5	R	5	UJ	1	U	5	UJ	5	U
METHYL-T-BUTYL ETHER	NE	70	NE	1	R	1	UJ	1	U	1	UJ	1	U
TERT-BUTYL ALCOHOL	NE	NE	NE	10	R	10	UJ	1	R	10	UJ	10	U
TRANS-1,2-DICHLOROETHENE	100	100	100	5	R	5	UJ	1	U	5	UJ	5	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-8
Summary of Overburden Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW4S 2001/05/16 REG AB33794 WATER µg/L		URSMW4S 2002/01/02 DUP AB49465 WATER µg/L		URSMW4S 2002/01/02 REG AB49463 WATER µg/L		URSMW5S 2001/05/16 REG AB33796 WATER µg/L		URSMW5S 2002/01/07 REG AB49645 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
1,1-DICHLOROETHANE	70	50	NE	5	U	1.35	J	1.32	J	5	U	5	U
1,2-DICHLOROBENZENE	600	600	600	NA		NA		NA		NA		NA	
1,3-DICHLOROBENZENE	600	600	NE	NA		NA		NA		NA		NA	
1,4-DICHLOROBENZENE	75	75	75	NA		NA		NA		NA		NA	
ACETONE	700	NE	NE	20	U	20	U	20	U	20	U	20	U
CARBON DISULFIDE	800	NE	NE	5	U	5	U	5	U	5	U	5	U
CHLOROBENZENE	4	50	100	5	U	5	U	5	U	5	U	5	U
CIS-1,2-DICHLOROETHENE	10	70	70	1.23	J	5	U	5	U	5	U	5	U
ISOPROPYL ETHER	NE	NE	NE	5	U	5	U	5	U	5	U	5	U
METHYL-T-BUTYL ETHER	NE	70	NE	2.93		1.38		1.41		9.45		1	U
TERT-BUTYL ALCOHOL	NE	NE	NE	2.09	J	10	U	10	U	10	U	10	U
TRANS-1,2-DICHLOROETHENE	100	100	100	5	U	5	U	5	U	5	U	5	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-9
Summary of Overburden (Pipechase) Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW6S 2001/05/16 REG AB33798 WATER µg/L		URSMW6S 2002/01/07 REG AB49643 WATER µg/L		URSMW7SR 2002/01/08 REG AB49708 WATER µg/L		URSMW8S 2001/05/23 REG AB34268 WATER µg/L		URSMW8S 2002/01/09 REG AB49750 WATER µg/L	
METHYL-T-BUTYL ETHER	NE	70	NE	27.5		22.5		1.37		1	U	1	U
TERT-BUTYL ALCOHOL	NE	NE	NE	15.4		22.6		10	U	10	U	10	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.

Table 5-10
Summary of Overburden (South Drainage Ditch) Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/l	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/l	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/l	B18W30S* 2000/07/05 REG 7038-001-01-1/3 WATER µg/l		B18W30S* 2000/09/19 DUP 9121-002-01-1 WATER µg/l		B18W30S* 2000/09/19 REG 9121-001-01-1 WATER µg/l		B18W30S* 2000/12/19 REG 12065-003-01-1/3 WATER µg/l	
ACETONE	700	NE	NE	5	U	6	J	3.44	J	6	R
BROMOMETHANE	10	10	NE	10	U	1	U	1	U	1	U
CARBON DISULFIDE	800	NE	NE	5	U	1	U	1	U	1	U
CHLOROMETHANE	30	30	NE	10	U	1	U	1	U	1	UJ
METHYL-T-BUTYL ETHER	NE	70	NE	NA		NA		NA		NA	
TOLUENE	1000	1000	1000	5	U	1	U	1	U	1	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-10
Summary of Overburden (South Drainage Ditch) Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/l	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/l	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/l	B18W30S* 2001/03/23 REG 103239-003-01-1/3 WATER µg/l		B18W30S* 2001/05/25 REG AB34400 WATER µg/l		B18W30S* 2001/10/04 REG AB43984 WATER µg/l		B18W30S* 2001/12/17 REG AB48808 WATER µg/l	
ACETONE	700	NE	NE	5	U	20	U	20	UJ	20	U
BROMOMETHANE	10	10	NE	1	U	5	U	5	UJ	5	U
CARBON DISULFIDE	800	NE	NE	1	U	5	U	5	UJ	5	U
CHLOROMETHANE	30	30	NE	1	U	5	U	5	UJ	5	U
METHYL-T-BUTYL ETHER	NE	70	NE	1	U	1	U	1	UJ	1	U
TOLUENE	1000	1000	1000	1	U	1	U	1	UJ	1	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-10
Summary of Overburden (South Drainage Ditch) Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/l	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/l	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/l	B18W30S* 2002/04/04 REG 204045-001-01-1/3 WATER µg/l		B18W30S* 2002/10/03 REG 210048-002-004-1/3 WATER µg/l		URSHP1 2001/04/20 REG AB32161 WATER µg/l		URSHP2 2001/04/23 REG AB32258 WATER µg/l	
ACETONE	700	NE	NE	5	UJ	10	U	20	U	20	U
BROMOMETHANE	10	10	NE	1	UJ	2.2	J	5	U	5	U
CARBON DISULFIDE	800	NE	NE	1	UJ	5	U	5	U	5	U
CHLOROMETHANE	30	30	NE	1	UJ	5.4	J	1.68	J	5	U
METHYL-T-BUTYL ETHER	NE	70	NE	1	UJ	5	U	3.27		1	U
TOLUENE	1000	1000	1000	1	UJ	5	U	1	U	1	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-10
Summary of Overburden (South Drainage Ditch) Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/l	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/l	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/l	URSMW12S 2001/05/22 REG AB34179 WATER µg/l		URSMW12S 2001/07/05 REG AB37495 WATER µg/l		URSMW12S 2002/01/04 REG AB49602 WATER µg/l		URSMW13S 2001/05/24 REG AB34403 WATER µg/l	
ACETONE	700	NE	NE	20	UJ	20	U	20	U	20	U
BROMOMETHANE	10	10	NE	5	UJ	5	U	5	U	5	U
CARBON DISULFIDE	800	NE	NE	5	UJ	5	U	5	U	5	U
CHLOROMETHANE	30	30	NE	5	UJ	5	U	5	U	5	U
METHYL-T-BUTYL ETHER	NE	70	NE	2.69	J	2.42		1.23		1	U
TOLUENE	1000	1000	1000	1	UJ	1	U	1	U	1	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-10
Summary of Overburden (South Drainage Ditch) Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/l	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/l	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/l	URSMW13S 2001/07/10 REG AB37781 WATER µg/l		URSMW13S 2002/01/09 REG AB49749 WATER µg/l		URSMW14S 2001/05/22 REG AB34178 WATER µg/l		URSMW14S 2001/07/06 REG AB37473 WATER µg/l	
ACETONE	700	NE	NE	20	U	20	U	20	UJ	20	U
BROMOMETHANE	10	10	NE	5	U	5	U	5	UJ	5	U
CARBON DISULFIDE	800	NE	NE	1.26	J	5	U	5	UJ	1.16	J
CHLOROMETHANE	30	30	NE	5	U	5	U	5	UJ	5	U
METHYL-T-BUTYL ETHER	NE	70	NE	1	U	1	U	3.39	J	2.12	
TOLUENE	1000	1000	1000	1	U	1	U	1	UJ	1	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-10
Summary of Overburden (South Drainage Ditch) Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/l	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/l	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/l	URSMW14S 2002/01/08 REG AB49707 WATER µg/l		URSMW15S 2001/05/24 REG AB34405 WATER µg/l		URSMW15S 2001/07/11 REG AB37785 WATER µg/l		URSMW15S 2002/01/07 REG AB49644 WATER µg/l	
ACETONE	700	NE	NE	20	U	20	U	20	U	20	U
BROMOMETHANE	10	10	NE	5	U	5	U	5	U	5	U
CARBON DISULFIDE	800	NE	NE	5	U	5	U	5	U	5	U
CHLOROMETHANE	30	30	NE	5	U	5	U	5	U	5	U
METHYL-T-BUTYL ETHER	NE	70	NE	2.5		1	U	1	U	1	U
TOLUENE	1000	1000	1000	1	U	1	U	1	U	1	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-10
Summary of Overburden (South Drainage Ditch) Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/l	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/l	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/l	URSMW16S 2001/05/21 DUP AB34098 WATER µg/l		URSMW16S 2001/05/21 REG AB34096 WATER µg/l		URSMW16S 2001/07/05 REG AB37493 WATER µg/l		URSMW16S 2002/01/03 REG AB49495 WATER µg/l	
ACETONE	700	NE	NE	20	U	20	U	20	U	20	U
BROMOMETHANE	10	10	NE	5	U	5	U	5	U	5	U
CARBON DISULFIDE	800	NE	NE	5	U	5	U	1.69	J	5	U
CHLOROMETHANE	30	30	NE	5	U	5	U	5	U	5	U
METHYL-T-BUTYL ETHER	NE	70	NE	1	U	1	U	1	U	1	U
TOLUENE	1000	1000	1000	1	U	1	U	1.69		1	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-10
Summary of Overburden (South Drainage Ditch) Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW17S 2001/05/21 REG AB34099 WATER µg/l		URSMW17S 2001/07/09 REG AB37721 WATER µg/l		URSMW17S 2002/01/04 REG AB49629 WATER µg/l		URSMW18S 2001/05/17 REG AB33851 WATER µg/l	
Analyte	µg/l	µg/l	µg/l								
ACETONE	700	NE	NE	20	U	20	U	20	U	20	U
BROMOMETHANE	10	10	NE	5	U	5	U	5	U	5	U
CARBON DISULFIDE	800	NE	NE	5	U	5	U	5	U	5	U
CHLOROMETHANE	30	30	NE	5	U	5	U	5	U	5	U
METHYL-T-BUTYL ETHER	NE	70	NE	1	U	1	U	1	U	1	U
TOLUENE	1000	1000	1000	1	U	1	U	1	U	1	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-10
Summary of Overburden (South Drainage Ditch) Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/l	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/l	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/l	URSMW18S 2001/07/03 DUP AB37376 WATER µg/l		URSMW18S 2001/07/03 REG AB37373 WATER µg/l		URSMW18S 2002/01/04 REG AB49627 WATER µg/l	
ACETONE	700	NE	NE	20	U	20	U	20	U
BROMOMETHANE	10	10	NE	5	U	5	U	5	U
CARBON DISULFIDE	800	NE	NE	5	U	5	U	5	U
CHLOROMETHANE	30	30	NE	5	U	5	U	5	U
METHYL-T-BUTYL ETHER	NE	70	NE	1	U	1	U	1	U
TOLUENE	1000	1000	1000	1	U	1	U	1	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W24S* 2000/06/29 REG 7012-008-04-1/2 WATER µg/L		B18W24S* 2000/09/19 REG 9121-004-04-1 WATER µg/L		B18W24S* 2000/12/19 REG 12065-002-04-1/2 WATER µg/L		B18W24S* 2001/03/23 REG 103239-001-04-1/2 WATER µg/L	
1,2,4-TRICHLOROBENZENE	9	9	70	11.1	U	11	U	11	U	11	U
1,3-DICHLOROBENZENE	600	600	NE	11.1	U	11	U	NA		NA	
1,4-DICHLOROBENZENE	75	75	75	11.1	U	11	UJ	NA		NA	
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	11.1	U	11	U	11	U	6	J
DIETHYL PHTHALATE	5000	5000	NE	11.1	U	11	U	11	U	11	U
DI-N-BUTYL PHTHALATE	900	900	NE	11.1	U	11	U	11	U	20	U
DI-N-OCTYL PHTHALATE	100	100	NE	11.1	U	11	U	11	U	11	U
PHENOL	4000	4000	NE	11.1	U	11	UJ	11	UJ	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W24S* 2001/05/31 REG AB34824 WATER µg/L		B18W24S* 2001/10/03 REG AB43781 WATER µg/L		B18W24S* 2001/12/12 REG AB48499 WATER µg/L		B18W24S* 2002/04/01 REG 204011-001-04-1/2 WATER µg/L	
Analyte	µg/L	µg/L	µg/L								
1,2,4-TRICHLOROBENZENE	9	9	70	10	U	11	U	10	UJ	11	U
1,3-DICHLOROBENZENE	600	600	NE	10	U	11	U	10	UJ	11	U
1,4-DICHLOROBENZENE	75	75	75	10	U	11	U	10	UJ	11	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	U	11	U	10	UJ	11	U
DIETHYL PHTHALATE	5000	5000	NE	10	U	11	U	10	UJ	11	U
DI-N-BUTYL PHTHALATE	900	900	NE	10	U	11	U	10	UJ	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	11	U	10	UJ	11	U
PHENOL	4000	4000	NE	10	U	11	U	10	UJ	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W24S* 2002/09/26 REG 209170-001-005-1/1 WATER µg/L		B18W25S* 2000/06/27 DUP 6172-002-04-1/2 WATER µg/L		B18W25S* 2000/06/27 REG 6172-001-04-1/2 WATER µg/L		B18W25S* 2000/09/18 REG 9110-001-04-1 WATER µg/L	
Analyte	µg/L	µg/L	µg/L								
1,2,4-TRICHLOROBENZENE	9	9	70	NA		11.1	U	11.1	U	12	U
1,3-DICHLOROBENZENE	600	600	NE	10	UJ	11.1	U	11.1	U	12	U
1,4-DICHLOROBENZENE	75	75	75	10	UJ	11.1	U	11.1	U	12	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	UJ	11.1	U	5	J	12	U
DIETHYL PHTHALATE	5000	5000	NE	10	UJ	11.1	U	11.1	U	12	U
DI-N-BUTYL PHTHALATE	900	900	NE	10	UJ	11.1	U	11.1	U	12	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	UJ	11.1	U	11.1	U	12	U
PHENOL	4000	4000	NE	10	UJ	11.1	U	11.1	U	12	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W25S* 2000/12/18 DUP 12060-002-04-1/2 WATER µg/L		B18W25S* 2000/12/18 REG 12060-001-04-1/2 WATER µg/L		B18W25S* 2001/03/22 REG 103223-002-04-1/2 WATER µg/L		B18W25S* 2001/05/24 REG AB34409 WATER µg/L	
1,2,4-TRICHLOROBENZENE	9	9	70	11	U	10	UJ	11	U	10	U
1,3-DICHLOROBENZENE	600	600	NE	NA		NA		NA		10	U
1,4-DICHLOROBENZENE	75	75	75	NA		NA		NA		10	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	11	U	**15**	**J**	11	U	10	U
DIETHYL PHTHALATE	5000	5000	NE	11	U	10	UJ	11	U	10	U
DI-N-BUTYL PHTHALATE	900	900	NE	11	U	10	UJ	11	U	10	U
DI-N-OCTYL PHTHALATE	100	100	NE	11	U	10	UJ	11	U	10	U
PHENOL	4000	4000	NE	11	UJ	10	UJ	11	U	10	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W25S* 2001/10/02 DUP AB43776 WATER µg/L		B18W25S* 2001/10/02 REG AB43775 WATER µg/L		B18W25S* 2001/12/11 DUP AB48386 WATER µg/L		B18W25S* 2001/12/11 REG AB48385 WATER µg/L	
Analyte	µg/L	µg/L	µg/L								
1,2,4-TRICHLOROBENZENE	9	9	70	10	UJ	10	UJ	11	U	11	U
1,3-DICHLOROBENZENE	600	600	NE	10	UJ	10	UJ	11	U	11	U
1,4-DICHLOROBENZENE	75	75	75	10	UJ	10	UJ	11	U	11	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	UJ	10	UJ	11	U	11	U
DIETHYL PHTHALATE	5000	5000	NE	10	UJ	10	UJ	11	U	11	U
DI-N-BUTYL PHTHALATE	900	900	NE	10	UJ	10	UJ	11	U	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	UJ	10	UJ	11	U	11	U
PHENOL	4000	4000	NE	10	UJ	10	UJ	11	U	11	U

Notes:

Qualifiers

U - The compound was not detected above the laboratory method detection limit.

J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.

R - Result regarded as unreliable. Analyte may or may not be present.

µg/L - micrograms per liter

NA - Not Analyzed

NE - Not Established.

Boxed results - indicate an exceedance in applicable standards.

* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W25S* 2002/03/28 DUP 204001-003-04-1/2 WATER µg/L		B18W25S* 2002/03/28 REG 204001-001-04-1/2 WATER µg/L		B18W25S* 2002/09/30 DUP 210007-002-023-1/2 WATER µg/L		B18W25S* 2002/09/30 REG 210007-001-017-1/6 WATER µg/L	
1,2,4-TRICHLOROBENZENE	9	9	70	12	U	12	U	NA		NA	
1,3-DICHLOROBENZENE	600	600	NE	12	U	12	U	11	U	11	U
1,4-DICHLOROBENZENE	75	75	75	12	U	12	U	11	U	11	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	12	U	12	U	11	U	11	U
DIETHYL PHTHALATE	5000	5000	NE	12	U	12	U	11	U	11	U
DI-N-BUTYL PHTHALATE	900	900	NE	12	U	12	U	11	U	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	12	U	12	U	11	U	11	U
PHENOL	4000	4000	NE	12	U	12	U	11	U	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W26S* 2000/06/28 REG 7012-007-04-1/2 WATER µg/L		B18W26S* 2000/09/21 REG 9147-004-01-1 WATER µg/L		B18W26S* 2000/12/21 REG 12088-008-04-1/2 WATER µg/L		B18W26S* 2001/03/22 REG 103223-001-07-1/3 WATER µg/L	
1,2,4-TRICHLOROBENZENE	9	9	70	10.5	U	10	U	12	U	11	U
1,3-DICHLOROBENZENE	600	600	NE	10.5	U	10	U	NA		NA	
1,4-DICHLOROBENZENE	75	75	75	10.5	U	10	U	NA		NA	
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10.5	U	10	U	**29**		11	U
DIETHYL PHTHALATE	5000	5000	NE	10.5	U	10	U	12	U	11	U
DI-N-BUTYL PHTHALATE	900	900	NE	10.5	U	10	U	12	U	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	10.5	U	10	U	12	U	11	U
PHENOL	4000	4000	NE	10.5	U	10	U	12	U	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W26S* 2001/05/25 DUP AB34397 WATER µg/L		B18W26S* 2001/05/25 REG AB34396 WATER µg/L		B18W26S* 2001/10/03 REG AB43782 WATER µg/L		B18W26S* 2001/12/13 REG AB48636 WATER µg/L	
Analyte	µg/L	µg/L	µg/L								
1,2,4-TRICHLOROBENZENE	9	9	70	10	U	10	U	11	U	11	U
1,3-DICHLOROBENZENE	600	600	NE	10	U	10	U	11	U	11	U
1,4-DICHLOROBENZENE	75	75	75	10	U	10	U	11	U	11	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	U	10	U	11	U	11	U
DIETHYL PHTHALATE	5000	5000	NE	10	U	10	U	11	U	11	U
DI-N-BUTYL PHTHALATE	900	900	NE	10	U	10	U	11	U	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	10	U	11	U	11	U
PHENOL	4000	4000	NE	10	U	10	U	11	U	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W26S* 2002/04/03 REG 204028-002-04-1/2 WATER µg/L		B18W26S* 2002/09/24 REG 209154-001-007-1/2 WATER µg/L		B18W27S* 2000/06/28 REG 7012-001-04-1/2 WATER µg/L		B18W27S* 2000/09/20 REG 9134-001-04-1 WATER µg/L	
Analyte	µg/L	µg/L	µg/L								
1,2,4-TRICHLOROBENZENE	9	9	70	NA		NA		11.1	U	11	U
1,3-DICHLOROBENZENE	600	600	NE	12	U	11	UJ	11.1	U	11	U
1,4-DICHLOROBENZENE	75	75	75	12	U	11	UJ	11.1	U	11	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	12	U	11	UJ	11.1	U	11	U
DIETHYL PHTHALATE	5000	5000	NE	12	U	11	UJ	11.1	U	11	U
DI-N-BUTYL PHTHALATE	900	900	NE	12	U	11	UJ	11.1	U	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	12	U	11	UJ	11.1	U	11	U
PHENOL	4000	4000	NE	12	U	11	UJ	11.1	U	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W27S* 2000/12/21 REG 12088-006-07-1/4 WATER µg/L		B18W27S* 2001/03/21 DUP 103208-002-04-1/2 WATER µg/L		B18W27S* 2001/03/21 REG 103208-001-04-1/2 WATER µg/L		B18W27S* 2001/05/30 REG AB34618 WATER µg/L	
Analyte	µg/L	µg/L	µg/L								
1,2,4-TRICHLOROBENZENE	9	9	70	12	U	11	U	11	U	10	U
1,3-DICHLOROBENZENE	600	600	NE	NA		NA		NA		10	U
1,4-DICHLOROBENZENE	75	75	75	NA		NA		NA		10	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	12	U	11	U	11	U	10	U
DIETHYL PHTHALATE	5000	5000	NE	12	U	65		70		10	U
DI-N-BUTYL PHTHALATE	900	900	NE	12	U	11	U	11	U	10	U
DI-N-OCTYL PHTHALATE	100	100	NE	12	U	11	U	11	U	10	U
PHENOL	4000	4000	NE	12	U	11	U	11	U	10	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W27S* 2001/10/04 REG AB43983 WATER µg/L		B18W27S* 2001/12/13 REG AB48635 WATER µg/L		B18W27S* 2002/04/03 REG 204028-001-04-1/2 WATER µg/L		B18W27S* 2002/09/25 REG 209160-001-012-1/2 WATER µg/L	
1,2,4-TRICHLOROBENZENE	9	9	70	10	UJ	11	U	NA		NA	
1,3-DICHLOROBENZENE	600	600	NE	10	UJ	11	U	12	U	11	UJ
1,4-DICHLOROBENZENE	75	75	75	10	UJ	11	U	12	U	11	UJ
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	UJ	**62.2**		12	U	11	UJ
DIETHYL PHTHALATE	5000	5000	NE	10	UJ	11	U	12	U	11	UJ
DI-N-BUTYL PHTHALATE	900	900	NE	10	UJ	11	U	12	U	11	UJ
DI-N-OCTYL PHTHALATE	100	100	NE	10	UJ	11	U	12	U	11	UJ
PHENOL	4000	4000	NE	10	UJ	11	U	12	U	11	UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W28S* 2000/06/29 REG 7012-005-04-1/2 WATER µg/L		B18W28S* 2000/09/21 REG 9147-002-09-1 WATER µg/L		B18W28S* 2000/12/20 REG 12088-003-04-1/2 WATER µg/L		B18W28S* 2001/03/20 REG 103200-001-04-1/2 WATER µg/L	
1,2,4-TRICHLOROBENZENE	9	9	70	11	U	12	U	**11**	**J**	1	J
1,3-DICHLOROBENZENE	600	600	NE	11	U	12	U	NA		NA	
1,4-DICHLOROBENZENE	75	75	75	11	U	12	U	NA		NA	
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	11	U	12	U	11	U	11	U
DIETHYL PHTHALATE	5000	5000	NE	11	U	12	U	11	U	11	U
DI-N-BUTYL PHTHALATE	900	900	NE	11	U	12	U	11	U	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	11	U	12	U	11	U	11	U
PHENOL	4000	4000	NE	11	U	12	U	11	U	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W28S* 2001/05/31 REG AB34821 WATER µg/L		B18W28SR* 2001/10/05 REG AB43987 WATER µg/L		B18W28SR* 2001/12/14 REG AB48691 WATER µg/L		B18W28SR* 2002/04/02 REG 204022-001-04-1/2 WATER µg/L	
1,2,4-TRICHLOROBENZENE	9	9	70	6.51	R	14	U	1.88	J	NA	
1,3-DICHLOROBENZENE	600	600	NE	1.06	J	14	U	1.19	J	12	U
1,4-DICHLOROBENZENE	75	75	75	10	U	14	U	1.16	J	12	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	U	14	U	**105**	**J**	12	U
DIETHYL PHTHALATE	5000	5000	NE	10	U	14	U	11	UJ	12	U
DI-N-BUTYL PHTHALATE	900	900	NE	10	U	14	U	11	UJ	1.1	J
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	14	U	11	UJ	12	U
PHENOL	4000	4000	NE	10	U	14	U	11	UJ	12	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W28SR* 2002/09/25 REG 209160-002-014-1/2 WATER µg/L		B18W28SR* 2002/09/25 REG 209160-002-014-1/2DL WATER µg/L		B18W29S* 2000/06/30 REG 7012-004-04-1/2 WATER µg/L		B18W29S* 2000/09/20 REG 9134-004-04-1 WATER µg/L	
1,2,4-TRICHLOROBENZENE	9	9	70	NA		NA		12.8	U	12	U
1,3-DICHLOROBENZENE	600	600	NE	11	UJ	NA		12.8	U	12	U
1,4-DICHLOROBENZENE	75	75	75	11	UJ	NA		12.8	U	12	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	NA		**270**	**J**	12.8	U	12	U
DIETHYL PHTHALATE	5000	5000	NE	11	UJ	NA		12.8	U	12	U
DI-N-BUTYL PHTHALATE	900	900	NE	11	UJ	NA		12.8	U	12	U
DI-N-OCTYL PHTHALATE	100	100	NE	11	UJ	NA		12.8	U	12	U
PHENOL	4000	4000	NE	11	UJ	NA		12.8	U	12	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W29S* 2000/12/20 REG 12088-001-04-1 WATER µg/L		B18W29S* 2001/03/20 REG 103200-002-04-1/1 WATER µg/L		B18W29SR* 2001/10/08 REG AB44188 WATER µg/L		B18W29SR* 2001/12/14 REG AB48690 WATER µg/L	
1,2,4-TRICHLOROBENZENE	9	9	70	12	U	11	U	12	U	10	UJ
1,3-DICHLOROBENZENE	600	600	NE	NA		NA		12	U	10	UJ
1,4-DICHLOROBENZENE	75	75	75	NA		NA		12	U	10	UJ
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	12	U	11	U	**39.2**		**85.7**	
DIETHYL PHTHALATE	5000	5000	NE	12	U	11	U	12	U	10	UJ
DI-N-BUTYL PHTHALATE	900	900	NE	12	U	1	J	12	U	10	UJ
DI-N-OCTYL PHTHALATE	100	100	NE	12	U	11	U	12	U	10	UJ
PHENOL	4000	4000	NE	12	U	11	U	12	U	10	UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W29SR* 2002/04/01 REG 204011-002-04-1/2 WATER µg/L		B18W29SR* 2002/09/26 REG 209170-003-003-1/2 WATER µg/L		URSMW10S 2001/05/15 REG AB33601 WATER µg/L		URSMW10S 2002/01/03 REG AB49494 WATER µg/L	
1,2,4-TRICHLOROBENZENE	9	9	70	13	U	NA		10	UJ	11	U
1,3-DICHLOROBENZENE	600	600	NE	13	U	11	UJ	10	UJ	11	U
1,4-DICHLOROBENZENE	75	75	75	13	U	11	UJ	10	UJ	11	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	13	U	11	UJ	10	UJ	1.7	J
DIETHYL PHTHALATE	5000	5000	NE	13	U	11	UJ	10	UJ	11	U
DI-N-BUTYL PHTHALATE	900	900	NE	13	U	11	UJ	10	UJ	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	13	U	11	UJ	10	UJ	11	U
PHENOL	4000	4000	NE	13	U	11	UJ	10	UJ	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW11S 2001/05/16 DUP AB33802 WATER µg/L		URSMW11S 2002/01/08 REG AB49706 WATER µg/L		URSMW1S 2001/05/14 DUP AB33489 WATER µg/L		URSMW1S 2001/05/14 REG AB33488 WATER µg/L	
1,2,4-TRICHLOROBENZENE	9	9	70	10	U	11	R	10	U	10	U
1,3-DICHLOROBENZENE	600	600	NE	10	U	11	U	10	U	10	U
1,4-DICHLOROBENZENE	75	75	75	10	U	11	U	10	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	U	11	U	10	U	10	U
DIETHYL PHTHALATE	5000	5000	NE	10	U	11	U	10	U	10	U
DI-N-BUTYL PHTHALATE	900	900	NE	10	U	11	U	10	U	10	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	11	U	10	U	10	U
PHENOL	4000	4000	NE	10	U	11	U	10	U	10	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW1S 2001/12/19 REG AB48979 WATER µg/L		URSMW20S 2002/04/04 REG 204043-001-04-1/2 WATER µg/L		URSMW2S 2001/05/15 REG AB33603 WATER µg/L		URSMW2S 2001/12/20 REG AB49084 WATER µg/L	
Analyte	µg/L	µg/L	µg/L								
1,2,4-TRICHLOROBENZENE	9	9	70	10	U	NA		10	UJ	11	U
1,3-DICHLOROBENZENE	600	600	NE	10	U	11	UJ	10	UJ	11	U
1,4-DICHLOROBENZENE	75	75	75	10	U	11	UJ	10	UJ	11	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	U	**49**	**J**	10	UJ	11	U
DIETHYL PHTHALATE	5000	5000	NE	10	U	11	UJ	10	UJ	11	U
DI-N-BUTYL PHTHALATE	900	900	NE	10	U	3.8	UJ	10	UJ	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	11	UJ	10	UJ	11	U
PHENOL	4000	4000	NE	10	U	3.4	J	10	UJ	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW4S 2001/05/16 REG AB33794 WATER µg/L		URSMW4S 2002/01/02 DUP AB49465 WATER µg/L		URSMW4S 2002/01/02 REG AB49463 WATER µg/L		URSMW5S 2001/05/16 REG AB33796 WATER µg/L	
1,2,4-TRICHLOROBENZENE	9	9	70	10	U	11	U	11	U	10	U
1,3-DICHLOROBENZENE	600	600	NE	10	U	11	U	11	U	10	U
1,4-DICHLOROBENZENE	75	75	75	10	U	11	U	11	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	U	11	U	11	U	10	U
DIETHYL PHTHALATE	5000	5000	NE	10	U	11	U	11	U	10	U
DI-N-BUTYL PHTHALATE	900	900	NE	10	U	11	U	11	U	10	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	11	U	11	U	7.28	J
PHENOL	4000	4000	NE	10	U	11	U	11	U	10	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-11
Summary of Overburden Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW5S 2002/01/07 REG AB49645 WATER µg/L	
Analyte	µg/L	µg/L	µg/L		
1,2,4-TRICHLOROBENZENE	9	9	70	11	UJ
1,3-DICHLOROBENZENE	600	600	NE	11	UJ
1,4-DICHLOROBENZENE	75	75	75	11	UJ
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	11	UJ
DIETHYL PHTHALATE	5000	5000	NE	11	UJ
DI-N-BUTYL PHTHALATE	900	900	NE	11	UJ
DI-N-OCTYL PHTHALATE	100	100	NE	11	UJ
PHENOL	4000	4000	NE	11	UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-12
Summary of Overburden (Pipechase) Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW6S 2001/05/16 REG AB33798 WATER µg/L		URSMW6S 2002/01/07 REG AB49643 WATER µg/L		URSMW7SR 2002/01/08 REG AB49708 WATER µg/L		URSMW8S 2001/05/23 REG AB34268 WATER µg/L		URSMW8S 2002/01/09 REG AB49750 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
DI-N-OCTYL PHTHALATE	100	100	NE	7.7	J	11	UJ	11	U	10	U	13	UJ
PHENOL	4000	4000	NE	1.32	J	11	UJ	11	U	10	U	13	UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-13
Summary of Overburden (South Drainage Ditch) Analytical Results - Semi-Volatile Organic Compunds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W30S* 2000/07/05 REG 7038-001-04-1 WATER µg/L		B18W30S* 2000/09/19 DUP 9121-002-04-1 WATER µg/L		B18W30S* 2000/09/19 REG 9121-001-04-1 WATER µg/L		B18W30S* 2000/12/19 REG 12065-003-04-1/2 WATER µg/l	
Analyte	µg/L	µg/L	µg/L								
4,6-DINITRO-2-METHYLPHENOL	NE	100	NE	21.7	U	22	U	22	U	23	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10.9	U	11	U	11	U	11	U
DI-N-BUTYL PHTHALATE	900	900	NE	10.9	U	11	U	11	U	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	10.9	U	11	U	11	U	11	U
HEXACHLOROCYCLOPENTADIENE	50	50	50	10.9	U	11	U	11	U	11	U
PHENOL	4000	4000	NE	10.9	U	11	UJ	11	U	11	UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-13
Summary of Overburden (South Drainage Ditch) Analytical Results - Semi-Volatile Organic Compunds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W30S* 2001/03/23 REG 103239-003-04-1/2 WATER µg/L		B18W30S* 2001/05/25 REG AB34400 WATER µg/L		B18W30S* 2001/10/04 REG AB43984 WATER µg/L		B18W30S* 2001/12/17 REG AB48808 WATER µg/L	
Analyte	µg/L	µg/L	µg/L								
4,6-DINITRO-2-METHYLPHENOL	NE	100	NE	22	U	10	U	10	UJ	11	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	**10**	**J**	10	U	10	UJ	11	U
DI-N-BUTYL PHTHALATE	900	900	NE	19	U	10	U	10	UJ	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	11	U	10	U	10	UJ	11	U
HEXACHLOROCYCLOPENTADIENE	50	50	50	11	U	20	U	20	UJ	22	U
PHENOL	4000	4000	NE	11	U	10	U	10	UJ	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-13
Summary of Overburden (South Drainage Ditch) Analytical Results - Semi-Volatile Organic Compunds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W30S* 2002/04/04 REG 204045-001-04-1/2 WATER µg/L		B18W30S* 2002/10/03 REG 210048-002-014-1/2 WATER µg/L		URSHP1 2001/04/20 REG AB32161 WATER µg/L		URSHP2 2001/04/23 REG AB32258 WATER µg/L	
4,6-DINITRO-2-METHYLPHENOL	NE	100	NE	21	U	21	U	10		10	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	**13**		11	U	14.3	U	8.54	U
DI-N-BUTYL PHTHALATE	900	900	NE	11	U	11	U	10	U	10	U
DI-N-OCTYL PHTHALATE	100	100	NE	11	U	11	U	10	U	10	U
HEXACHLOROCYCLOPENTADIENE	50	50	50	11	U	11	U	20		20	U
PHENOL	4000	4000	NE	11	U	11	U	10	U	10	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-13
Summary of Overburden (South Drainage Ditch) Analytical Results - Semi-Volatile Organic Compunds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW12S 2001/05/22 REG AB34179 WATER µg/L		URSMW12S 2001/07/05 REG AB37495 WATER µg/L		URSMW12S 2002/01/04 REG AB49602 WATER µg/L		URSMW13S 2001/05/24 REG AB34403 WATER µg/L	
Analyte	µg/L	µg/L	µg/L								
4,6-DINITRO-2-METHYLPHENOL	NE	100	NE	10	U	10	U	11	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	1.66	J	10	U	**51**		10	U
DI-N-BUTYL PHTHALATE	900	900	NE	10	U	10	U	11	U	10	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	10	U	11	U	10	U
HEXACHLOROCYCLOPENTADIENE	50	50	50	20	U	20	U	21	U	20	U
PHENOL	4000	4000	NE	10	U	10	U	11	U	10	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-13
Summary of Overburden (South Drainage Ditch) Analytical Results - Semi-Volatile Organic Compunds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW13S 2001/07/10 REG AB37781 WATER µg/L		URSMW13S 2002/01/09 REG AB49749 WATER µg/L		URSMW14S 2001/05/22 REG AB34178 WATER µg/L		URSMW14S 2001/07/06 REG AB37473 WATER µg/L	
Analyte	µg/L	µg/L	µg/L								
4,6-DINITRO-2-METHYLPHENOL	NE	100	NE	10	U	11	UJ	10	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	4.86	J	11	UJ	2.45	J	**13.3**	
DI-N-BUTYL PHTHALATE	900	900	NE	10	U	11	UJ	10	U	10	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	11	UJ	10	U	10	U
HEXACHLOROCYCLOPENTADIENE	50	50	50	20	U	22	UJ	20	U	20	U
PHENOL	4000	4000	NE	2.79	J	11	UJ	10	U	5.1	J

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-13
Summary of Overburden (South Drainage Ditch) Analytical Results - Semi-Volatile Organic Compunds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW14S 2002/01/08 REG AB49707 WATER µg/L		URSMW15S 2001/05/24 REG AB34405 WATER µg/L		URSMW15S 2001/07/11 REG AB37785 WATER µg/L		URSMW15S 2002/01/07 REG AB49644 WATER µg/L	
Analyte	µg/L	µg/L	µg/L								
4,6-DINITRO-2-METHYLPHENOL	NE	100	NE	11	U	10	U	10	U	14	UJ
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	11	U	10	U	**17.5**		**82**	**J**
DI-N-BUTYL PHTHALATE	900	900	NE	11	U	10	U	10	U	14	UJ
DI-N-OCTYL PHTHALATE	100	100	NE	11	U	10	U	10	U	14	UJ
HEXACHLOROCYCLOPENTADIENE	50	50	50	22	U	20	U	20	U	29	UJ
PHENOL	4000	4000	NE	11	U	10	U	1.47	J	14	UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-13
Summary of Overburden (South Drainage Ditch) Analytical Results - Semi-Volatile Organic Compunds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW16S 2001/05/21 DUP AB34098 WATER µg/L		URSMW16S 2001/05/21 REG AB34096 WATER µg/L		URSMW16S 2001/07/05 REG AB37493 WATER µg/L		URSMW16S 2002/01/03 REG AB49495 WATER µg/L	
Analyte	µg/L	µg/L	µg/L								
4,6-DINITRO-2-METHYLPHENOL	NE	100	NE	10	U	10	U	10	U	11	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	U	10	U	24	U	**10.6**	**J**
DI-N-BUTYL PHTHALATE	900	900	NE	10	U	10	U	10	U	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	10	U	10	U	11	U
HEXACHLOROCYCLOPENTADIENE	50	50	50	20	U	20	U	20	U	21	U
PHENOL	4000	4000	NE	10	U	10	U	10	U	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-13
Summary of Overburden (South Drainage Ditch) Analytical Results - Semi-Volatile Organic Compunds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW17S 2001/05/21 REG AB34099 WATER µg/L		URSMW17S 2001/07/09 REG AB37721 WATER µg/L		URSMW17S 2002/01/04 REG AB49629 WATER µg/L		URSMW17S 2002/03/25 REG 203126-001-01-1/2 WATER µg/L	
Analyte	µg/L	µg/L	µg/L								
4,6-DINITRO-2-METHYLPHENOL	NE	100	NE	10	U	10	U	20	UJ	22	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	U	**28.1**		**43.1**	**J**	11	U
DI-N-BUTYL PHTHALATE	900	900	NE	10	U	10	U	20	UJ	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	6.61	J	10	U	20	UJ	11	U
HEXACHLOROCYCLOPENTADIENE	50	50	50	20	U	20	U	40	UJ	11	U
PHENOL	4000	4000	NE	10	U	2.61	J	20	UJ	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-13
Summary of Overburden (South Drainage Ditch) Analytical Results - Semi-Volatile Organic Compunds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW18S 2001/05/17 REG AB33851 WATER µg/L		URSMW18S 2001/07/03 DUP AB37376 WATER µg/L		URSMW18S 2001/07/03 REG AB37373 WATER µg/L		URSMW18S 2002/01/04 REG AB49627 WATER µg/L	
4,6-DINITRO-2-METHYLPHENOL	NE	100	NE	10	U	10	U	10	U	22	UJ
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	U	32.6	UJ	**380**	**J**	**9.31**	**J**
DI-N-BUTYL PHTHALATE	900	900	NE	10	U	10	U	10	U	22	UJ
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	1.28	J	1.1	J	22	UJ
HEXACHLOROCYCLOPENTADIENE	50	50	50	20	U	20	U	20	U	44	UJ
PHENOL	4000	4000	NE	10	U	10	U	2.37	J	22	UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-13
Summary of Overburden (South Drainage Ditch) Analytical Results - Semi-Volatile Organic Compunds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW18S 2002/03/25 REG 203126-003-01-1/2 WATER µg/L	
Analyte	µg/L	µg/L	µg/L		
4,6-DINITRO-2-METHYLPHENOL	NE	100	NE	22	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	**37**	
DI-N-BUTYL PHTHALATE	900	900	NE	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	11	U
HEXACHLOROCYCLOPENTADIENE	50	50	50	11	U
PHENOL	4000	4000	NE	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-14
Summary of Overburden Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W24S* (UNFIL) 2000/06/29 REG 7012-008-06-1 WATER µg/L	B18W24S* (UNFIL) 2000/09/19 REG 9121-004-06-1 WATER µg/L	B18W24S* (UNFIL) 2000/12/19 REG 12065-002-06-1 WATER µg/L	B18W24S* (UNFIL) 2001/03/23 REG 103239-001-06-1/1 WATER µg/L	B18W24S* (UNFIL) 2001/05/31 REG AB34824 WATER µg/L	B18W24S* (UNFIL) 2001/10/03 REG AB43781 WATER µg/L	B18W24S* (UNFIL) 2001/12/12 REG AB48499 WATER µg/L
ALUMINUM	200	NE	NE	43.6	147	**839**	**961**	**683**	**234**	180 U
ANTIMONY	20	6	6	6 U	3.7 U	3.7 U	4.5 U	15 U	15 U	15 U
ARSENIC	8	10	NE	5 U	3.2 U	3.2 U	4.1 U	7.5 U	7.5 U	7.5 U
BARIUM	2000	2000	2000	203	158	84	59.1	106 J	129 J	91.8
BERYLLIUM	20	4	4	1 U	0.1 U	0.1 U	0.2 U	15 U	15 U	15 U
CADMIUM	4	5	5	3 U	0.4 U	0.4 U	0.4 U	3.5 U	3.5 U	3.5 U
CALCIUM	NE	NE	NE	87300	73200	38400	26300	55100	65500	44500
CHROMIUM	100	100	100	2.01	3.1	6.4	5.6	50 U	50 U	50 U
COBALT	NE	NE	NE	5 U	1	0.9 U	0.8 U	20 U	20 U	20 U
COPPER	1000	1300*	1300*	3.86	4 R	4.1	4.9 U	50 U	50 U	50 U
IRON	300	NE	NE	20.5	208 R	**1260**	**1250**	**953**	280 U	**501**
LEAD	10	15*	15*	1.5 UJ	1.5 U	1.5 U	1.5 U	8 U	8 U	8 U
MAGNESIUM	NE	NE	NE	24000	15900	9210	6700	12100	15900	11100
MANGANESE	50	NE	NE	1.72	4.5	22.2	19.7	40 U	40 U	40 U
MERCURY	2	2	2	0.2 U	0.1	0.1 U	0.1 U	0.7 U	0.7 U	0.7 U
NICKEL	100	NE	NE	3.02	2 U	2.3	1.4	50 U	50 U	50 U
POTASSIUM	NE	NE	NE	4580	5710	3330	2180	4030 J	4550 J	3460
SELENIUM	50	50	50	16.4	12.5	12.6	13.8	40 U	40 U	40 U
SILVER	NE	NE	NE	1.5	1.4	1.1	1.4 U	20 U	20 U	20 U
SODIUM	50000	NE	NE	45500	30100	18000	12600	20300	30400 J	22100
VANADIUM	NE	NE	NE	2.03	3	2.2	1.2 U	50 U	50 U	50 U
ZINC	5000	NE	NE	15 U	4 U	8.5	6	50 U	50 U	50 U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-14
Summary of Overburden Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W24S* (UNFIL) 2002/04/01 REG 204011-001-06-1/1 WATER µg/L	B18W24S* (UNFIL) 2002/09/26 REG 209170-001-006-1/1 WATER µg/L	B18W25S* (UNFIL) 2000/06/27 DUP 6172-002-06-1/1 WATER µg/L	B18W25S* (UNFIL) 2000/06/27 REG 6172-001-06-1/1 WATER µg/L	B18W25S* (UNFIL) 2000/09/18 REG 9110-001-06-1 WATER µg/L	B18W25S* (UNFIL) 2000/12/18 DUP 12060-002-06-1 WATER µg/L	B18W25S* (UNFIL) 2000/12/18 REG 12060-001-06-1 WATER µg/L
ALUMINUM	200	NE	NE	55.3 R	136 J	48.4	57.8	**662**	75.4 J	76.1 J
ANTIMONY	20	6	6	4.5 U	2.5 UJ	5.4 UJ	5.4 UJ	3.7 U	3.7 U	3.7 U
ARSENIC	8	10	NE	4.1 U	3.4 UJ	4.5 U	4.5 U	3.2 U	3.2 U	3.2 U
BARIUM	2000	2000	2000	62	143 J	53.1	55.2	73.7	56.6	56.1
BERYLLIUM	20	4	4	0.2 U	0.1 UJ	0.9 U	0.108	0.1 U	0.1 U	0.1 U
CADMIUM	4	5	5	0.4 U	0.3 UJ	2.7 U	2.7 U	0.4 U	0.4 U	0.4 U
CALCIUM	NE	NE	NE	32900	67300 J	39700	41500	49000	45400	45100
CHROMIUM	100	100	100	0.9 U	2.1 J	1.57	0.951	2.7	1.1	0.8 U
COBALT	NE	NE	NE	0.8 U	0.6 UJ	4.5 U	4.5 U	0.9 U	0.9 U	0.9 U
COPPER	1000	1300*	1300*	4.9 U	2.9 J	11.8	12	8.6	4.8	5.2
IRON	300	NE	NE	36.2	184 J	36.3	29.9	**1090**	90.3	89
LEAD	10	15*	15*	1.5 U	1.6 UJ	2.7 U	2.7 U	1.5 U	1.5 U	1.5 U
MAGNESIUM	NE	NE	NE	7270	16500 J	12600	13100	15200	12200	12200
MANGANESE	50	NE	NE	1.1	7.5 J	**165**	**170**	**420**	**120**	**118**
MERCURY	2	2	2	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U
NICKEL	100	NE	NE	1.1 U	2.1 J	29.2 R	30.3 R	13.8	11.1	11.4
POTASSIUM	NE	NE	NE	2340	5360 J	1620	1640	2310	2040	2030
SELENIUM	50	50	50	9.5	22.2 J	3.99	3.6	2.3 U	2.3 U	2.3 U
SILVER	NE	NE	NE	1.4 U	0.89 J	2.7 U	2.7 U	0.7 U	0.7 U	0.7 U
SODIUM	50000	NE	NE	13400	32800 J	29700	30500	32800	30600	29700
VANADIUM	NE	NE	NE	1.2 U	0.92 J	1.72	1.73	2.6	1.6	1.2
ZINC	5000	NE	NE	5.6 U	9.5 J	7.02	6.23	5.5	4	4 U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Pro
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-14
Summary of Overburden Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W25S* (UNFIL) 2001/03/22 REG 103223-002-06-1/1 WATER µg/L	B18W25S* (UNFIL) 2001/05/24 REG AB34409 WATER µg/L	B18W25S* (UNFIL) 2001/10/02 DUP AB43776 WATER µg/L	B18W25S* (UNFIL) 2001/10/02 REG AB43775 WATER µg/L	B18W25S* (UNFIL) 2001/12/11 DUP AB48386 WATER µg/L	B18W25S* (UNFIL) 2001/12/11 REG AB48385 WATER µg/L	B18W25S* (UNFIL) 2002/03/28 DUP 204001-003-06-1/1 WATER µg/L
ALUMINUM	200	NE	NE	**8200**	**259 J**	**222**	**257**	**589**	**466**	653 R
ANTIMONY	20	6	6	4.5 U	15 U	15 U	15 U	15 U	15 U	4.5 U
ARSENIC	8	10	NE	4.1 U	7.5 U	7.5 U	7.5 U	7.5 U	7.5 U	4.1 U
BARIUM	2000	2000	2000	128	54.2 J	70.4	72.6	53.4	51.5	53.4
BERYLLIUM	20	4	4	0.4	15 U	15 U	15 U	15 U	15 U	0.2 U
CADMIUM	4	5	5	0.4 U	3.5 U	3.5 U	3.5 U	3.5 U	3.5 U	0.4 U
CALCIUM	NE	NE	NE	32700	31400	32400	32600	26200	25800	28600
CHROMIUM	100	100	100	11	50 U	50 U	50 U	50 U	50 U	1.2 J
COBALT	NE	NE	NE	3.3	20 U	20 U	20 U	20 U	20 U	0.8 U
COPPER	1000	1300*	1300*	8	50 U	50 U	50 U	50 U	50 U	4.9 U
IRON	300	NE	NE	**7260**	280 U	280 U	280 U	**416**	**305**	**596**
LEAD	10	15*	15*	4.1	8 U	8 U	8 U	8 U	8 U	1.5 U
MAGNESIUM	NE	NE	NE	10600	8050 J	9420	9520	7060	6960	7570
MANGANESE	50	NE	NE	**447**	**387**	**572**	**561**	**608**	**593**	**61**
MERCURY	2	2	2	0.1 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.1 U
NICKEL	100	NE	NE	18.8	50 U	50 U	50 U	50 U	50 U	1.5 J
POTASSIUM	NE	NE	NE	5040	2580	2100	2080	2320	2210	1850
SELENIUM	50	50	50	6.5	40 U	40 U	40 U	40 U	40 U	6.2
SILVER	NE	NE	NE	1.4 U	20 U	20 U	20 U	20 U	20 U	1.4 U
SODIUM	50000	NE	NE	25800	26400 R	24900 J	25100 J	22900	22300	22200
VANADIUM	NE	NE	NE	13.1	50 U	50 U	50 U	50 U	50 U	1.6
ZINC	5000	NE	NE	27.3	51.5 R	50 U	50 U	50 U	50 U	8.4

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Pro
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-14
Summary of Overburden Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W25S* (UNFIL) 2002/03/28 REG 204001-001-06-1/1 WATER µg/L	B18W25S* (UNFIL) 2002/09/30 DUP 210007-002-030-1/1 WATER µg/L	B18W25S* (UNFIL) 2002/09/30 REG 210007-001-027-1/3 WATER µg/L	B18W26S* (UNFIL) 2000/06/28 REG 7012-007-06-1 WATER µg/L	B18W26S* (UNFIL) 2000/09/21 REG 9147-004-01-1 WATER µg/L	B18W26S* (UNFIL) 2000/12/21 REG 12088-008-06-1/0 WATER µg/L	B18W26S* (UNFIL) 2001/03/22 REG 103223-001-10-1/2 WATER µg/L
ALUMINUM	200	NE	NE	677 R	**572**	**347**	200 U	94.3	29	55.3 U
ANTIMONY	20	6	6	4.5 U	2.5 U	2.5 U	6 U	3.7 U	3.7 U	4.5 U
ARSENIC	8	10	NE	4.1 U	3.4 U	3.4 U	5 U	3.2 U	3.2 U	4.1 U
BARIUM	2000	2000	2000	53.6	73.7	73.9	139 R	170	89	85.1
BERYLLIUM	20	4	4	0.2 U	0.1 U	0.1 U	1 U	0.1 U	0.1 U	0.2 U
CADMIUM	4	5	5	0.4 U	0.3 U	0.3 U	3 U	0.4 U	0.4 U	0.4 U
CALCIUM	NE	NE	NE	28800	30800	30800	35600	42400	30700	29900
CHROMIUM	100	100	100	3.2 J	2.9	2.3	5 U	0.8 U	0.8 U	0.9 U
COBALT	NE	NE	NE	0.8 U	0.6 U	0.6 U	5 U	0.9 U	0.9 U	0.8 U
COPPER	1000	1300*	1300*	4.9 U	3.3	3.3	1.24	1.2 R	2	4.9 U
IRON	300	NE	NE	**590**	**484**	224	**6140**	**8240**	**6110**	**6920**
LEAD	10	15*	15*	1.5 U	1.6 U	1.6 U	1.5 UJ	1.5 U	1.5 U	1.5 U
MAGNESIUM	NE	NE	NE	7680	9080	9090	9330	9990	7060	7250
MANGANESE	50	NE	NE	**64.2**	**401**	**394**	**610**	**580**	**452**	**431**
MERCURY	2	2	2	0.1 U	0.1 U	0.1 U	0.2 U	0.1 U	0.1 U	0.1 U
NICKEL	100	NE	NE	6.9 J	6.9	6.2	5 U	2 U	2 U	1.1 U
POTASSIUM	NE	NE	NE	1820	2130	2120	6100	6680	3150	3030
SELENIUM	50	50	50	4.9	3.5 U	5	5 U	2.3 U	2.3 U	3.4 U
SILVER	NE	NE	NE	1.4 U	0.6 U	0.6 U	1.11	0.7 U	0.7 U	1.4 U
SODIUM	50000	NE	NE	22000	23300	23500	17300	18300	10700	10300
VANADIUM	NE	NE	NE	1.8	0.73	0.7 U	5 U	0.9 U	0.9 U	1.2 U
ZINC	5000	NE	NE	5.7	10	5.5	15 U	4 U	4 U	5.6 U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Pro
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W26S* (UNFIL) 2001/05/25 DUP AB34397 WATER µg/L		B18W26S* (UNFIL) 2001/05/25 REG AB34396 WATER µg/L		B18W26S* (UNFIL) 2001/10/03 REG AB43782 WATER µg/L		B18W26S* (UNFIL) 2001/12/13 REG AB48636 WATER µg/L		B18W26S* (UNFIL) 2002/04/03 REG 204028-002-06-1/1 WATER µg/L		B18W26S* (UNFIL) 2002/09/24 REG 209154-001-011-1/1 WATER µg/L		B18W27S* (UNFIL) 2000/06/28 REG 7012-001-06-1 WATER µg/L	
ALUMINUM	200	NE	NE	180	U	180	U	180	U	180	U	30.9	U	39	J	31.8	
ANTIMONY	20	6	6	15	U	15	U	15	U	15	U	2.5	U	2.5	U	6	U
ARSENIC	8	10	NE	7.5	U	7.5	U	7.5	U	7.5	U	3.4	U	5		5	U
BARIUM	2000	2000	2000	111		129		155	J	109		94.6		158		60.6	R
BERYLLIUM	20	4	4	15	U	15	U	15	U	15	U	0.2	U	0.1	U	1	U
CADMIUM	4	5	5	3.5	U	3.5	U	3.5	U	3.5	U	0.3	U	0.3	U	3	U
CALCIUM	NE	NE	NE	35800		40100		41200		32900		29500		37600		38200	
CHROMIUM	100	100	100	50	U	50	U	50	U	50	U	1.5		1.3	U	5	U
COBALT	NE	NE	NE	20	U	20	U	20	U	20	U	0.6	U	0.6	U	5	U
COPPER	1000	1300*	1300*	50	U	50	U	50	U	50	U	4.2		1	U	5	U
IRON	300	NE	NE	**7070**	**J**	**7950**	**J**	**8640**		**7170**		**6670**		**6740**		251	
LEAD	10	15*	15*	8	U	8	U	8	U	8	U	1.6	U	1.6	U	1.5	UJ
MAGNESIUM	NE	NE	NE	7340		8300		8920		7560		6760		8240		10600	
MANGANESE	50	NE	NE	**461**		**519**		**465**		**362**		**338**		**360**		**2530**	
MERCURY	2	2	2	0.7	U	0.7	U	0.7	U	0.7	U	0.1	U	0.1	U	0.2	U
NICKEL	100	NE	NE	50	U	50	U	50	U	50	U	1.1	R	1.1	U	5	U
POTASSIUM	NE	NE	NE	4310		4870		5170	J	3320		3110		5660		4100	
SELENIUM	50	50	50	40	U	40	U	40	U	40	U	3.5	U	3.5	U	5	U
SILVER	NE	NE	NE	20	U	20	U	20	U	20	U	0.89	R	0.6	U	0.984	
SODIUM	50000	NE	NE	15200		17200		18200	J	12900		11500	E	15000		24700	
VANADIUM	NE	NE	NE	50	U	50	U	50	U	50	U	0.76		0.7	U	5	U
ZINC	5000	NE	NE	50	U	50	U	50	U	50	U	7.4		6.7		15	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Pro
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-14
Summary of Overburden Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W27S* (UNFIL) 2000/09/20 REG 9134-001-06-1 WATER µg/L	B18W27S* (UNFIL) 2000/12/21 REG 12088-006-11-1/2 WATER µg/L	B18W27S* (UNFIL) 2001/03/21 DUP 103208-002-06-1/1 WATER µg/L	B18W27S* (UNFIL) 2001/03/21 REG 103208-001-06-1/1 WATER µg/L	B18W27S* (UNFIL) 2001/05/30 REG AB34618 WATER µg/L	B18W27S* (UNFIL) 2001/10/04 REG AB43983 WATER µg/L	B18W27S* (UNFIL) 2001/12/13 REG AB48635 WATER µg/L
ALUMINUM	200	NE	NE	**243**	23.1 U	**954**	**882**	180 U	180 UJ	180 U
ANTIMONY	20	6	6	3.7 U	**6.4**	3.7 U	3.7 U	15 U	15 UJ	15 U
ARSENIC	8	10	NE	4.4	3.2 U	3.2 U	3.2 U	7.5 U	7.5 UJ	7.5 U
BARIUM	2000	2000	2000	62.8	55.5	58.4	55.6	56.4	57.5 UJ	61.7
BERYLLIUM	20	4	4	0.1 U	0.1 U	0.1 U	0.1 U	15 U	15 UJ	15 U
CADMIUM	4	5	5	0.4 U	0.4 U	0.4 U	0.4 U	3.5 U	3.5 UJ	3.5 U
CALCIUM	NE	NE	NE	36300	37400	37300	36000	46100	41700 UJ	46500
CHROMIUM	100	100	100	1.2	1.5	2.8	2.9	50 U	50 UJ	50 U
COBALT	NE	NE	NE	1.1	1	0.9 U	0.9 U	20 U	20 UJ	20 U
COPPER	1000	1300*	1300*	2.2	1.9	4.2	3.8	50 U	50 UJ	50 U
IRON	300	NE	NE	**436 J**	287	**892**	**864**	283	287 UJ	**372**
LEAD	10	15*	15*	1.5 U	1.5 U	1.5 U	1.7	8 U	8 UJ	8 U
MAGNESIUM	NE	NE	NE	9770	9780	9660	9300	12000	10900 UJ	12400
MANGANESE	50	NE	NE	**2310**	**2450**	**2440**	**2340**	**2820**	2650 UJ	**3000**
MERCURY	2	2	2	0.1 U	0.1 U	0.1 U	0.1 U	0.7 U	0.7 UJ	0.7 U
NICKEL	100	NE	NE	2 U	2 U	2 U	2 U	50 U	50 UJ	50 U
POTASSIUM	NE	NE	NE	4270	3580	3370	3330	3770	4210	4110
SELENIUM	50	50	50	2.3 U	2.3 U	2.3 U	2.3 U	40 U	40 UJ	40 U
SILVER	NE	NE	NE	0.7 U	2.2	0.7	1.7	20 U	20 UJ	20 U
SODIUM	50000	NE	NE	22600	22600	22400	21500	26700	25400 J	27300
VANADIUM	NE	NE	NE	0.96	1.3	4.1	3.2	50 U	50 UJ	50 U
ZINC	5000	NE	NE	4 U	4 U	4.5	4 U	50 U	50 UJ	50 U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Pro
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-14
Summary of Overburden Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W27S* (UNFIL) 2002/04/03 REG 204028-001-06-1/1 WATER µg/L	B18W27S* (UNFIL) 2002/09/25 REG 209160-001-018-1/1 WATER µg/L	B18W28S* (UNFIL) 2000/06/29 REG 7012-005-06-1 WATER µg/L	B18W28S* (UNFIL) 2000/09/21 REG 9147-002-09-1 WATER µg/L	B18W28S* (UNFIL) 2000/12/20 REG 12088-003-06-1 WATER µg/L	B18W28S* (UNFIL) 2001/03/20 REG 103200-001-06-1/1 WATER µg/L	B18W28S* (UNFIL) 2001/05/31 REG AB34821 WATER µg/L
ALUMINUM	200	NE	NE	30.9 U	30.9 UJ	100	**38800**	**762**	**13600**	**879**
ANTIMONY	20	6	6	2.5 U	2.5 UJ	6 U	3.7 U	3.7 U	3.7 U	15 U
ARSENIC	8	10	NE	3.4 U	3.4 UJ	5 U	**11.1**	3.2 U	3.2 U	7.5 U
BARIUM	2000	2000	2000	51.2	58.9 J	74 R	472	110	198	76.2 J
BERYLLIUM	20	4	4	0.2 U	0.1 UJ	1 U	3.7	0.43	0.51	15 U
CADMIUM	4	5	5	0.3 U	0.3 UJ	3 U	0.4 U	0.4 U	0.48	3.5 U
CALCIUM	NE	NE	NE	38800	39600 J	28300	35400	23200	29200	30600
CHROMIUM	100	100	100	1.3 U	1.3 UJ	2.97	**1110**	20.6	**258**	50 U
COBALT	NE	NE	NE	0.6 U	0.6 UJ	5 U	29	1.6	8.7	20 U
COPPER	1000	1300*	1300*	4.2	2.8 J	4.07	121 R	17.5	37	50 U
IRON	300	NE	NE	**316**	249 J	125	**71400**	**1980**	**23200**	**2030**
LEAD	10	15*	15*	1.6 U	1.7 J	1.5 UJ	**69.9**	6.7	**22.8**	8 U
MAGNESIUM	NE	NE	NE	10000	9520 J	15000	27600	12300	15900	13200
MANGANESE	50	NE	NE	**2530**	**2510 J**	12.3	**4220**	**550**	**1490**	**166**
MERCURY	2	2	2	0.1 U	0.1 UJ	0.2 U	0.1 U	0.1 U	0.1 U	0.7 U
NICKEL	100	NE	NE	1.5 R	2.1 J	17.9 R	**308**	33.8	81.2	50 U
POTASSIUM	NE	NE	NE	3150	4700 J	791	7180	844	2930	2000 UJ
SELENIUM	50	50	50	3.5 U	3.5 UJ	5 U	2.3 U	2.3 U	2.3 U	40 U
SILVER	NE	NE	NE	0.84 R	0.6 UJ	3 U	84.3	6.9	20.6	20 U
SODIUM	50000	NE	NE	23300 JE	25600 J	44000	41600	30700	27300	30000
VANADIUM	NE	NE	NE	0.9	0.7 UJ	1.47	59.5	3.7	24.2	50 U
ZINC	5000	NE	NE	5.9	4.7 J	15 U	222	28.8	59.8	50 U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Pro
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-14
Summary of Overburden Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W28S* (FIL) 2001/05/31 REG AB34822 WATER µg/L	B18W28SR* (UNFIL) 2001/10/05 REG AB43987 WATER µg/L	B18W28SR* (FIL) 2001/12/14 REG AB48691 WATER µg/L	B18W28SR* (UNFIL) 2001/12/14 REG AB48692 WATER µg/L	B18W28SR* (UNFIL) 2002/04/02 REG 204022-001-06-1/1 WATER µg/L	B18W28SR* (UNFIL) 2002/09/25 REG 209160-002-019-1/1 WATER µg/L	B18W29S* (UNFIL) 2000/06/30 REG 7012-004-06-1 WATER µg/L
ALUMINUM	200	NE	NE	180 U	**560**	180 U	180 U	**366**	**450 J**	**4360**
ANTIMONY	20	6	6	15 U	15 U	15 U	15 U	2.5 U	2.5 UJ	6 U
ARSENIC	8	10	NE	7.5 U	7.5 U	7.5 U	7.5 U	3.4 U	3.4 UJ	5 U
BARIUM	2000	2000	2000	60.1 J	50 U	50 U	50 U	9.2	33.7 J	269 R
BERYLLIUM	20	4	4	15 U	15 U	15 U	15 U	0.2 U	0.1 UJ	0.331
CADMIUM	4	5	5	3.5 U	3.5 U	3.5 U	3.5 U	0.3 U	0.3 UJ	3 U
CALCIUM	NE	NE	NE	28700	26500	39800	41400	11300	29100 J	39100
CHROMIUM	100	100	100	50 U	50 U	50 U	50 U	1.3 U	1.3 UJ	**702**
COBALT	NE	NE	NE	20 U	20 U	20 U	20 U	0.6 U	0.6 UJ	11.2
COPPER	1000	1300*	1300*	50 U	50 U	50 U	50 U	10.1	8.9 J	51.1
IRON	300	NE	NE	280 U	**750**	275 U	275 U	**495**	**680 J**	**10700**
LEAD	10	15*	15*	8 U	8 U	8 U	8 U	1.9	1.6 J	4.69 UJ
MAGNESIUM	NE	NE	NE	12200	5920	8260	8570	2260	6200 J	17000
MANGANESE	50	NE	NE	40 U	40 U	40 U	40 U	10.7	20.2 J	**251**
MERCURY	2	2	2	0.7 U	0.7 U	0.7 U	0.7 U	0.1 U	0.1 UJ	0.2 U
NICKEL	100	NE	NE	50 U	50 U	50 U	50 U	1.6 R	2 J	512 R
POTASSIUM	NE	NE	NE	2000 UJ	2000 U	2000 U	2000 U	943	2540 J	2310
SELENIUM	50	50	50	40 U	40 U	40 U	40 U	3.5 U	3.5 UJ	5 U
SILVER	NE	NE	NE	20 U	20 U	20 U	20 U	0.6 R	0.6 UJ	3.29
SODIUM	50000	NE	NE	29000	14500	16500	17200	6260	14900 J	35400
VANADIUM	NE	NE	NE	50 U	50 U	50 U	50 U	2.9	2.4 J	14.1
ZINC	5000	NE	NE	50 U	50 U	50 U	50 U	13.3	14.5 J	26.6

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Pro
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-14
Summary of Overburden Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W29S* (UNFIL)	B18W29S* (UNFIL)	B18W29S* (UNFIL)	B18W29S* (UNFIL)	B18W29S* (FIL)	B18W29SR* (UNFIL)	B18W29SR* (UNFIL)
Date Collected:				2000/09/20	2000/12/20	2001/03/20	2001/06/05	2001/06/05	2001/10/08	2001/12/14
Analysis Type:				REG	REG	REG	REG	REG	REG	REG
Lab Sample ID:				9134-006-01-1	12088-001-05-1	103200-002-05-1/1	AB35173	AB35174	AB44188	AB48690
Matrix:				WATER	WATER	WATER	WATER	WATER	WATER	WATER
Unit:				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Analyte	µg/L	µg/L	µg/L							
ALUMINUM	200	NE	NE	**981**	41.8	**2690**	**388 J**	180 U	180 U	180 U
ANTIMONY	20	6	6	3.7 U	3.7 U	**6.9**	15 U	15 U	15 U	15 U
ARSENIC	8	10	NE	3.2 U	3.2 U	3.2 U	7.5 U	7.5 U	7.5 U	7.5 U
BARIUM	2000	2000	2000	175	185	459	278	294	292 J	288
BERYLLIUM	20	4	4	0.11	0.1 U	0.1 U	15 U	15 U	15 U	15 U
CADMIUM	4	5	5	0.4 U	0.4 U	0.4 U	3.5 U	3.5 U	3.5 U	3.5 U
CALCIUM	NE	NE	NE	30900	28600	81500	67300 J	61700 J	112000	114000
CHROMIUM	100	100	100	**194**	**141**	**2190**	**127**	50 U	50 U	50 U
COBALT	NE	NE	NE	12.9	5.7	8	20 U	20 U	20 U	20 U
COPPER	1000	1300*	1300*	24.5	9.2	40.8	50 U	50 U	50 U	50 U
IRON	300	NE	NE	**2450 J**	**777**	**13800**	**1280 J**	289 R	280 U	275 U
LEAD	10	15*	15*	2.2	1.5 U	4.6	8 U	8 U	8 U	8 U
MAGNESIUM	NE	NE	NE	12000	12900	31800	21300	21500	31800	28600
MANGANESE	50	NE	NE	**736**	**90.3**	**421**	**746**	**587**	**962**	**69.5**
MERCURY	2	2	2	0.1 U	0.1 U	0.1 U	0.7 U	0.7 U	0.7 U	0.7 U
NICKEL	100	NE	NE	**479**	**417**	**291**	**470**	**502**	50 U	50 U
POTASSIUM	NE	NE	NE	1270	749	1910	2000 U	2000 U	2780 J	2000 U
SELENIUM	50	50	50	2.3 U	2.3 U	2.3 U	40 U	40 U	40 U	40 U
SILVER	NE	NE	NE	0.96	0.7 U	3.7	20 UJ	20 UJ	20 U	20 U
SODIUM	50000	NE	NE	32200	33600	**55400**	**51300**	**54500**	**63700 J**	49400
VANADIUM	NE	NE	NE	3.2	0.9 U	5.7	50 U	50 U	50 U	50 U
ZINC	5000	NE	NE	482	286	86.9	50 U	50 U	50 UJ	50 U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Pro
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-14
Summary of Overburden Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W29SR* (UNFIL) 2002/04/01 REG 204011-002-06-1/1 WATER µg/L	B18W29SR* (UNFIL) 2002/09/26 REG 209170-003-008-1/1 WATER µg/L	URSMW10S (UNFIL) 2001/05/15 REG AB33601 WATER µg/L	URSMW10S (FIL) 2001/05/15 REG AB33602 WATER µg/L	URSMW10S (UNFIL) 2002/01/03 REG AB49494 WATER µg/L	URSMW11S (UNFIL) 2001/05/16 REG AB33802 WATER µg/L	URSMW11S (UNFIL) 2002/01/08 REG AB49706 WATER µg/L
ALUMINUM	200	NE	NE	55.3 R	30.9 UJ	180 U	180 U	180 U	180 U	180 U
ANTIMONY	20	6	6	4.5 U	2.5 UJ	15 U	15 U	15 U	15 U	15 U
ARSENIC	8	10	NE	4.1 U	3.4 UJ	7.5 U	7.5 U	7.5 U	7.5 U	7.5 U
BARIUM	2000	2000	2000	236	246 J	98.7	95.7	98.8	124	82.4
BERYLLIUM	20	4	4	0.2 U	0.1 UJ	15 U	15 U	15 U	15 U	15 U
CADMIUM	4	5	5	0.4 U	0.3 UJ	3.5 U	3.5 U	3.5 U	3.5 U	3.5 U
CALCIUM	NE	NE	NE	84900	88900 J	33900	34500	31400	26300	18300
CHROMIUM	100	100	100	0.9 U	1.3 UJ	50 U	50 U	50 U	50 U	50 U
COBALT	NE	NE	NE	0.8 U	0.6 UJ	20 U	20 U	20 U	20 U	20 U
COPPER	1000	1300*	1300*	4.9 U	3 J	50 U	50 U	50 U	50 U	50 U
IRON	300	NE	NE	17.8 U	24.3 UJ	**1220**	**682**	**2800**	285 J	275 U
LEAD	10	15*	15*	1.5 U	1.6 UJ	8 U	8 U	8 U	8 U	8 U
MAGNESIUM	NE	NE	NE	21100	19200 J	11700	11300	12400	9060	6870
MANGANESE	50	NE	NE	38.8	32.9 J	**2010**	**1950**	**2190**	**657**	40 U
MERCURY	2	2	2	0.1 U	0.1 U	0.75 U	0.75 U	0.7 U	0.7 U	0.7 U
NICKEL	100	NE	NE	7.2	3.2 J	50 U	50 U	50 U	50 U	50 U
POTASSIUM	NE	NE	NE	1320	2050 J	4720	4390	3700	2970	5000 U
SELENIUM	50	50	50	3.4 U	3.5 UJ	40 U	40 U	40 U	40 U	40 U
SILVER	NE	NE	NE	1.4 U	0.6 UJ	20 U	20 U	20 U	20 U	20 U
SODIUM	50000	NE	NE	45600	42900 J	15800	14500	16200	33200	30400
VANADIUM	NE	NE	NE	1.2 U	0.7 UJ	50 U	50 U	50 U	50 U	50 U
ZINC	5000	NE	NE	9.7	10.2 J	50 U	183	50 U	56.4	50 U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Pro
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-14
Summary of Overburden Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW1S (UNFIL) 2001/05/14 DUP AB33489 WATER µg/L	URSMW1S (UNFIL) 2001/05/14 REG AB33488 WATER µg/L	URSMW1S (UNFIL) 2001/12/19 REG AB48979 WATER µg/L	URSMW20S (UNFIL) 2002/04/04 REG 204043-001-06-1/1 WATER µg/L	URSMW2S (UNFIL) 2001/05/15 REG AB33603 WATER µg/L	URSMW2S (FIL) 2001/05/15 REG AB33604 WATER µg/L	URSMW2S (UNFIL) 2001/12/20 REG AB49084 WATER µg/L
ALUMINUM	200	NE	NE	180 U	180 U	**286**	137	180 U	180 U	180 U
ANTIMONY	20	6	6	15 U	15 U	15 U	2.5 U	15 U	15 U	15 U
ARSENIC	8	10	NE	7.5 U	7.5 U	7.5 U	3.4 U	7.5 U	7.5 U	7.5 U
BARIUM	2000	2000	2000	50 U	52.3	50 U	43.8	60.7	62.9	51.2
BERYLLIUM	20	4	4	15 U	15 U	15 U	0.2 U	15 U	15 U	15 U
CADMIUM	4	5	5	3.5 U	3.5 U	3.5 U	0.3 U	3.5 U	3.5 U	3.5 U
CALCIUM	NE	NE	NE	15900	16500	15600	22600	30600	31500	23400
CHROMIUM	100	100	100	50 U	50 U	50 U	1.3 U	50 U	50 U	50 U
COBALT	NE	NE	NE	20 U	20 U	20 U	0.6 U	20 U	20 U	20 U
COPPER	1000	1300*	1300*	50 U	50 U	50 U	2.1	50 U	50 U	50 U
IRON	300	NE	NE	280 U	280 U	275 U	90.9	**934**	**1000**	**957**
LEAD	10	15*	15*	8 U	8 U	8 U	1.6 U	8 U	8 U	8 U
MAGNESIUM	NE	NE	NE	7130	7330	6970	5890	12000	12400	9700
MANGANESE	50	NE	NE	40 U	40 U	40 U	**186**	**6610**	**7240**	**5640**
MERCURY	2	2	2	0.75 U	0.75 U	0.7 U	0.1 U	0.75 U	0.75 U	0.7 U
NICKEL	100	NE	NE	50 U	50 U	50 U	3.7	50 U	50 U	50 U
POTASSIUM	NE	NE	NE	2000 U	2000 U	2000 U	1400	2000 U	2000 U	2000 U
SELENIUM	50	50	50	40 U	40 U	40 U	3.5 U	40 U	40 U	40 U
SILVER	NE	NE	NE	20 U	20 U	20 U	0.6 UJ	20 U	20 U	20 U
SODIUM	50000	NE	NE	9980	10200	10400	19200	45600	**50300**	47700 J
VANADIUM	NE	NE	NE	50 U	50 U	50 U	0.7 U	50 U	50 U	50 U
ZINC	5000	NE	NE	50 U	58.4	50 U	16.1	50 U	50 U	50 U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Pro
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-14
Summary of Overburden Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW4S (UNFIL) 2001/05/16 REG AB33794 WATER µg/L	URSMW4S (FIL) 2001/05/16 REG AB33795 WATER µg/L	URSMW4S (UNFIL) 2002/01/02 DUP AB49465 WATER µg/L	URSMW4S (UNFIL) 2002/01/02 REG AB49463 WATER µg/L	URSMW5S (UNFIL) 2001/05/16 REG AB33796 WATER µg/L	URSMW5S (FIL) 2001/05/16 REG AB33797 WATER µg/L	URSMW5S (UNFIL) 2002/01/07 REG AB49645 WATER µg/L
ALUMINUM	200	NE	NE	180 U	180 U	180 U	180 U	180 U	180 U	**518**
ANTIMONY	20	6	6	15 U	15 U	15 U	15 U	15 U	15 U	15 U
ARSENIC	8	10	NE	7.5 U	7.5 U	7.5 U	7.5 U	7.5 U	7.5 U	7.5 U
BARIUM	2000	2000	2000	60.7	52.5	66.2	60	59.8	60.2	66.4
BERYLLIUM	20	4	4	15 U	15 U	15 U	15 U	15 U	15 U	15 U
CADMIUM	4	5	5	3.5 U	3.5 U	3.5 U	3.5 U	3.5 U	3.5 U	3.5 U
CALCIUM	NE	NE	NE	26300	23100	33900	30800	59600	60600	41700
CHROMIUM	100	100	100	50 U	50 U	50 U	50 U	50 U	50 U	50 U
COBALT	NE	NE	NE	20 U	20 U	20 U	20 U	20 U	20 U	20 U
COPPER	1000	1300*	1300*	50 U	50 U	50 U	50 U	50 U	50 U	50 U
IRON	300	NE	NE	**6540 J**	**4970 J**	**8360**	**7630**	**1030 J**	280 UJ	**848**
LEAD	10	15*	15*	8 U	8 U	8 U	8 U	8 U	8 U	8 U
MAGNESIUM	NE	NE	NE	11500	10200	14600	13300	19700	20400	14700
MANGANESE	50	NE	NE	**5140**	**4470**	**7000**	**6420**	**494**	**520**	40 U
MERCURY	2	2	2	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U
NICKEL	100	NE	NE	50 U	50 U	50 U	50 U	50 U	50 U	50 U
POTASSIUM	NE	NE	NE	2000 U	2000 U	2000 U	2000 U	2000 U	2000 U	5000 U
SELENIUM	50	50	50	40 U	40 U	40 U	40 U	40 U	40 U	40 U
SILVER	NE	NE	NE	20 U	20 U	20 U	20 U	20 U	20 U	20 U
SODIUM	50000	NE	NE	18100	16000	30000	27000	31600	33200	24400
VANADIUM	NE	NE	NE	50 U	50 U	50 U	50 U	50 U	50 U	50 U
ZINC	5000	NE	NE	50 U	50 U	50 U	50 U	50 U	50 U	50 U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Pro
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-14
Summary of Overburden Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW5S (FIL) 2002/01/07 REG AB49646 WATER µg/L	
ALUMINUM	200	NE	NE	180	U
ANTIMONY	20	6	6	15	U
ARSENIC	8	10	NE	7.5	U
BARIUM	2000	2000	2000	67.4	
BERYLLIUM	20	4	4	15	U
CADMIUM	4	5	5	3.5	U
CALCIUM	NE	NE	NE	45100	
CHROMIUM	100	100	100	50	U
COBALT	NE	NE	NE	20	U
COPPER	1000	1300*	1300*	50	U
IRON	300	NE	NE	275	U
LEAD	10	15*	15*	8	U
MAGNESIUM	NE	NE	NE	15800	
MANGANESE	50	NE	NE	40	U
MERCURY	2	2	2	0.7	U
NICKEL	100	NE	NE	50	U
POTASSIUM	NE	NE	NE	5000	U
SELENIUM	50	50	50	40	U
SILVER	NE	NE	NE	20	U
SODIUM	50000	NE	NE	27900	
VANADIUM	NE	NE	NE	50	U
ZINC	5000	NE	NE	50	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Pro
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-15
Summary of Overburden (Pipechase) Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW6S (UNFIL) 2001/05/16 REG AB33798 WATER µg/L		URSMW6S (FIL) 2001/05/16 REG AB33799 WATER µg/L		URSMW6S (UNFIL) 2002/01/07 REG AB49643 WATER µg/L		URSMW7SR (UNFIL) 2002/01/08 REG AB49708 WATER µg/L	
Analyte	µg/L	µg/L	µg/L								
ALUMINUM	200	NE	NE	**1730**		**889**		180	U	180	U
BARIUM	2000	2000	2000	50	U	50	U	50	U	50	U
CALCIUM	NE	NE	NE	31400		26800		25300		25900	
IRON	300	NE	NE	280	R	556	R	275	U	**1120**	
MAGNESIUM	NE	NE	NE	2170	J	2810	J	8800		5590	
MANGANESE	50	NE	NE	40	U	40	U	**107**		**810**	
POTASSIUM	NE	NE	NE	58400		40900		7490		5000	U
SODIUM	50000	NE	NE	37900		33400		22700		13000	
ZINC	5000	NE	NE	50	U	50	U	50	U	69.2	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-15
Summary of Overburden (Pipechase) Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW8S (UNFIL) 2001/05/23 REG AB34268 WATER µg/L		URSMW8S (UNFIL) 2002/01/10 REG AB49901 WATER µg/L		URSMW8S (FIL) 2002/01/10 REG AB49902 WATER µg/L	
Analyte	µg/L	µg/L	µg/L						
ALUMINUM	200	NE	NE	180	U	180	U	180	U
BARIUM	2000	2000	2000	50	U	69.5		50	U
CALCIUM	NE	NE	NE	17800		27700		28500	
IRON	300	NE	NE	280	U	275	U	275	U
MAGNESIUM	NE	NE	NE	6450		7110		6830	
MANGANESE	50	NE	NE	**169**		40	U	40	U
POTASSIUM	NE	NE	NE	2000	U	2960		2020	
SODIUM	50000	NE	NE	25900		**51500**		19400	
ZINC	5000	NE	NE	110		72.3	R	209	R

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-16
Summary of Overburden (South Drainage Ditch) Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Analysis Type: / Date Collected: / Matrix: / Dilution Factor:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W30S* (UNFIL) 2000/07/05 REG 7038-001-05-1 WATER		B18W30S* (UNFIL) 2000/09/19 DUP 9121-002-06-1 WATER		B18W30S* (UNFIL) 2000/09/19 REG 9121-001-06-1 WATER		B18W30S* (UNFIL) 2000/12/19 REG 12065-003-06-1 WATER	
Analyte	µg/L	µg/L	µg/L	µg/L		µg/L		µg/L		µg/L	
ALUMINUM	200	NE	NE	200	U	52.6		48		**577**	
ARSENIC	8	10	NE	4.75		3.5		3.2	U	3.2	U
BARIUM	2000	2000	2000	147	R	155		165		126	
BERYLLIUM	20	4	4	1	U	0.1	U	0.1	U	0.1	U
CALCIUM	NE	NE	NE	45200		48100		51500		46000	
CHROMIUM	100	100	100	0.873		4.1		6.3		1.4	
COBALT	NE	NE	NE	5	U	1.3		1		0.9	U
COPPER	1000	1300*	1300*	3.13	R	2.7	R	3.8	R	2.8	
IRON	300	NE	NE	**1280**		**1550**	**J**	**1910**	**J**	**1000**	
LEAD	10	15*	15*	3	U	1.8		1.5	U	1.5	U
MAGNESIUM	NE	NE	NE	14700		16100		17200		14900	
MANGANESE	50	NE	NE	**2080**		**2260**		**2420**		**2430**	
NICKEL	100	NE	NE	2.33	R	3		2.7		2.9	
POTASSIUM	NE	NE	NE	1590		1570		1600		1200	
SILVER	NE	NE	NE	3	U	1.1		1.1		0.73	
SODIUM	50000	NE	NE	13400		10900		11600		7220	
VANADIUM	NE	NE	NE	5	U	0.9	U	0.9	U	0.9	U
ZINC	5000	NE	NE	14		4	U	4	U	5.1	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/qualityassurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program.
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-16
Summary of Overburden (South Drainage Ditch) Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Analysis Type: Date Collected: Matrix: Dilution Factor: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	B18W30S* (UNFIL) 2001/03/23 REG 103239-003-06-1/1 WATER µg/L		B18W30S* (UNFIL) 2001/05/25 REG AB34400 WATER µg/L		B18W30S* (UNFIL) 2001/05/25 REG AB34401 WATER µg/L		B18W30S* (UNFIL) 2001/10/04 REG AB43984 WATER µg/L	
ALUMINUM	200	NE	NE	**345**		180	U	180	U	180	UJ
ARSENIC	8	10	NE	4.1	U	7.5	U	7.5	U	7.5	UJ
BARIUM	2000	2000	2000	105		144		121		160	UJ
BERYLLIUM	20	4	4	0.26		15	U	15	U	15	UJ
CALCIUM	NE	NE	NE	36500		51000		44300		47600	UJ
CHROMIUM	100	100	100	1.7		50	U	50	U	50	UJ
COBALT	NE	NE	NE	1.6		20	U	20	U	20	UJ
COPPER	1000	1300*	1300*	4.9	U	50	U	50	U	50	UJ
IRON	300	NE	NE	**1070**		**820**	**J**	**781**	**J**	734	UJ
LEAD	10	15*	15*	1.5	U	8	U	8	U	8	UJ
MAGNESIUM	NE	NE	NE	12300		16300		13900		15300	UJ
MANGANESE	50	NE	NE	**1580**		**2290**		**2000**		2670	UJ
NICKEL	100	NE	NE	2.1		50	U	50	U	50	UJ
POTASSIUM	NE	NE	NE	937		2000	U	2000	U	2000	U
SILVER	NE	NE	NE	1.4	U	20	U	20	U	20	UJ
SODIUM	50000	NE	NE	6040		11900		12200		19100	J
VANADIUM	NE	NE	NE	1.2	U	50	U	50	U	50	UJ
ZINC	5000	NE	NE	12		50	U	114	R	50	UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/qualityassurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program.
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-16
Summary of Overburden (South Drainage Ditch) Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Analysis Type: Date Collected: Matrix: Dilution Factor:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	B18W30S* (UNFIL) 2001/12/17 REG AB48808 WATER		B18W30S* (UNFIL) 2002/04/04 REG 204045-001-06-1/1 WATER		B18W30S* (UNFIL) 2002/10/03 REG 210048-002-019-1/1 WATER		URSHP1 (UNFIL) 2001/04/20 REG AB32161 WATER	
Analyte	µg/L	µg/L	µg/L	µg/L		µg/L		µg/L		µg/L	
ALUMINUM	200	NE	NE	180	U	30.9	R	95.8		**3000**	
ARSENIC	8	10	NE	7.5	U	3.4	U	5.6		7.5	U
BARIUM	2000	2000	2000	163		150		203		197	
BERYLLIUM	20	4	4	15	U	0.2	U	0.1	U	15	U
CALCIUM	NE	NE	NE	50800		51300		54700		85500	
CHROMIUM	100	100	100	50	U	1.3	U	1.3	U	50	U
COBALT	NE	NE	NE	20	U	0.6	U	0.72		20	U
COPPER	1000	1300*	1300*	50	U	1	U	1.4		50	U
IRON	300	NE	NE	**583**		730	R	**758**		**3180**	
LEAD	10	15*	15*	8	U	1.6	U	1.6	U	8	U
MAGNESIUM	NE	NE	NE	16300		16800		17200		16800	
MANGANESE	50	NE	NE	**2930**		**2980**		**3540**		**389**	
NICKEL	100	NE	NE	50	U	2.2		1.2		50	U
POTASSIUM	NE	NE	NE	2000	U	1050		1620		2000	U
SILVER	NE	NE	NE	20	U	0.6	U	0.6	U	20	U
SODIUM	50000	NE	NE	17600		11300		19900		21700	
VANADIUM	NE	NE	NE	50	U	0.7	U	0.7	U	50	U
ZINC	5000	NE	NE	50	U	4	R	5.8		50	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/qualityassurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program.
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-16
Summary of Overburden (South Drainage Ditch) Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Analysis Type: Date Collected: Matrix: Dilution Factor: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSHP2 (UNFIL) 2001/04/23 REG AB32258 WATER µg/L		URSMW12S (UNFIL) 2001/05/22 REG AB34179 WATER µg/L		URSMW12S (UNFIL) 2001/07/05 REG AB37495 WATER µg/L		URSMW12S (UNFIL) 2002/01/04 REG AB49602 WATER µg/L	
ALUMINUM	200	NE	NE	**872**		180	U	180	U	180	U
ARSENIC	8	10	NE	7.5	U	7.5	U	7.5	U	7.5	U
BARIUM	2000	2000	2000	69.9		155		134		89	
BERYLLIUM	20	4	4	15	U	15	U	15	U	15	U
CALCIUM	NE	NE	NE	38700		70300		62100		54100	
CHROMIUM	100	100	100	50	U	50	U	50	U	50	U
COBALT	NE	NE	NE	20	U	20	U	20	U	20	U
COPPER	1000	1300*	1300*	50	U	50	U	50	U	50	U
IRON	300	NE	NE	**965**	**J**	**432**		**448**		**376**	
LEAD	10	15*	15*	8	U	8	U	8	U	8	U
MAGNESIUM	NE	NE	NE	8850		8360		7340		6820	
MANGANESE	50	NE	NE	**393**		**4130**		**3340**		**2250**	
NICKEL	100	NE	NE	50	U	50	U	50	U	50	U
POTASSIUM	NE	NE	NE	2700		3870		2000	U	2000	U
SILVER	NE	NE	NE	20	U	20	U	20	U	20	U
SODIUM	50000	NE	NE	21000		15100		10800	J	11900	
VANADIUM	NE	NE	NE	50	U	50	U	50	U	50	U
ZINC	5000	NE	NE	114		50	U	50	U	50	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/qualityassurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program.
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-16
Summary of Overburden (South Drainage Ditch) Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Analysis Type: Date Collected: Matrix: Dilution Factor: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW13S (UNFIL) 2001/05/24 REG AB34403 WATER µg/L		URSMW13S (FIL) 2001/05/24 REG AB34404 WATER µg/L		URSMW13S (UNFIL) 2001/07/10 REG AB37781 WATER µg/L		URSMW13S (FIL) 2001/07/10 REG AB37782 WATER µg/L	
ALUMINUM	200	NE	NE	180	U	180	U	**433**	**J**	180	UJ
ARSENIC	8	10	NE	7.5	U	7.5	U	7.5	U	7.5	U
BARIUM	2000	2000	2000	141		137		137	J	143	J
BERYLLIUM	20	4	4	15	U	15	U	15	U	15	U
CALCIUM	NE	NE	NE	141000		141000		106000	J	120000	J
CHROMIUM	100	100	100	50	U	50	U	50	U	50	U
COBALT	NE	NE	NE	20	U	20	U	20	U	20	U
COPPER	1000	1300*	1300*	50	U	50	U	50	U	50	U
IRON	300	NE	NE	280	U	280	U	**524**		280	U
LEAD	10	15*	15*	8	U	8	U	8	U	8	U
MAGNESIUM	NE	NE	NE	32700		33200		28100	J	30400	J
MANGANESE	50	NE	NE	**108**		**100**		**791**	**J**	**516**	**J**
NICKEL	100	NE	NE	50	U	50	U	50	U	50	U
POTASSIUM	NE	NE	NE	5700		6170		7560	J	8150	J
SILVER	NE	NE	NE	20	U	20	U	20	U	20	U
SODIUM	50000	NE	NE	32600		34300		38100	J	38400	J
VANADIUM	NE	NE	NE	50	U	50	U	50	UJ	50	UJ
ZINC	5000	NE	NE	50	U	50	U	50	UJ	50	UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/qualityassurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program.
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-16
Summary of Overburden (South Drainage Ditch) Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Analysis Type: Date Collected: Matrix: Dilution Factor:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW13S (UNFIL) 2002/01/09 REG AB49749 WATER		URSMW14S (UNFIL) 2001/05/22 REG AB34178 WATER		URSMW14S (UNFIL) 2001/07/06 REG AB37473 WATER		URSMW14S (FIL) 2001/07/06 REG AB37474 WATER	
Analyte	µg/L	µg/L	µg/L	µg/L		µg/L		µg/L		µg/L	
ALUMINUM	200	NE	NE	**629**		180	U	180	U	180	U
ARSENIC	8	10	NE	7.5	U	7.5	U	7.5	U	7.5	U
BARIUM	2000	2000	2000	139		141		168		133	
BERYLLIUM	20	4	4	15	U	15	U	15	U	15	U
CALCIUM	NE	NE	NE	106000		70200		65000		51200	
CHROMIUM	100	100	100	50	U	50	U	50	U	50	U
COBALT	NE	NE	NE	20	U	20	U	20	U	20	U
COPPER	1000	1300*	1300*	50	U	50	U	50	U	50	U
IRON	300	NE	NE	**1140**		280	U	**1430**		**906**	
LEAD	10	15*	15*	8	U	8	U	8	U	8	U
MAGNESIUM	NE	NE	NE	25500		19000		19000		15000	
MANGANESE	50	NE	NE	**239**		**633**		**1610**		**1280**	
NICKEL	100	NE	NE	50	U	50	U	50	U	50	U
POTASSIUM	NE	NE	NE	5000	U	3410		4710		4200	
SILVER	NE	NE	NE	20	U	20	U	20	U	20	U
SODIUM	50000	NE	NE	26800		30100		40000	J	35100	J
VANADIUM	NE	NE	NE	50	U	50	U	50	U	50	U
ZINC	5000	NE	NE	50	U	50	U	50	U	50	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/qualityassurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program.
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-16
Summary of Overburden (South Drainage Ditch) Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Analysis Type: Date Collected: Matrix: Dilution Factor:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW14S (UNFIL) 2002/01/08 REG AB49707 WATER		URSMW15S (UNFIL) 2001/05/24 REG AB34405 WATER		URSMW15S (FIL) 2001/05/24 REG AB34406 WATER		URSMW15S (UNFIL) 2001/07/11 REG AB37785 WATER	
Analyte	µg/L	µg/L	µg/L	µg/L		µg/L		µg/L		µg/L	
ALUMINUM	200	NE	NE	180	U	180	U	180	U	**394**	
ARSENIC	8	10	NE	7.5	U	7.5	U	7.5	U	7.5	U
BARIUM	2000	2000	2000	117		65.9	J	92.4	J	155	
BERYLLIUM	20	4	4	15	U	15	U	15	U	15	U
CALCIUM	NE	NE	NE	52700		67500	J	90000	J	128000	
CHROMIUM	100	100	100	50	U	50	U	50	U	50	U
COBALT	NE	NE	NE	20	U	20	U	20	U	20	U
COPPER	1000	1300*	1300*	50	U	50	U	50	U	50	U
IRON	300	NE	NE	**397**		280	U	280	U	280	U
LEAD	10	15*	15*	8	U	8	U	8	U	8	U
MAGNESIUM	NE	NE	NE	14600		13100	J	17800	J	28700	
MANGANESE	50	NE	NE	**733**		40	R	96.5	R	**177**	
NICKEL	100	NE	NE	50	U	50	U	50	U	50	U
POTASSIUM	NE	NE	NE	5000	U	4450	J	6100	J	9050	
SILVER	NE	NE	NE	20	U	20	U	20	U	20	U
SODIUM	50000	NE	NE	23100		16800	J	23100	J	**76400**	
VANADIUM	NE	NE	NE	50	U	50	U	50	U	50	U
ZINC	5000	NE	NE	50	U	50	U	50	U	51.7	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/qualityassurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program.
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-16
Summary of Overburden (South Drainage Ditch) Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Analysis Type: Date Collected: Matrix: Dilution Factor: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW15S (UNFIL) 2002/01/07 REG AB49644 WATER µg/L		URSMW16S (UNFIL) 2001/05/21 DUP AB34098 WATER µg/L		URSMW16S (UNFIL) 2001/05/21 REG AB34096 WATER µg/L		URSMW16S (UNFIL) 2001/07/05 REG AB37493 WATER µg/L	
ALUMINUM	200	NE	NE	180	U	180	U	180	U	180	U
ARSENIC	8	10	NE	7.5	U	7.5	U	7.5	U	7.5	U
BARIUM	2000	2000	2000	84.2		121	J	125	J	128	J
BERYLLIUM	20	4	4	15	U	15	U	15	U	15	U
CALCIUM	NE	NE	NE	70700		48600		50200		45200	J
CHROMIUM	100	100	100	50	U	50	U	50	U	50	U
COBALT	NE	NE	NE	20	U	20	U	20	U	20	U
COPPER	1000	1300*	1300*	50	U	50	U	50	U	50	U
IRON	300	NE	NE	275	U	**860**		**874**		**942**	
LEAD	10	15*	15*	8	U	8	U	8	U	8	U
MAGNESIUM	NE	NE	NE	15300		14800		15300		14300	J
MANGANESE	50	NE	NE	**157**		**2760**		**2840**		**2310**	**J**
NICKEL	100	NE	NE	50	U	50	U	50	U	50	U
POTASSIUM	NE	NE	NE	5000	U	2000	U	2000	U	2000	U
SILVER	NE	NE	NE	20	U	20	U	20	U	20	U
SODIUM	50000	NE	NE	16400		15900		16300		10300	J
VANADIUM	NE	NE	NE	50	U	50	U	50	U	50	U
ZINC	5000	NE	NE	50	U	50	U	50	U	50	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/qualityassurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program.
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-16
Summary of Overburden (South Drainage Ditch) Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Analysis Type: Date Collected: Matrix: Dilution Factor:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW16S (FIL) 2001/07/05 REG AB37494 WATER		URSMW16S (UNFIL) 2002/01/03 REG AB49495 WATER		URSMW17S (UNFIL) 2001/05/21 REG AB34099 WATER		URSMW17S (UNFIL) 2001/07/09 REG AB37721 WATER	
Analyte	µg/L	µg/L	µg/L	µg/L		µg/L		µg/L		µg/L	
ALUMINUM	200	NE	NE	180	U	180	U	180	U	180	UJ
ARSENIC	8	10	NE	7.5	U	7.5	U	7.5	U	7.5	U
BARIUM	2000	2000	2000	146	J	115		96	J	96.8	J
BERYLLIUM	20	4	4	15	U	15	U	15	U	15	U
CALCIUM	NE	NE	NE	52500	J	48900		19600		19200	J
CHROMIUM	100	100	100	50	U	50	U	50	U	50	U
COBALT	NE	NE	NE	20	U	20	U	20	U	20	U
COPPER	1000	1300*	1300*	50	U	50	U	50	U	50	U
IRON	300	NE	NE	**955**		**1900**		280	U	280	U
LEAD	10	15*	15*	8	U	8	U	8	U	8	U
MAGNESIUM	NE	NE	NE	16600	J	15800		18100		17300	J
MANGANESE	50	NE	NE	**2670**	**J**	**2990**		**604**		**575**	**J**
NICKEL	100	NE	NE	50	U	50	U	50	U	50	U
POTASSIUM	NE	NE	NE	2000	U	2000	U	2560		2960	
SILVER	NE	NE	NE	20	U	20	U	20	U	20	U
SODIUM	50000	NE	NE	11100	J	19400		35500		37100	
VANADIUM	NE	NE	NE	50	U	50	U	50	U	50	U
ZINC	5000	NE	NE	50	U	50	U	50	U	50	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/qualityassurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program.
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-16
Summary of Overburden (South Drainage Ditch) Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Analysis Type: Date Collected: Matrix: Dilution Factor:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW17S (FIL) 2001/07/09 REG AB37722 WATER		URSMW17S (UNFIL) 2002/01/04 REG AB49629 WATER		URSMW17S (FIL) 2002/01/04 REG AB49630 WATER		URSMW17S (UNFIL) 2002/03/25 REG 203126-001-03-1/1 WATER	
Analyte	µg/L	µg/L	µg/L	µg/L		µg/L		µg/L		µg/L	
ALUMINUM	200	NE	NE	180	UJ	180	R	764	R	**288**	
ARSENIC	8	10	NE	7.5	U	7.5	U	7.5	U	4.1	U
BARIUM	2000	2000	2000	95.1	J	61.9		72		81.6	
BERYLLIUM	20	4	4	15	U	15	U	15	U	0.2	U
CALCIUM	NE	NE	NE	19200	J	10400		9110		13700	
CHROMIUM	100	100	100	50	U	50	U	50	U	0.9	U
COBALT	NE	NE	NE	20	U	20	U	20	U	0.8	U
COPPER	1000	1300*	1300*	50	U	50	U	50	U	4.9	U
IRON	300	NE	NE	280	U	275	R	1080	R	**321**	
LEAD	10	15*	15*	8	U	8	U	8	U	1.5	U
MAGNESIUM	NE	NE	NE	16400	J	14200		13000		15400	
MANGANESE	50	NE	NE	**559**	**J**	**401**		**422**		**460**	
NICKEL	100	NE	NE	50	U	50	U	50	U	4.8	
POTASSIUM	NE	NE	NE	3030	J	2000	U	2000	U	1220	
SILVER	NE	NE	NE	20	U	20	U	20	U	1.4	U
SODIUM	50000	NE	NE	34000	J	38000		34000		32800	
VANADIUM	NE	NE	NE	50	U	50	U	50	U	1.2	U
ZINC	5000	NE	NE	50	U	50	U	50	U	7.8	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/qualityassurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program.
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-16
Summary of Overburden (South Drainage Ditch) Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Analysis Type: Date Collected: Matrix: Dilution Factor: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW18S (UNFIL) 2001/05/17 REG AB33851 WATER µg/L		URSMW18S (FIL) 2001/05/17 REG AB33852 WATER µg/L		URSMW18S (UNFIL) 2001/07/03 DUP AB37376 WATER µg/L		URSMW18S (UNFIL) 2001/07/03 REG AB37373 WATER µg/L	
ALUMINUM	200	NE	NE	**379**		180	U	180	U	180	U
ARSENIC	8	10	NE	7.5	U	7.5	U	7.5	U	7.5	U
BARIUM	2000	2000	2000	50	U	50	U	50	U	50	U
BERYLLIUM	20	4	4	15	U	15	U	15	U	15	U
CALCIUM	NE	NE	NE	21100		24000		18000		20400	
CHROMIUM	100	100	100	50	U	50	U	50	U	50	U
COBALT	NE	NE	NE	20	U	20	U	20	U	20	U
COPPER	1000	1300*	1300*	50	U	50	U	50	U	50	U
IRON	300	NE	NE	**538**	**J**	280	UJ	280	U	280	U
LEAD	10	15*	15*	8	U	8	U	8	U	8	U
MAGNESIUM	NE	NE	NE	12200	J	13700	J	10000		11400	
MANGANESE	50	NE	NE	40	U	40	U	**158**		**140**	
NICKEL	100	NE	NE	50	U	50	U	50	U	50	U
POTASSIUM	NE	NE	NE	2000	U	2000	U	2000	U	2000	U
SILVER	NE	NE	NE	20	U	20	U	20	U	20	U
SODIUM	50000	NE	NE	23100	J	26300	J	29700	J	31000	J
VANADIUM	NE	NE	NE	50	U	50	U	50	U	50	U
ZINC	5000	NE	NE	50	U	50	U	50	U	50	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/qualityassurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program.
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-16
Summary of Overburden (South Drainage Ditch) Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Analysis Type: Date Collected: Matrix: Dilution Factor:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW18S (UNFIL) 2002/01/04 REG AB49627 WATER		URSMW18S (FIL) 2002/01/04 REG AB49628 WATER		URSMW18S (UNFIL) 2002/03/25 REG 203126-003-03-1/1 WATER	
Analyte	µg/L	µg/L	µg/L	µg/L		µg/L		µg/L	
ALUMINUM	200	NE	NE	**77700**		180	U	75.9	
ARSENIC	8	10	NE	**11.9**		7.5	U	4.1	U
BARIUM	2000	2000	2000	732		50	U	21.6	
BERYLLIUM	20	4	4	15	U	15	U	0.2	U
CALCIUM	NE	NE	NE	32400		17300		13700	
CHROMIUM	100	100	100	**130**		50	U	0.9	U
COBALT	NE	NE	NE	111		20	U	0.8	U
COPPER	1000	1300*	1300*	71.5		50	U	4.9	U
IRON	300	NE	NE	**103000**	**J**	275	U	40.3	
LEAD	10	15*	15*	**77.5**		8	U	1.5	U
MAGNESIUM	NE	NE	NE	59600		8930		7610	
MANGANESE	50	NE	NE	**5000**		40	U	**54.3**	
NICKEL	100	NE	NE	**193**		50	U	1.1	U
POTASSIUM	NE	NE	NE	19000		2000	U	688	
SILVER	NE	NE	NE	20	U	20	U	1.4	U
SODIUM	50000	NE	NE	31000		27000		27100	
VANADIUM	NE	NE	NE	193		50	U	1.2	U
ZINC	5000	NE	NE	488		50	U	5.6	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/qualityassurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program.
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	B18W24S* 2000/06/29 REG WATER pCi/L		B18W24S* 2000/09/19 REG WATER pCi/L		B18W24S* 2000/12/19 REG WATER pCi/L		B18W24S* 2001/03/23 REG WATER pCi/L		B18W24S* 2001/05/25 REG WATER pCi/L	
Analyte	pCi/L	pCi/L										
ACTINIUM-228	NE	NE	-3.92+/-26.35	U	NA		NA		NA		NA	
BISMUTH-212	NE	NE	-45.56+/-55.93	U	NA		NA		NA		NA	
BISMUTH-214	NE	NE	-7.44+/-14.09	U	NA		NA		NA		NA	
GROSS ALPHA	NE	NE	145.67+/-6.92		241+/-8.78	J	101+/-3.12	J	254+/-6.17		530+/-10.9	
GROSS BETA	NE	NE	101.44+/-3.36		194+/-4.64		34.8+/-1.3		72.1+/-2.71		155+/-3.99	
LEAD-212	NE	NE	-0.08+/-10.36	U	NA		NA		NA		NA	
LEAD-214	NE	NE	7.59+/-23.75	U	NA		NA		NA		NA	
NET ALPHA	15	15	-41.46		-131.56	J	-25.88	J	**19.13**		-1.9	
PROTACTINIUM-234M	NE	NE	-748.3+/-791	U	NA		NA		NA		NA	
RADIUM-226	NE	NE	0.11+/-0.23	J	4.5+/-0.919		0.645+/-0.338		2.25+/-0.589	J	1.97+/-0.735	J
RADIUM-226+228	5	5	NA		**5.145**		1.505		2.7445	J	2.2985	J
RADIUM-228	NE	NE	NA		1.29+/-0.646	U	1.72+/-0.995	U	0.989+/-0.468	U	0.657+/-0.537	U
THALLIUM-208	NE	NE	5.27+/-19.15	U	NA		NA		NA		NA	
THORIUM-228	NE	NE	0.2+/-0.21	U	0.388+/-0.241	U	0.265+/-0.125	U	1.21+/-0.475		0.0201+/-0.0652	U
THORIUM-230	NE	NE	0.25+/-0.23	J	0.637+/-0.331	U	0.0913+/-0.0348	U	0.247+/-0.179		0.0934+/-0.0576	
THORIUM-232	NE	NE	0.2+/-0.2	U	0.236+/-0.117	U	0.066+/-0.0235	U	0.176+/-0.101	U	0.0147+/-0.0171	
THORIUM-234	NE	NE	16.51+/-86.93	U	NA		NA		NA		NA	
TOTAL URANIUM (µg/L)	30	30	**317.55+/-12.31**		**548+/-79.4**		**186+/-28.4**		**351+/-71.7**		**761+/-168**	
URANIUM-233/234	NE	NE	90+/-19.77		182+/-26.5		61.8+/-9.5		112+/-23.1		261+/-57.9	
URANIUM-235/236	NE	NE	3.59+/-1.29		7.56+/-2.13		3.18+/-0.803		5.87+/-1.92		17.9+/-4.99	
URANIUM-238	NE	NE	93.54+/-20.53		183+/-26.7		61.9+/-9.53		117+/-24.1		253+/-56.4	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit: Analyte	New Jersey State Primary Drinking Water Standards MCL pCi/L	USEPA Safe Drinking Water Act MCL pCi/L	B18W24S* 2001/10/03 REG WATER pCi/L	B18W24S* 2001/12/12 REG WATER pCi/L	B18W24S* 2002/04/01 REG WATER pCi/L	B18W24S* 2002/10/01 REG WATER pCi/L	B18W25S* 2000/06/27 DUP WATER pCi/L	B18W25S* 2000/06/27 REG WATER pCi/L
ACTINIUM-228	NE	NE	NA	NA	NA		10.13+/-28.58 U	9.92+/-24.67 U
BISMUTH-212	NE	NE	NA	NA	NA		27.2+/-47.65 U	58.88+/-55.97 J
BISMUTH-214	NE	NE	NA	NA	NA		-15.02+/-11.36 U	-4.59+/-11.36 U
GROSS ALPHA	NE	NE	160+/-5.73	186+/-4.46	289+/-14.6	303+/-17	56.14+/-5.41	38.55+/-4.47
GROSS BETA	NE	NE	74+/-2.11	49+/-1.72	107+/-6.43	97.2+/-5.85	40.84+/-2.56	20.94+/-1.84
LEAD-212	NE	NE	NA	NA	NA		-4.66+/-7.65 U	3.87+/-13.04 U
LEAD-214	NE	NE	NA	NA	NA		-9.25+/-11.55 U	-2.5+/-11.83 U
NET ALPHA	15	15	-17.02	**52.95**	**24.97**	68.8	-12.3	-27.32
PROTACTINIUM-234M	NE	NE	NA	NA	NA		528.7+/-904.4 U	-570.5+/-677.9 U
RADIUM-226	NE	NE	1.18+/-0.512 J	1.59+/-0.469 J	0.705+/-0.315	0.561+/-0.311	0.48+/-0.3 R	2.12+/-0.58 J
RADIUM-226+228	5	5	1.5225 J	1.754 J	1.009 J	0.931 J	NA	NA
RADIUM-228	NE	NE	0.685+/-0.437 U	0.328+/-0.429 U	0.304+/-0.362 J	0.37+/-0.593 J	NA	NA
THALLIUM-208	NE	NE	NA	NA	NA		6.16+/-15.69 U	-8.01+/-18.03 U
THORIUM-228	NE	NE	-0.0617+/-0.163 U	0.0921+/-0.234 U	0.419+/-0.218	0.0549+/-0.134 J	0.1+/-0.14 U	0.03+/-0.08 U
THORIUM-230	NE	NE	0.123+/-0.122 U	0.289+/-0.185	0.664+/-0.246 R	0.123+/-0.0959 UJ	0.65+/-0.38 J	0.62+/-0.34 J
THORIUM-232	NE	NE	0.0698+/-0.0945 U	0.0495+/-0.132 U	0.175+/-0.13	0.0921+/-0.084 UJ	0.18+/-0.2 U	0.14+/-0.16 U
THORIUM-234	NE	NE	NA	NA	NA		37.22+/-83.68 U	17.48+/-85.23 U
TOTAL URANIUM (µg/L)	30	30	**256+/-38.7**	**192+/-26.2**	**396+/-52.4**	**329+/-58.9**	**127.22+/-4.93**	**113.92+/-4.44**
URANIUM-233/234	NE	NE	86.6+/-13.2	65.7+/-9.04	124+/-16.6	114+/-20.7	33.55+/-7.3	31.61+/-6.45
URANIUM-235/236	NE	NE	5.22+/-1.42	3.45+/-0.927	8.03+/-1.94	11.2+/-2.64	1.26+/-0.63	1.26+/-0.56
URANIUM-238	NE	NE	85.2+/-13	63.9+/-8.81	132+/-17.6	109+/-19.8	33.63+/-7.32	33+/-6.71

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit: Analyte	New Jersey State Primary Drinking Water Standards MCL pCi/L	USEPA Safe Drinking Water Act MCL pCi/L	B18W25S* 2000/09/18 REG WATER pCi/L		B18W25S* 2000/12/18 DUP WATER pCi/L		B18W25S* 2000/12/18 REG WATER pCi/L		B18W25S* 2001/03/22 REG WATER pCi/L		B18W25S* 2001/05/24 REG WATER pCi/L	
ACTINIUM-228	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-212	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-214	NE	NE	NA		NA		NA		NA		NA	
GROSS ALPHA	NE	NE	49.9+/-4.02	J	23.2+/-1.49	J	51.2+/-2.37	J	36.9+/-2.4		61.5+/-3.29	J
GROSS BETA	NE	NE	38.8+/-2.23		9.88+/-0.909		13.2+/-0.944		15.7+/-1.7		30.4+/-1.82	
LEAD-212	NE	NE	NA		NA		NA		NA		NA	
LEAD-214	NE	NE	NA		NA		NA		NA		NA	
NET ALPHA	15	15	-21.92	J	-23.46	J	-2.36	J	3.912		1.48	J
PROTACTINIUM-234M	NE	NE	NA		NA		NA		NA		NA	
RADIUM-226	NE	NE	0.771+/-0.5		0.799+/-0.384	U	0.688+/-0.302	U	0.924+/-0.444	J	0.876+/-0.576	J
RADIUM-226+228	5	5	1.321		0.865	U	1.064	U	1.293	J	1.367	J
RADIUM-228	NE	NE	1.1+/-0.462	U	0.931+/-0.538	U	1.44+/-0.869	U	0.738+/-0.34	U	0.982+/-0.697	U
THALLIUM-208	NE	NE	NA		NA		NA		NA		NA	
THORIUM-228	NE	NE	0.822+/-0.409	U	0.179+/-0.0847	U	0.393+/-0.188	U	2.11+/-0.672		0.0386+/-0.049	U
THORIUM-230	NE	NE	0.332+/-0.23	U	0.0606+/-0.0297	U	0.143+/-0.0424	U	1.23+/-0.447		0.0627+/-0.0594	U
THORIUM-232	NE	NE	0.203+/-0.164	U	0.0237+/-2	U	0.114+/-0.0472	U	0.822+/-0.342		0.00392+/-0.0244	U
THORIUM-234	NE	NE	NA		NA		NA		NA		NA	
TOTAL URANIUM (µg/L)	30	30	**106+/-15.4**		**66.2+/-90.7**		**76.7+/-10.5**		**47.7+/-7.41**		**89.6+/-12.5**	
URANIUM-233/234	NE	NE	35.3+/-5.17		23.5+/-3.22		26.3+/-3.63		16.3+/-2.53		28.8+/-4.06	
URANIUM-235/236	NE	NE	1.02+/-0.538		1.06+/-0.318		1.76+/-0.444		0.788+/-0.326		1.32+/-0.419	
URANIUM-238	NE	NE	35.5+/-5.19		22.1+/-3.05		25.5+/-3.54		15.9+/-2.49		29.9+/-4.2	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Date Collected: / Analysis Type: / Matrix: / Unit:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	B18W25S* 2001/10/02 DUP WATER pCi/L		B18W25S* 2001/10/02 REG WATER pCi/L		B18W25S* 2001/12/11 DUP WATER pCi/L		B18W25S* 2001/12/11 REG WATER pCi/L		B18W25S* 2002/03/28 DUP WATER pCi/L	
Analyte	pCi/L	pCi/L										
ACTINIUM-228	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-212	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-214	NE	NE	NA		NA		NA		NA		NA	
GROSS ALPHA	NE	NE	74+/-3.66		96+/-4.06		23.9+/-1.48		23+/-4.14		50.8+/-6.41	
GROSS BETA	NE	NE	48.2+/-1.7		49.5+/-1.71		11.9+/-0.906		11.3+/-2.59		32.2+/-3.82	
LEAD-212	NE	NE	NA		NA		NA		NA		NA	
LEAD-214	NE	NE	NA		NA		NA		NA		NA	
NET ALPHA	15	15	-8.77		**15.11**		4.546		4.149	J	3.15	
PROTACTINIUM-234M	NE	NE	NA		NA		NA		NA		NA	
RADIUM-226	NE	NE	0.925+/-0.477	J	0.814+/-0.434	J	0.781+/-0.363	J	0.666+/-0.298	J	-0.156+/-0.187	U
RADIUM-226+228	5	5	1.0785	J	0.8292	J	1.1775	J	0.853	J	-0.04395	U
RADIUM-228	NE	NE	0.307+/-0.375	U	0.0304+/-0.395	U	0.793+/-0.495	U	0.374+/-0.719	U	0.0681+/-0.384	U
THALLIUM-208	NE	NE	NA		NA		NA		NA		NA	
THORIUM-228	NE	NE	0.0815+/-0.163	U	0.0304+/-0.181	U	0.0621+/-0.166	U	0.0816+/-0.159	U	0.487+/-0.292	
THORIUM-230	NE	NE	0.0904+/-0.0918		0.0742+/-0.111	U	0+/-2.01	U	0.102+/-0.136	U	0.818+/-0.326	R
THORIUM-232	NE	NE	-0.00814+/-0.0163	U	0.0297+/-0.0698	U	0.00825+/-0.0661	U	-0.0412+/-0.042	U	0.097+/-0.0979	
THORIUM-234	NE	NE	NA		NA		NA		NA		NA	
TOTAL URANIUM (µg/L)	30	30	**118+/-15.9**		**118+/-15.4**		26.7+/-4.55		25.8+/-4.46		**69.6+/-10.9**	
URANIUM-233/234	NE	NE	41.5+/-5.6		39.8+/-5.25		9.78+/-1.65		9.96+/-1.67		22.6+/-3.6	
URANIUM-235/236	NE	NE	1.87+/-0.586		1.79+/-0.551		0.724+/-0.339		0.271+/-0.208	J	1.95+/-0.764	
URANIUM-238	NE	NE	39.4+/-5.34		39.3+/-5.19		8.85+/-1.53		8.62+/-1.5		23.1+/-3.66	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit: Analyte	New Jersey State Primary Drinking Water Standards MCL pCi/L	USEPA Safe Drinking Water Act MCL pCi/L	B18W25S* 2002/03/28 REG WATER pCi/L		B18W25S* 2002/09/30 DUP WATER pCi/L		B18W25S* 2002/09/30 REG WATER pCi/L		B18W26S* 2000/06/28 REG WATER pCi/L		B18W26S* 2000/09/21 REG WATER pCi/L	
ACTINIUM-228	NE	NE	NA		NA		NA		-20.55+/-21.94	U	NA	
BISMUTH-212	NE	NE	NA		NA		NA		33.73+/-37.6	U	NA	
BISMUTH-214	NE	NE	NA		NA		NA		-11.28+/-11.2	U	NA	
GROSS ALPHA	NE	NE	36.7+/-4.48		160+/-12		172+/-13		6.37+/-1.8		3.3+/-1.01	
GROSS BETA	NE	NE	30.5+/-3.07		56+/-4.43		53.8+/-4.37		10.66+/-1.49		6.63+/-1.35	
LEAD-212	NE	NE	NA		NA		NA		3.9+/-9.89	U	NA	
LEAD-214	NE	NE	NA		NA		NA		-17.8+/-12.05	U	NA	
NET ALPHA	15	15	-9.12		14.71		**31.66**		0.58		1.413	
PROTACTINIUM-234M	NE	NE	NA		NA		NA		519.5+/-1021	U	NA	
RADIUM-226	NE	NE	0.183+/-0.238	J	0.211+/-0.164		0.275+/-0.202		2.37+/-0.66		0.977+/-0.621	U
RADIUM-226+228	5	5	0.2651	J	0.1205		1.101	J	NA		1.6485	
RADIUM-228	NE	NE	0.0821+/-0.466	J	-0.181+/-0.536	U	0.826+/-0.496	J	NA		1.16+/-0.602	
THALLIUM-208	NE	NE	NA		NA		NA		-4.52+/-16	U	NA	
THORIUM-228	NE	NE	0.836+/-0.403		0.16+/-0.191	U	0.123+/-0.197	J	0.11+/-0.18	U	0.211+/-0.0885	U
THORIUM-230	NE	NE	0.259+/-0.16	J	0.111+/-0.138	U	0.333+/-0.17	J	0.5+/-0.33	J	0.0643+/-0.0533	J
THORIUM-232	NE	NE	-0.0104+/-0.0673	U	0.037+/-0.07	U	0.0788+/-0.0817	UJ	0.09+/-0.15	U	0.0676+/-0.0323	U
THORIUM-234	NE	NE	NA		NA		NA		34.58+/-110.5	U	NA	
TOTAL URANIUM (µg/L)	30	30	**64+/-10.1**		**210+/-34.5**		**204+/-30.6**		8.27+/-0.27		2.42+/-0.944	
URANIUM-233/234	NE	NE	23.1+/-3.62		68.1+/-11.4		68.2+/-10.4		3.25+/-1.02		0.963+/-0.349	
URANIUM-235/236	NE	NE	1.42+/-0.641		7.99+/-1.82		4.24+/-1.04		0.12+/-0.17	U	0.232+/-0.0989	U
URANIUM-238	NE	NE	21.3+/-3.4		69.2+/-11.6		67.9+/-10.3		2.48+/-0.85		0.808+/-0.317	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Date Collected: / Analysis Type: / Matrix: / Unit: / Analyte	New Jersey State Primary Drinking Water Standards MCL pCi/L	USEPA Safe Drinking Water Act MCL pCi/L	B18W26S* 2000/12/21 REG WATER pCi/L		B18W26S* 2001/03/22 REG WATER pCi/L		B18W26S* 2001/05/25 DUP WATER pCi/L		B18W26S* 2001/05/25 REG WATER pCi/L		B18W26S* 2001/10/03 REG WATER pCi/L	
ACTINIUM-228	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-212	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-214	NE	NE	NA		NA		NA		NA		NA	
GROSS ALPHA	NE	NE	3.96+/-0.69	J	4.55+/-0.771		3.93+/-1.05		6.19+/-1.17		1.65+/-0.838	
GROSS BETA	NE	NE	4.57+/-0.84		3.6+/-0.825		7.25+/-1.06		7.11+/-1.13		5.44+/-0.678	
LEAD-212	NE	NE	NA		NA		NA		NA		NA	
LEAD-214	NE	NE	NA		NA		NA		NA		NA	
NET ALPHA	15	15	-0.248	J	-0.186		7.50E-02		2.7045		0.20585	J
PROTACTINIUM-234M	NE	NE	NA		NA		NA		NA		NA	
RADIUM-226	NE	NE	0.583+/-0.371	U	0.676+/-0.37	J	0.767+/-0.56	U	0.319+/-0.331	U	1.23+/-0.558	J
RADIUM-226+228	5	5	1.1265	U	1.271	J	0.651	U	0.448	U	1.463	J
RADIUM-228	NE	NE	1.67+/-0.983	U	1.19+/-0.71	U	0.535+/-0.477	U	0.577+/-0.449	U	0.466+/-0.335	U
THALLIUM-208	NE	NE	NA		NA		NA		NA		NA	
THORIUM-228	NE	NE	0.335+/-0.155	U	0.808+/-0.334		0.00524+/-0.0378	U	0.0303+/-0.0406	U	0.00879+/-0.184	U
THORIUM-230	NE	NE	0.165+/-0.0923	U	0.134+/-0.0993	U	0.0973+/-0.0485		0.0791+/-0.0551		0.0764+/-0.102	U
THORIUM-232	NE	NE	0.135+/-0.0481	U	0.0645+/-0.0432	U	0.00512+/-0.0271	U	0.0247+/-0.0298	U	-0.00944+/-0.0529	U
THORIUM-234	NE	NE	NA		NA		NA		NA		NA	
TOTAL URANIUM (µg/L)	30	30	5.87+/-1.31		6.85+/-1.58		5.52+/-1.38		4.99+/-1.29		2.53+/-1.06	
URANIUM-233/234	NE	NE	2.12+/-0.467		2.37+/-0.546		1.96+/-0.486		1.77+/-0.452		0.564+/-0.29	J
URANIUM-235/236	NE	NE	0.138+/-0.103		0.172+/-0.123	U	0.11+/-0.104	U	0.111+/-0.111	U	0.0863+/-0.121	U
URANIUM-238	NE	NE	1.95+/-0.441		2.28+/-0.53		1.84+/-0.465		1.66+/-0.432		0.837+/-0.356	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Date Collected: / Analysis Type: / Matrix: / Unit:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	B18W26S* 2001/12/13 REG WATER pCi/L		B18W26S* 2002/04/03 REG WATER pCi/L		B18W26S* 2002/09/24 REG WATER pCi/L		B18W27S* 2000/06/28 REG WATER pCi/L		B18W27S* 2000/09/20 REG WATER pCi/L	
Analyte	pCi/L	pCi/L										
ACTINIUM-228	NE	NE	NA		NA		NA		1.93+/-27.06	U	NA	
BISMUTH-212	NE	NE	NA		NA		NA		-7.96+/-51.06	U	NA	
BISMUTH-214	NE	NE	NA		NA		NA		-16.33+/-14.55	U	NA	
GROSS ALPHA	NE	NE	2.44+/-0.579		1.66+/-0.57		4.37+/-1.85		0.25+/-1.65	J	1.01+/-0.557	U
GROSS BETA	NE	NE	4.59+/-0.798		4.4+/-0.905		6.08+/-1.37		5.73+/-1.55		3.85+/-1.23	
LEAD-212	NE	NE	NA		NA		NA		-7.12+/-22.72	U	NA	
LEAD-214	NE	NE	NA		NA		NA		-5.32+/-17.42	U	NA	
NET ALPHA	15	15	1.47147		-0.207	J	3.2321	J	-1.07	J	0.7045	U
PROTACTINIUM-234M	NE	NE	NA		NA		NA		136.2+/-934.9	U	NA	
RADIUM-226	NE	NE	0.665+/-0.346	J	0.665+/-0.451		1.34+/-0.486		0.74+/-0.42	J	0.965+/-0.683	U
RADIUM-226+228	5	5	0.8245	J	1.114	J	2.061	J	NA		0.975	U
RADIUM-228	NE	NE	0.319+/-0.743	U	0.449+/-0.342	J	0.721+/-0.556	J	NA		0.985+/-0.472	U
THALLIUM-208	NE	NE	NA		NA		NA		6.75+/-24.89	U	NA	
THORIUM-228	NE	NE	0.0298+/-0.0702	U	0.236+/-0.179	UJ	0.173+/-0.291	J	0.26+/-0.28	U	0.116+/-0.0611	U
THORIUM-230	NE	NE	0.0904+/-0.0917		0.23+/-0.152	R	-0.00475+/-0.153	J	0.67+/-0.41	J	0.122+/-0.0721	J
THORIUM-232	NE	NE	-0.0163+/-0.0232	U	0.0255+/-0.0632	J	-0.038+/-0.0392	J	0.09+/-0.15	U	0.0777+/-0.0249	U
THORIUM-234	NE	NE	NA		NA		NA		167+/-130.9	J	NA	
TOTAL URANIUM (µg/L)	30	30	1.41+/-0.789		1.98+/-1.24		2.3+/-1.07		0.27+/-0.02		0.51+/-0.386	U
URANIUM-233/234	NE	NE	0.496+/-0.286		1.09+/-0.56		0.392+/-0.265		0.75+/-0.51	J	0.221+/-0.094	U
URANIUM-235/236	NE	NE	-0.00694+/-0.0788	U	0.326+/-0.31	UJ	-0.0341+/-0.0344	J	0.24+/-0.3	U	0.222+/-0.0943	U
URANIUM-238	NE	NE	0.476+/-0.265		0.614+/-0.415		0.78+/-0.358		0.45+/-0.38	J	0.168+/-0.129	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit: Analyte	New Jersey State Primary Drinking Water Standards MCL pCi/L	USEPA Safe Drinking Water Act MCL pCi/L	B18W27S* 2000/12/21 REG WATER pCi/L		B18W27S* 2001/03/21 DUP WATER pCi/L		B18W27S* 2001/03/21 REG WATER pCi/L		B18W27S* 2001/05/30 REG WATER pCi/L		B18W27S* 2001/10/04 REG WATER pCi/L	
ACTINIUM-228	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-212	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-214	NE	NE	NA		NA		NA		NA		NA	
GROSS ALPHA	NE	NE	1.09+/-0.591	U	3.39+/-0.637		3.59+/-0.673		-0.155+/-0.392	U	0.122+/-0.575	U
GROSS BETA	NE	NE	3.76+/-1.39		3.1+/-0.886		3.24+/-0.958		3.72+/-0.92		4.32+/-0.604	
LEAD-212	NE	NE	NA		NA		NA		NA		NA	
LEAD-214	NE	NE	NA		NA		NA		NA		NA	
NET ALPHA	15	15	0.875	U	0.143		0.1915		-0.27645	U	0.15695	U
PROTACTINIUM-234M	NE	NE	NA		NA		NA		NA		NA	
RADIUM-226	NE	NE	1.3+/-0.76		2.18+/-0.625	J	0.538+/-0.352	J	0.997+/-0.593	J	0.598+/-0.349	J
RADIUM-226+228	5	5	1.95		2.6135	J	0.7885	J	1.286	J	1.365	J
RADIUM-228	NE	NE	1.3+/-0.773	U	0.867+/-0.414	U	0.501+/-0.237	U	0.578+/-0.429	U	0.767+/-0.444	
THALLIUM-208	NE	NE	NA		NA		NA		NA		NA	
THORIUM-228	NE	NE	0.571+/-0.307	U	1.07+/-0.386		0.8+/-0.33		-0.0331+/-0.0645	U	0.152+/-0.209	U
THORIUM-230	NE	NE	0.251+/-0.136	U	0.132+/-0.0449	U	0.135+/-0.0775	U	0.065+/-0.0441		0.0329+/-0.0775	U
THORIUM-232	NE	NE	0.167+/-2.01	U	0.0637+/-0.0747		0.115+/-0.0105	U	0+/-2	UJ	0.0072+/-0.0577	U
THORIUM-234	NE	NE	NA		NA		NA		NA		NA	
TOTAL URANIUM (µg/L)	30	30	0.402+/-0.139	U	4.63+/-1.21		4.58+/-1.22		0.219+/-0.252	U	-0.055+/-0.077	U
URANIUM-233/234	NE	NE	0.148+/-0.0763	U	1.57+/-0.415		1.78+/-0.449		0.089+/-0.108	U	-0.039+/-0.083	U
URANIUM-235/236	NE	NE	0.149+/-0.0765	U	0.274+/-0.142	U	0.177+/-0.0906	U	0.0949+/-0.108	U	-0.0148+/-0.0783	U
URANIUM-238	NE	NE	0.133+/-0.0451	U	1.54+/-0.407		1.53+/-0.409		0.059+/-0.0829	U	-0.0161+/-0.0229	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit: Analyte	New Jersey State Primary Drinking Water Standards MCL pCi/L	USEPA Safe Drinking Water Act MCL pCi/L	B18W27S* 2001/12/13 REG WATER pCi/L		B18W27S* 2002/04/03 REG WATER pCi/L		B18W27S* 2002/09/25 REG WATER pCi/L		B18W28S* 2000/06/30 REG WATER pCi/L		B18W28S* 2000/09/21 REG WATER pCi/L	
ACTINIUM-228	NE	NE	NA		NA		NA		27.52+/-17.32	J	NA	
BISMUTH-212	NE	NE	NA		NA		NA		-15.36+/-35.69	U	NA	
BISMUTH-214	NE	NE	NA		NA		NA		-8.42+/-11.29	U	NA	
GROSS ALPHA	NE	NE	1.8+/-0.668	J	-0.204+/-0.546	U	0.208+/-0.488	J	8.1+/-2.2		45.3+/-2.82	
GROSS BETA	NE	NE	4.8+/-0.906		4.37+/-0.89		3.55+/-0.711		6.85+/-1.56		32.7+/-1.89	
LEAD-212	NE	NE	NA		NA		NA		6.68+/-10.8	U	NA	
LEAD-214	NE	NE	NA		NA		NA		-6.46+/-11.6	U	NA	
NET ALPHA	15	15	1.1264	J	-0.9861	J	-0.4709	J	2.1	J	**24.237**	
PROTACTINIUM-234M	NE	NE	NA		NA		NA		225.7+/-917	U	NA	
RADIUM-226	NE	NE	0.612+/-0.308	J	0.512+/-0.292		0.573+/-0.459	UJ	0.98+/-0.46	J	7.59+/-1.35	
RADIUM-226+228	5	5	0.803	J	0.625	J	0.9715	J	NA		**11.39**	
RADIUM-228	NE	NE	0.382+/-0.452	U	0.113+/-0.332	J	0.685+/-0.594	J	NA		3.8+/-0.758	
THALLIUM-208	NE	NE	NA		NA		NA		-6.65+/-16.3	U	NA	
THORIUM-228	NE	NE	0.114+/-0.174	U	0.333+/-0.305	J	-0.0763+/-0.275	J	0.07+/-0.13	U	1.18+/-0.294	
THORIUM-230	NE	NE	0.0458+/-0.11	U	0.239+/-0.167	R	0.0326+/-0.179	J	0.56+/-0.33	J	4.46+/-0.754	B
THORIUM-232	NE	NE	0+/-2.01	UJ	-0.0163+/-0.0327	U	-0.028+/-0.0405	J	0.18+/-0.18	U	1.55+/-0.335	
THORIUM-234	NE	NE	NA		NA		NA		432.3+/-130		NA	
TOTAL URANIUM (µg/L)	30	30	0.844+/-0.634		0.652+/-0.74	UJ	0.733+/-0.62		14.08+/-0.58		27.6+/-4.29	
URANIUM-233/234	NE	NE	0.399+/-0.251		0.641+/-0.432		0.418+/-0.286		3.43+/-1.03		11.4+/-1.71	
URANIUM-235/236	NE	NE	-0.0268+/-0.0311	U	0.0341+/-0.186	J	0.0418+/-0.0838	UJ	0.29+/-0.26	J	0.463+/-0.225	
URANIUM-238	NE	NE	0.288+/-0.213		0.214+/-0.247	UJ	0.24+/-0.208		2.28+/-0.78		9.2+/-1.44	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit: Analyte	New Jersey State Primary Drinking Water Standards MCL pCi/L	USEPA Safe Drinking Water Act MCL pCi/L	B18W28S* 2000/12/20 REG WATER pCi/L		B18W28S* 2001/03/20 REG WATER pCi/L		B18W28S* 2001/05/31 REG WATER pCi/L		B18W28SR* 2001/10/05 REG WATER pCi/L		B18W28SR* 2001/12/14 REG WATER pCi/L	
ACTINIUM-228	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-212	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-214	NE	NE	NA		NA		NA		NA		NA	
GROSS ALPHA	NE	NE	17.9+/-1.92	J	25.1+/-2.07		13.1+/-1.73		84.1+/-2.95		63.2+/-2.44	
GROSS BETA	NE	NE	7.71+/-1.54		5.8+/-1.38		6.78+/-1.35		43.6+/-1.38		21.3+/-1.22	
LEAD-212	NE	NE	NA		NA		NA		NA		NA	
LEAD-214	NE	NE	NA		NA		NA		NA		NA	
NET ALPHA	15	15	5.005	J	7.033		3.886		**15.14**		**15.2**	
PROTACTINIUM-234M	NE	NE	NA		NA		NA		NA		NA	
RADIUM-226	NE	NE	0.753+/-0.449		1.85+/-0.638	J	0.467+/-0.428	U	1.12+/-0.518	J	1.45+/-0.463	J
RADIUM-226+228	5	5	1.453		2.825	J	2.2735	J	1.324	J	1.4301	J
RADIUM-228	NE	NE	1.4+/-0.811	U	0.975+/-0.418		2.04+/-0.764	J	0.408+/-0.503	U	-0.0398+/-0.4	U
THALLIUM-208	NE	NE	NA		NA		NA		NA		NA	
THORIUM-228	NE	NE	0.366+/-0.156		2.57+/-0.753		0.181+/-0.0862		-0.0942+/-0.136	U	0.16+/-0.183	U
THORIUM-230	NE	NE	1.1+/-0.271		4.44+/-1.14		0.556+/-0.139		0.919+/-0.341		0.229+/-0.158	
THORIUM-232	NE	NE	0.356+/-0.13		1.81+/-0.567		0.228+/-0.0815		-0.00369+/-0.0769	U	0.0356+/-0.0636	U
THORIUM-234	NE	NE	NA		NA		NA		NA		NA	
TOTAL URANIUM (µg/L)	30	30	18.4+/-3.18		26.5+/-4.26		13.3+/-2.66		**103+/-14.2**		**65.5+/-9.08**	
URANIUM-233/234	NE	NE	6.41+/-1.11		8.82+/-1.43		4.5+/-0.901		33.2+/-4.63		23.2+/-3.26	
URANIUM-235/236	NE	NE	0.365+/-0.186		0.397+/-0.211		0.274+/-0.177		1.36+/-0.504		3.3+/-0.784	
URANIUM-238	NE	NE	6.12+/-1.07		8.85+/-1.43		4.44+/-0.893		34.4+/-4.78		21.5+/-3.05	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Date Collected: / Analysis Type: / Matrix: / Unit:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	B18W28SR* 2002/04/02 REG WATER pCi/L		B18W28SR* 2002/09/25 REG WATER pCi/L		B18W29S* 2000/07/06 REG WATER pCi/L		B18W29S* 2000/09/21 REG WATER pCi/L		B18W29S* 2000/12/21 REG WATER pCi/L	
Analyte	pCi/L	pCi/L										
ACTINIUM-228	NE	NE	NA		NA		42.33+/-35.22	J	NA		NA	
BISMUTH-212	NE	NE	NA		NA		11.58+/-77.29	U	NA		NA	
BISMUTH-214	NE	NE	NA		NA		-9.39+/-14.32	U	NA		NA	
GROSS ALPHA	NE	NE	29.8+/-1.61		74.2+/-6.51		5.9+/-1.46		1.32+/-0.684		2+/-0.526	J
GROSS BETA	NE	NE	15.1+/-1.05		32.1+/-2.76		6.13+/-1.57		2.87+/-1.26		1.71+/-0.645	
LEAD-212	NE	NE	NA		NA		-8.84+/-27.08	U	NA		NA	
LEAD-214	NE	NE	NA		NA		-7.53+/-21.04	U	NA		NA	
NET ALPHA	15	15	7.812		**15.89**		3.52	J	-0.3265		1.08045	J
PROTACTINIUM-234M	NE	NE	NA		NA		-825.8+/-744.9	U	NA		NA	
RADIUM-226	NE	NE	0.762+/-0.422		1.11+/-0.487		0.91+/-0.41	J	1.1+/-0.677	U	1.36+/-0.485	
RADIUM-226+228	5	5	1.255	J	1.618	J	NA		1.07	U	1.94	
RADIUM-228	NE	NE	0.493+/-0.381	J	0.508+/-0.527	J	NA		1.04+/-0.511	U	1.16+/-0.681	U
THALLIUM-208	NE	NE	NA		NA		7.02+/-19.41	U	NA		NA	
THORIUM-228	NE	NE	0.115+/-0.347	J	0.14+/-0.214	J	0.02+/-0.09	U	2.91+/-0.738		0.173+/-0.102	U
THORIUM-230	NE	NE	1.97+/-0.543	R	0.311+/-0.231		0.74+/-0.4	J	0.356+/-0.222	J	0.221+/-0.102	
THORIUM-232	NE	NE	-0.015+/-0.118	U	0.0247+/-0.0671	J	0.11+/-0.16	U	0.195+/-0.0694	U	0.0788+/-0.0396	U
THORIUM-234	NE	NE	NA		NA		-44.87+/-90.1	U	NA		NA	
TOTAL URANIUM (µg/L)	30	30	29.4+/-5.92		**82.2+/-12.9**		2.98+/-0.1		2.37+/-1.75		1.31+/-0.536	
URANIUM-233/234	NE	NE	11.6+/-2.22		29.4+/-4.62		1.73+/-0.68		0.998+/-0.667	U	0.444+/-0.187	
URANIUM-235/236	NE	NE	0.578+/-0.415		1.51+/-0.54		0.24+/-0.25	U	0.769+/-0.367	U	0.0911+/-0.07	U
URANIUM-238	NE	NE	9.81+/-1.99		27.4+/-4.34		0.53+/-0.34	J	0.763+/-0.587		0.43+/-0.18	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Date Collected: / Analysis Type: / Matrix: / Unit:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	B18W29S* 2001/03/21 REG WATER pCi/L		B18W29S* 2001/06/05 REG WATER pCi/L		B18W29SR* 2001/10/08 REG WATER pCi/L		B18W29SR* 2001/12/14 REG WATER pCi/L		B18W29SR* 2002/04/01 REG WATER pCi/L	
Analyte	pCi/L	pCi/L										
ACTINIUM-228	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-212	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-214	NE	NE	NA		NA		NA		NA		NA	
GROSS ALPHA	NE	NE	2.04+/-0.661		3.35+/-0.815		1.34+/-1.14	UJ	1.55+/-0.65	J	0.397+/-0.604	J
GROSS BETA	NE	NE	1.41+/-0.821	U	8.42+/-0.87		0.854+/-0.87	U	3.33+/-0.834		2.65+/-0.931	
LEAD-212	NE	NE	NA		NA		NA		NA		NA	
LEAD-214	NE	NE	NA		NA		NA		NA		NA	
NET ALPHA	15	15	0.692		1.9622		0.4471	J	0.49375	J	-1.105	J
PROTACTINIUM-234M	NE	NE	NA		NA		NA		NA		NA	
RADIUM-226	NE	NE	0.748+/-0.399	J	0.803+/-0.478	J	0.659+/-0.402	J	1.16+/-0.394	J	0.481+/-0.286	
RADIUM-226+228	5	5	1.214	J	1.308	J	0.8405	J	1.304	J	1.103	J
RADIUM-228	NE	NE	0.932+/-0.454	U	1.01+/-0.711	U	0.363+/-0.381	U	0.288+/-0.469	U	0.622+/-0.44	J
THALLIUM-208	NE	NE	NA		NA		NA		NA		NA	
THORIUM-228	NE	NE	0.737+/-0.353		0.114+/-0.116	U	0.0315+/-0.15	U	0.118+/-0.231	U	0.205+/-0.162	UJ
THORIUM-230	NE	NE	0.221+/-0.164		0.307+/-0.13		0.0137+/-0.0457	U	0.0534+/-0.0761	U	0.017+/-0.106	J
THORIUM-232	NE	NE	0.0777+/-0.0521	U	-0.00586+/-0.0302	U	0.0215+/-0.0431	U	-0.00961+/-0.0193	U	-0.0266+/-0.0638	U
THORIUM-234	NE	NE	NA		NA		NA		NA		NA	
TOTAL URANIUM (µg/L)	30	30	1.21+/-0.572		1.5+/-0.769		1.37+/-0.876		1.69+/-0.796		0.981+/-0.954	UJ
URANIUM-233/234	NE	NE	0.864+/-0.302		0.872+/-0.35		0.424+/-0.296	J	0.483+/-0.248		1.18+/-0.66	
URANIUM-235/236	NE	NE	0.168+/-0.0756	U	0.0316+/-0.0908	U	0.0238+/-0.0968	U	0.0165+/-0.104	U	0.372+/-0.391	UJ
URANIUM-238	NE	NE	0.4+/-0.192		0.5+/-0.258		0.457+/-0.294		0.565+/-0.267		0.272+/-0.315	UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	B18W29SR* 2002/09/26 REG WATER pCi/L		URSMW10S 2001/05/15 REG WATER pCi/L		URSMW10S 2002/01/03 REG WATER pCi/L		URSMW11S 2001/05/22 REG WATER pCi/L		URSMW11S 2002/01/11 REG WATER pCi/L	
Analyte	pCi/L	pCi/L										
ACTINIUM-228	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-212	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-214	NE	NE	NA		NA		NA		NA		NA	
GROSS ALPHA	NE	NE	2.57+/-0.765		34.7+/-3.31	J	20.1+/-1.6		0.677+/-0.69	J	0.695+/-0.69	J
GROSS BETA	NE	NE	1.77+/-0.458		16.2+/-1.88		11.8+/-1.04		3.4+/-0.988		2.08+/-0.561	
LEAD-212	NE	NE	NA		NA		NA		NA		NA	
LEAD-214	NE	NE	NA		NA		NA		NA		NA	
NET ALPHA	15	15	2.4209	J	5.73	J	12.2165		0.6434	J	0.6803	J
PROTACTINIUM-234M	NE	NE	NA		NA		NA		NA		NA	
RADIUM-226	NE	NE	0.256+/-0.355	J	6.16+/-0.938		3.19+/-0.59		0.895+/-0.447	J	0.483+/-0.287	J
RADIUM-226+228	5	5	0.893	J	**7.16**		3.5505		1.078	J	0.858	J
RADIUM-228	NE	NE	0.637+/-0.53	J	2+/-1.7	U	0.721+/-0.623	U	0.366+/-0.48	U	0.75+/-0.481	U
THALLIUM-208	NE	NE	NA		NA		NA		NA		NA	
THORIUM-228	NE	NE	-0.103+/-0.289	J	-0.00862+/-0.0525	U	0.0685+/-0.143	U	0.0482+/-0.0769	U	0.043+/-0.14	U
THORIUM-230	NE	NE	0.0677+/-0.16	J	0.149+/-0.0876	J	0.287+/-0.149	J	0.094+/-0.0519		0.152+/-0.136	U
THORIUM-232	NE	NE	0.229+/-0.224	UJ	0+/-2.01	UJ	0.123+/-0.0877		0.0537+/-0.0471	U	-0.0166+/-0.0463	U
THORIUM-234	NE	NE	NA		NA		NA		NA		NA	
TOTAL URANIUM (µg/L)	30	30	0.196+/-0.384	J	**42.2+/-5.89**		10.7+/-2.44		0.076+/-0.206	U	-0.063+/-0.075	U
URANIUM-233/234	NE	NE	0.0923+/-0.188	J	13.7+/-1.94		4.22+/-0.908		0.0654+/-0.0971	U	0.0822+/-0.134	U
URANIUM-235/236	NE	NE	-0.0107+/-0.0214	J	1.27+/-0.353		0.147+/-0.157	U	-0.0281+/-0.0254	U	-0.0374+/-0.0795	U
URANIUM-238	NE	NE	0.0675+/-0.129	J	14+/-1.98		3.59+/-0.821		0.0299+/-0.069	U	-0.0154+/-0.0219	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit: Analyte	New Jersey State Primary Drinking Water Standards MCL pCi/L	USEPA Safe Drinking Water Act MCL pCi/L	URSMW1S 2001/05/14 DUP WATER pCi/L		URSMW1S 2001/05/14 REG WATER pCi/L		URSMW1S 2001/12/19 REG WATER pCi/L		URSMW20S 2002/04/04 REG WATER pCi/L	
ACTINIUM-228	NE	NE	NA		NA		NA		NA	
BISMUTH-212	NE	NE	NA		NA		NA		NA	
BISMUTH-214	NE	NE	NA		NA		NA		NA	
GROSS ALPHA	NE	NE	1.25+/-0.59	J	0.155+/-0.395	U	1.68+/-0.553		0.236+/-0.501	J
GROSS BETA	NE	NE	2.41+/-0.837		1.16+/-0.796	U	2.29+/-0.915		2.9+/-0.992	
LEAD-212	NE	NE	NA		NA		NA		NA	
LEAD-214	NE	NE	NA		NA		NA		NA	
NET ALPHA	15	15	1.00087	J	-0.15245		0.9685	J	-0.5144	J
PROTACTINIUM-234M	NE	NE	NA		NA		NA		NA	
RADIUM-226	NE	NE	1.4+/-0.457	J	0.54+/-0.354	J	0.474+/-0.284		0.149+/-0.273	J
RADIUM-226+228	5	5	1.752	J	0.613	J	0.6345		0.982	J
RADIUM-228	NE	NE	0.704+/-0.409	U	0.146+/-0.424	U	0.321+/-0.494	U	0.833+/-0.436	
THALLIUM-208	NE	NE	NA		NA		NA		NA	
THORIUM-228	NE	NE	-0.0409+/-0.0726	U	0.0551+/-0.0617	U	0.169+/-0.137	U	0.533+/-0.308	
THORIUM-230	NE	NE	0.148+/-0.126	U	0.0547+/-0.0613	U	0.089+/-0.0963	U	0.181+/-0.186	UJ
THORIUM-232	NE	NE	0.00962+/-0.0407	U	0.0196+/-0.028	U	-0.0324+/-0.0398	U	0.0181+/-0.0363	UJ
THORIUM-234	NE	NE	NA		NA		NA		NA	
TOTAL URANIUM (µg/L)	30	30	0.608+/-0.327		0.523+/-0.31		0.931+/-0.636		0.528+/-0.813	J
URANIUM-233/234	NE	NE	0.0916+/-0.0865	U	0.125+/-0.09		0.363+/-0.24	J	0.555+/-0.441	
URANIUM-235/236	NE	NE	-0.00334+/-0.00669	U	0.0189+/-0.0436	U	0.103+/-0.131	U	0.0214+/-0.166	J
URANIUM-238	NE	NE	0.205+/-0.11		0.173+/-0.104		0.297+/-0.213		0.174+/-0.272	J

Notes:
Qualifiers
U - The compound was not detected above the
laboratory method detection limit.
J - Result is regarded as estimated due to limitations
identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank
as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in
standards.
* denotes groundwater samples associated with the
Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit: Analyte	New Jersey State Primary Drinking Water Standards MCL pCi/L	USEPA Safe Drinking Water Act MCL pCi/L	URSMW2S 2001/05/15 REG WATER pCi/L		URSMW2S 2001/12/20 REG WATER pCi/L		URSMW4S 2001/05/15 REG WATER pCi/L		URSMW4S 2002/01/02 DUP WATER pCi/L		URSMW4S 2002/01/02 REG WATER pCi/L	
ACTINIUM-228	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-212	NE	NE	NA		NA		NA		NA		NA	
BISMUTH-214	NE	NE	NA		NA		NA		NA		NA	
GROSS ALPHA	NE	NE	3.65+/-2	J	37.7+/-2.29		7.37+/-1.77	J	1.79+/-0.587		2.58+/-0.694	
GROSS BETA	NE	NE	3.18+/-1.06		15.8+/-1.26		8.49+/-1.18		7.13+/-0.937		6.35+/-0.906	
LEAD-212	NE	NE	NA		NA		NA		NA		NA	
LEAD-214	NE	NE	NA		NA		NA		NA		NA	
NET ALPHA	15	15	-48.25	J	8.28		6.82515	J	1.17	J	1.7706	J
PROTACTINIUM-234M	NE	NE	NA		NA		NA		NA		NA	
RADIUM-226	NE	NE	2.46+/-0.654		0.439+/-0.263		5.64+/-0.92		0.286+/-0.263	U	0.697+/-0.314	
RADIUM-226+228	5	5	2.8375		1.579		**9.46**		4.173		**5.047**	
RADIUM-228	NE	NE	0.755+/-0.6	U	1.14+/-0.636		3.82+/-0.611		4.03+/-0.609		4.35+/-0.653	
THALLIUM-208	NE	NE	NA		NA		NA		NA		NA	
THORIUM-228	NE	NE	0.0507+/-0.0872	U	0.0555+/-0.131	U	0.167+/-0.129	U	0.233+/-0.159	U	0.271+/-0.189	U
THORIUM-230	NE	NE	0.102+/-0.0717	J	0.0889+/-0.0803	U	0.0882+/-0.0699	U	0.175+/-0.0995	J	0.0597+/-0.0699	U
THORIUM-232	NE	NE	0.0279+/-0.0325		-0.00889+/-0.0308	U	0.0103+/-0.033	U	0.0103+/-0.0523	U	-0.0152+/-0.0419	U
THORIUM-234	NE	NE	NA		NA		NA		NA		NA	
TOTAL URANIUM (µg/L)	30	30	**74.4+/-10.7**		**43.2+/-5.42**		1.29+/-0.501		0.907+/-1.14	UJ	0.784+/-0.549	
URANIUM-233/234	NE	NE	25.8+/-3.73		13.7+/-1.76		0.186+/-0.152	U	0.315+/-0.226	J	0.529+/-0.272	J
URANIUM-235/236	NE	NE	1.3+/-0.395		1.42+/-0.344		0.0557+/-0.0677	U	0+/-2	UJ	0.0488+/-0.0936	U
URANIUM-238	NE	NE	24.8+/-3.61		14.3+/-1.82		0.424+/-0.168		0.305+/-0.226		0.256+/-0.184	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-17
Summary of Overburden Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	URSMW5S 2001/05/16 REG WATER pCi/L		URSMW5S 2002/01/08 REG WATER pCi/L	
Analyte	pCi/L	pCi/L				
ACTINIUM-228	NE	NE	NA		NA	
BISMUTH-212	NE	NE	NA		NA	
BISMUTH-214	NE	NE	NA		NA	
GROSS ALPHA	NE	NE	2.44+/-1.21		1.77+/-0.722	J
GROSS BETA	NE	NE	2.47+/-1.11		1.3+/-0.456	
LEAD-212	NE	NE	NA		NA	
LEAD-214	NE	NE	NA		NA	
NET ALPHA	15	15	0.4997		0.4913	J
PROTACTINIUM-234M	NE	NE	NA		NA	
RADIUM-226	NE	NE	0.0506+/-0.295	U	0.424+/-0.32	U
RADIUM-226+228	5	5	0.2198	U	2.302	J
RADIUM-228	NE	NE	0.389+/-0.611	U	2.09+/-0.698	J
THALLIUM-208	NE	NE	NA		NA	
THORIUM-228	NE	NE	0.156+/-0.117	U	0.127+/-0.0857	
THORIUM-230	NE	NE	0.00847+/-0.103	U	0.146+/-0.0866	J
THORIUM-232	NE	NE	4.04E-9+/-0.0536	U	0.0122+/-0.0244	U
THORIUM-234	NE	NE	NA		NA	
TOTAL URANIUM (µg/L)	30	30	3.08+/-0.789		1.66+/-0.841	
URANIUM-233/234	NE	NE	0.833+/-0.247		0.688+/-0.332	
URANIUM-235/236	NE	NE	0.0873+/-0.0718		0.0914+/-0.116	U
URANIUM-238	NE	NE	1.02+/-0.265		0.545+/-0.282	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
B - Indicates that the analyte was found in the associated blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-18
Summary of Overburden (Pipechase) Analytical Results - Radiological
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	URSMW6S 2001/05/16 REG WATER pCi/L		URSMW6S 2002/01/07 REG WATER pCi/L		URSMW7SR 2002/01/08 REG WATER pCi/L		URSMW8S 2001/05/24 REG WATER pCi/L		URSMW8S 2002/01/14 REG WATER pCi/L	
Analyte	pCi/L	pCi/L										
GROSS ALPHA	NE	NE	1.29+/-1.1	U	2.34+/-0.74	J	16.7+/-1.3	J	1.91+/-0.743	J	1.67+/-0.665	J
GROSS BETA	NE	NE	50.3+/-2.8		6.97+/-0.682		5.87+/-0.595		3.08+/-0.877		1.57+/-0.433	
NET ALPHA	15	15	-0.1535		0.834	J	-2.12	J	0.3	J	1.02145	J
RADIUM-226	NE	NE	0.376+/-0.358	U	1.54+/-0.509	J	0.917+/-0.449	J	0.805+/-0.464	J	0.235+/-0.254	U
RADIUM-226+228	5	5	0.431	U	1.9755	J	1.2375	J	0.8535	J	-0.005	U
RADIUM-228	NE	NE	0.486+/-0.521	U	0.871+/-0.579	U	0.641+/-0.46	U	0.097+/-0.715	U	-0.245+/-0.573	U
THORIUM-228	NE	NE	0.154+/-0.0929		0.0854+/-0.0901	U	0.202+/-0.153	U	0.0474+/-0.0788	U	0.0773+/-0.13	U
THORIUM-230	NE	NE	0.0531+/-0.0754	U	0.165+/-0.109	J	0.191+/-0.111	J	0.0329+/-0.0974	U	0.203+/-0.122	J
THORIUM-232	NE	NE	0.00884+/-0.0307	U	-0.0116+/-0.0568	U	0.0431+/-0.0558	U	0.073+/-0.0978	U	0.0363+/-0.0422	
TOTAL URANIUM (µg/L)	30	30	2.06+/-0.671		1.99+/-0.85		29.3+/-5.36		2.41+/-0.852		0.721+/-0.606	U
URANIUM-233/234	NE	NE	0.719+/-0.246		0.695+/-0.306		8.59+/-1.63		0.703+/-0.273		0.507+/-0.29	
URANIUM-235/236	NE	NE	0.093+/-0.104	U	0.169+/-0.146		0.45+/-0.272		0.114+/-0.103		0.0481+/-0.111	U
URANIUM-238	NE	NE	0.678+/-0.225		0.642+/-0.285		9.78+/-1.8		0.793+/-0.286		0.235+/-0.203	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
blank as well as in the sample.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.

Table 5-19

Summary of Overburden (South Drainage Ditch) Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit: Analyte	New Jersey State Primary Drinking Water Standards MCL pCi/L	USEPA Safe Drinking Water Act MCL pCi/L	B18W30S* 2000/07/05 REG WATER pCi/L		B18W30S* 2000/09/19 DUP WATER pCi/L		B18W30S* 2000/09/19 REG WATER pCi/L		B18W30S* 2000/12/19 REG WATER pCi/L		B18W30S* 2001/03/23 REG WATER pCi/L		B18W30S* 2001/05/25 REG WATER pCi/L	
ACTINIUM-228	NE	NE	5.86+/-26.23	U	NA		NA		NA		NA		NA	
BISMUTH-212	NE	NE	-12.25+/-35.64	U	NA		NA		NA		NA		NA	
BISMUTH-214	NE	NE	-10.54+/-11.51	U	NA		NA		NA		NA		NA	
GROSS ALPHA	NE	NE	2.28+/-1.44	J	1.94+/-0.817	J	3.19+/-1.02	J	11.7+/-1.09	J	5.96+/-0.951		6.72+/-1.23	
GROSS BETA	NE	NE	5.31+/-1.2		5.17+/-1.04		5.51+/-1.09		4.01+/-0.687		7.2+/-1.19		4.25+/-1.18	
LEAD-212	NE	NE	6.39+/-10.71	U	NA		NA		NA		NA		NA	
LEAD-214	NE	NE	-12.92+/-11.57	U	NA		NA		NA		NA		NA	
NET ALPHA	15	15	0.725	J	-0.7295	J	0.804	J	-1.085	J	1.447		2.64	
PROTACTINIUM-234M	NE	NE	-24.65+/-743.8	U	NA		NA		NA		NA		NA	
RADIUM-226	NE	NE	0.75+/-0.42	J	0.73+/-0.453		1.46+/-0.616		0.525+/-0.363	U	0.578+/-0.365	U	0.753+/-0.451	J
RADIUM-226+228	5	5	NA		1.355		2.2		0.8225	U	0.6995	U	1.983	J
RADIUM-228	NE	NE	NA		1.25+/-0.605	U	1.48+/-0.662	U	1.12+/-0.678	U	0.821+/-0.401	U	1.23+/-0.628	
THALLIUM-208	NE	NE	-7.5+/-16.01	U	NA		NA		NA		NA		NA	
THORIUM-228	NE	NE	0.17+/-0.23	U	0.679+/-0.339	U	0.655+/-0.37	U	0.235+/-0.1	U	0.997+/-0.376		0.028+/-0.0463	U
THORIUM-230	NE	NE	0.77+/-0.43	J	0.425+/-0.245	U	0.593+/-0.269	U	0.136+/-0.0795		0.0702+/-0.0669	U	0.0273+/-0.033	U
THORIUM-232	NE	NE	0.14+/-0.18	U	0.209+/-0.0323	U	0.102+/-2	U	0.0683+/-0.0124	U	0.162+/-0.0507	U	-0.0109+/-0.0155	U
THORIUM-234	NE	NE	28.46+/-101.1	U	NA		NA		NA		NA		NA	
TOTAL URANIUM (µg/L)	30	30	2.69+/-0.07		3.44+/-1.9		1.62+/-1.23		16.7+/-3.19		6.42+/-1.41		5.87+/-1.58	
URANIUM-233/234	NE	NE	0.81+/-0.47		1.29+/-0.684		1.66+/-0.73		6.76+/-1.24		2.29+/-0.506		1.99+/-0.538	
URANIUM-235/236	NE	NE	0.13+/-0.21	U	0.439+/-0.04	U	0.378+/-0.148	U	0.475+/-0.233		0.166+/-0.106	U	0.14+/-0.127	
URANIUM-238	NE	NE	0.68+/-0.43	J	1.16+/-0.637		0.537+/-0.412		5.55+/-1.07		2.14+/-0.475		1.95+/-0.53	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-19

Summary of Overburden (South Drainage Ditch) Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	B18W30S* 2001/10/04 REG WATER pCi/L		B18W30S* 2001/12/17 REG WATER pCi/L		B18W30S* 2002/04/04 REG WATER pCi/L		URSHP1 2001/04/20 REG WATER pCi/L		URSHP2 2001/04/23 REG WATER pCi/L		URSMW12S 2001/05/22 REG WATER pCi/L	
Analyte	pCi/L	pCi/L												
ACTINIUM-228	NE	NE	NA		NA		NA		NA		NA		NA	
BISMUTH-212	NE	NE	NA		NA		NA		NA		NA		NA	
BISMUTH-214	NE	NE	NA		NA		NA		NA		NA		NA	
GROSS ALPHA	NE	NE	1.03+/-0.665	U	2.14+/-0.511		5.51+/-1.01		5.41+/-2.19		206+/-9.96		1.41+/-0.61	J
GROSS BETA	NE	NE	2.32+/-0.467		2.67+/-0.707		3.71+/-0.886		4.66+/-2.66		50.9+/-3.83		4.53+/-0.793	
LEAD-212	NE	NE	NA		NA		NA		NA		NA		NA	
LEAD-214	NE	NE	NA		NA		NA		NA		NA		NA	
NET ALPHA	15	15	0.0865	J	1.03455		0.8085	J	3.323	J	**68.52**		-0.9862	J
PROTACTINIUM-234M	NE	NE	NA		NA		NA		NA		NA		NA	
RADIUM-226	NE	NE	0.559+/-0.332	J	1.27+/-0.402	J	0.141+/-0.239	J	1.61+/-0.662		1.86+/-0.782		0.742+/-0.465	J
RADIUM-226+228	5	5	1.332	J	1.5795	J	0.694	J	2.83	J	2.761		1.1545	J
RADIUM-228	NE	NE	0.773+/-0.344		0.619+/-0.483	U	0.553+/-0.425	J	1.22+/-1.12	J	0.901+/-0.494		0.825+/-0.843	U
THALLIUM-208	NE	NE	NA		NA		NA		NA		NA		NA	
THORIUM-228	NE	NE	0.219+/-0.227	U	0.0568+/-0.193	U	0.382+/-0.349	J	0.323+/-0.57	J	-0.338+/-0.47	J	0.0301+/-0.0879	U
THORIUM-230	NE	NE	0.05+/-0.119	U	0.372+/-0.225		0.185+/-0.214	J	0.115+/-0.234	J	1.1+/-0.519		0.0118+/-0.0289	U
THORIUM-232	NE	NE	0.038+/-0.136	U	-0.0447+/-0.0818	U	0.0138+/-0.0858	J	0.046+/-0.148	J	-0.187+/-0.239	J	0.0118+/-0.0289	U
THORIUM-234	NE	NE	NA		NA		NA		NA		NA		NA	
TOTAL URANIUM (µg/L)	30	30	1.13+/-0.713		1.64+/-0.489		6.47+/-2.31		2.4+/-0.954		**200+/-22.2**		3.29+/-1.07	
URANIUM-233/234	NE	NE	0.53+/-0.296	J	0.545+/-0.164		2.45+/-0.839		1.19+/-0.398		67.2+/-7.52		1.28+/-0.397	
URANIUM-235/236	NE	NE	0.103+/-0.131	U	0.0309+/-0.0558	U	0.223+/-0.259	UJ	0.106+/-0.147	J	3.68+/-0.808		0.0324+/-0.0747	U
URANIUM-238	NE	NE	0.362+/-0.239		0.545+/-0.164		2.14+/-0.777		0.791+/-0.32		66.6+/-7.47		1.1+/-0.361	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-19

Summary of Overburden (South Drainage Ditch) Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit: Analyte	New Jersey State Primary Drinking Water Standards MCL pCi/L	USEPA Safe Drinking Water Act MCL pCi/L	URSMW12S 2001/07/05 REG WATER pCi/L	URSMW12S 2002/01/04 REG WATER pCi/L	URSMW13S 2001/05/25 REG WATER pCi/L	URSMW13S 2001/07/10 REG WATER pCi/L	URSMW13S 2002/01/11 REG WATER pCi/L	URSMW14S 2001/05/22 REG WATER pCi/L
ACTINIUM-228	NE	NE	NA	NA	NA	NA	NA	NA
BISMUTH-212	NE	NE	NA	NA	NA	NA	NA	NA
BISMUTH-214	NE	NE	NA	NA	NA	NA	NA	NA
GROSS ALPHA	NE	NE	1.04+/-1.05 UJ	3.74+/-0.67	2.75+/-0.907	10.2+/-2.67	11.4+/-1.94 J	2.63+/-0.881 J
GROSS BETA	NE	NE	3.22+/-0.913	5.08+/-0.728	4.24+/-0.959	9.68+/-1.97	9.15+/-1.25	5.32+/-1.01
LEAD-212	NE	NE	NA	NA	NA	NA	NA	NA
LEAD-214	NE	NE	NA	NA	NA	NA	NA	NA
NET ALPHA	15	15	-0.7799 J	-1.0405	-2.0585	4.488	4.026 J	0.74285 J
PROTACTINIUM-234M	NE	NE	NA	NA	NA	NA	NA	NA
RADIUM-226	NE	NE	0.819+/-0.388	0.636+/-0.269	0.578+/-0.494 U	0.294+/-0.264 U	0.429+/-0.315 J	0.974+/-0.472 J
RADIUM-226+228	5	5	1.171	0.8565	1.559 J	0.292 U	0.521 J	1.609 J
RADIUM-228	NE	NE	0.704+/-0.468 U	0.441+/-0.491 U	1.27+/-0.6 J	0.29+/-0.404 U	0.184+/-0.597 U	0.635+/-0.629 J
THALLIUM-208	NE	NE	NA	NA	NA	NA	NA	NA
THORIUM-228	NE	NE	-0.0729+/-0.249 U	0.0492+/-0.192 U	-0.0236+/-0.029 U	-0.0277+/-0.142 U	0.19+/-0.144 U	0.124+/-0.107 U
THORIUM-230	NE	NE	0.044+/-0.0832 U	0.136+/-0.107 J	0.0457+/-0.0423 U	0.0918+/-0.0849 U	0.315+/-0.142 J	0.0689+/-0.0521 U
THORIUM-232	NE	NE	0.0109+/-0.0496 U	0.00841+/-0.0381 U	0.0039+/-0.0243 U	0.0582+/-0.0808 U	0.0112+/-0.0536 U	0.172+/-0.0706
THORIUM-234	NE	NE	NA	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/L)	30	30	2.71+/-1.13	7.6+/-1.86	6.99+/-1.7	8.86+/-1.52	10.7+/-2.36	3.05+/-1.07
URANIUM-233/234	NE	NE	0.892+/-0.38	2.17+/-0.572	2.41+/-0.587	2.58+/-0.466	3.57+/-0.794	0.833+/-0.322
URANIUM-235/236	NE	NE	0.0538+/-0.103 U	0.161+/-0.153 U	0.137+/-0.13 U	0.182+/-0.102	0.234+/-0.174	0.0883+/-0.111 U
URANIUM-238	NE	NE	0.901+/-0.38	2.53+/-0.624	2.33+/-0.572	2.95+/-0.509	3.57+/-0.794	1.01+/-0.36

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-19

Summary of Overburden (South Drainage Ditch) Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	URSMW14S	URSMW14S	URSMW15S	URSMW15S	URSMW15S	URSMW16S
Date Collected:			2001/07/06	2002/01/08	2001/05/25	2001/07/10	2002/01/07	2001/05/21
Analysis Type:			REG	REG	REG	REG	REG	DUP
Matrix:			WATER	WATER	WATER	WATER	WATER	WATER
Unit:			pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L
Analyte	pCi/L	pCi/L						
ACTINIUM-228	NE	NE	NA	NA	NA	NA	NA	NA
BISMUTH-212	NE	NE	NA	NA	NA	NA	NA	NA
BISMUTH-214	NE	NE	NA	NA	NA	NA	NA	NA
GROSS ALPHA	NE	NE	0.68+/-1.86 UJ	2.17+/-0.659 J	2.33+/-1.04	3.16+/-4.05 UJ	13.9+/-1.78 J	5.98+/-1.53
GROSS BETA	NE	NE	0.38+/-1.69 UJ	2.27+/-0.45	4.48+/-1.3	-0.0477+/-3.13 UJ	11.4+/-0.957	4.48+/-1.14
LEAD-212	NE	NE	NA	NA	NA	NA	NA	NA
LEAD-214	NE	NE	NA	NA	NA	NA	NA	NA
NET ALPHA	15	15	-1.22245 J	1.2909 J	-0.361	-3.886 J	7.647 J	-0.651
PROTACTINIUM-234M	NE	NE	NA	NA	NA	NA	NA	NA
RADIUM-226	NE	NE	0.722+/-0.363	1.12+/-0.433 J	0.894+/-0.614 J	1.06+/-0.412	0.875+/-0.37 J	0.934+/-0.449
RADIUM-226+228	5	5	1.0005	1.359 J	1.1415 J	0.945	1.048 J	1.164
RADIUM-228	NE	NE	0.557+/-0.474 U	0.478+/-0.471 U	0.495+/-0.892 U	-0.23+/-0.516 U	0.346+/-0.555 U	0.46+/-0.501 U
THALLIUM-208	NE	NE	NA	NA	NA	NA	NA	NA
THORIUM-228	NE	NE	0.13+/-0.158 U	0.117+/-0.112 U	0.0382+/-0.0489 U	-0.0196+/-0.15 U	0.476+/-0.219	0.0607+/-0.102 U
THORIUM-230	NE	NE	0.0284+/-0.0644 U	0.0708+/-0.0623 U	0.12+/-0.0604	0.0509+/-0.0728 U	0.514+/-0.197 J	0.147+/-0.087 J
THORIUM-232	NE	NE	-0.000717+/-0.0788 U	0.0291+/-0.0504 U	-0.0142+/-0.0165 U	0.0255+/-0.0513 U	0.232+/-0.141	0+/-2 U
THORIUM-234	NE	NE	NA	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/L)	30	30	2.83+/-1.13	1.1+/-0.657	3.31+/-1.06	10.9+/-2.45	10.7+/-2.33	8.94+/-1.52
URANIUM-233/234	NE	NE	0.947+/-0.408	0.48+/-0.26	1.41+/-0.413	3.34+/-0.78	2.47+/-0.621	3.43+/-0.571
URANIUM-235/236	NE	NE	0.0109+/-0.105 U	0.0822+/-0.116 U	0.201+/-0.145	0.112+/-0.129 U	0.233+/-0.179	0.231+/-0.138
URANIUM-238	NE	NE	0.95+/-0.379	0.358+/-0.22	1.08+/-0.355	3.65+/-0.823	3.55+/-0.783	2.97+/-0.512

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-19

Summary of Overburden (South Drainage Ditch) Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	URSMW16S 2001/05/21 REG WATER pCi/L		URSMW16S 2001/07/05 REG WATER pCi/L		URSMW16S 2002/01/03 REG WATER pCi/L		URSMW17S 2001/05/21 REG WATER pCi/L		URSMW17S 2001/07/10 REG WATER pCi/L		URSMW17S 2002/01/04 REG WATER pCi/L	
Analyte	pCi/L	pCi/L												
ACTINIUM-228	NE	NE	NA		NA		NA		NA		NA		NA	
BISMUTH-212	NE	NE	NA		NA		NA		NA		NA		NA	
BISMUTH-214	NE	NE	NA		NA		NA		NA		NA		NA	
GROSS ALPHA	NE	NE	4.83+/-0.984		4.59+/-1.04		2.23+/-0.564		0.221+/-0.459	U	0.295+/-0.631	U	0.947+/-0.652	U
GROSS BETA	NE	NE	6.05+/-0.854		1.82+/-0.86		3.11+/-0.71		3.81+/-0.861		1.47+/-0.763		1.49+/-1.27	U
LEAD-212	NE	NE	NA		NA		NA		NA		NA		NA	
LEAD-214	NE	NE	NA		NA		NA		NA		NA		NA	
NET ALPHA	15	15	-2.451		-0.11535		-0.469		-0.18		0.0244		0.63385	J
PROTACTINIUM-234M	NE	NE	NA		NA		NA		NA		NA		NA	
RADIUM-226	NE	NE	0.868+/-0.5		1.45+/-0.498		0.502+/-0.231		0.34+/-0.312	U	0.873+/-0.427		0.363+/-0.29	U
RADIUM-226+228	5	5	1.0955		1.33		1.522		0.2575	U	1.634		0.4075	U
RADIUM-228	NE	NE	0.455+/-0.557	U	-0.24+/-0.449	U	1.02+/-0.449		0.175+/-0.494	U	0.761+/-0.396		0.452+/-0.462	U
THALLIUM-208	NE	NE	NA		NA		NA		NA		NA		NA	
THORIUM-228	NE	NE	0.0133+/-0.15	U	0.0777+/-0.277	U	0.0423+/-0.156	U	0.148+/-0.122	U	0.0529+/-0.162	U	0.0643+/-0.118	U
THORIUM-230	NE	NE	0.164+/-0.104	J	-0.0119+/-0.0612	U	0.0959+/-0.0992	U	0.0472+/-0.0655	U	0.153+/-0.112		0.00771+/-0.0529	U
THORIUM-232	NE	NE	-0.00209+/-0.0492	U	-0.0349+/-0.0408	U	-0.0108+/-0.0216	U	0.00371+/-0.0327	U	-0.0272+/-0.0317	U	0.0316+/-0.0598	U
THORIUM-234	NE	NE	NA		NA		NA		NA		NA		NA	
TOTAL URANIUM (µg/L)	30	30	9.06+/-1.53		5.95+/-1.84		3.07+/-1.21		0.333+/-0.235		0.192+/-0.308	U	0.247+/-0.321	U
URANIUM-233/234	NE	NE	4.04+/-0.632		2.68+/-0.73		1.6+/-0.515		0.228+/-0.148		0.234+/-0.194		0.278+/-0.188	J
URANIUM-235/236	NE	NE	0.231+/-0.118		0.0707+/-0.181	U	0.198+/-0.179	U	0.177+/-0.136	U	0.0101+/-0.0779	U	-0.0149+/-0.0211	U
URANIUM-238	NE	NE	3.01+/-0.514		1.99+/-0.618		1+/-0.404		0.0845+/-0.0761		0.0631+/-0.103	U	0.0852+/-0.108	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-19

Summary of Overburden (South Drainage Ditch) Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit: Analyte	New Jersey State Primary Drinking Water Standards MCL pCi/L	USEPA Safe Drinking Water Act MCL pCi/L	URSMW17S 2002/03/25 REG WATER pCi/L	URSMW18S 2001/05/17 REG WATER pCi/L	URSMW18S 2001/07/03 DUP WATER pCi/L	URSMW18S 2001/07/03 REG WATER pCi/L	URSMW18S 2002/01/04 REG WATER pCi/L	URSMW18S 2002/03/27 REG WATER pCi/L
ACTINIUM-228	NE	NE	NA	NA	NA	NA	NA	NA
BISMUTH-212	NE	NE	NA	NA	NA	NA	NA	NA
BISMUTH-214	NE	NE	NA	NA	NA	NA	NA	NA
GROSS ALPHA	NE	NE	1.08+/-0.753 U	0.885+/-0.514 U	1.74+/-2.07 UJ	1.67+/-2.78 UJ	83.3+/-9.42	-0.336+/-0.568 J
GROSS BETA	NE	NE	3.22+/-1.26 J	3.01+/-0.6	3.95+/-1.75	1.23+/-3.04 UJ	139+/-8.63	2.98+/-1.24 J
LEAD-212	NE	NE	NA	NA	NA	NA	NA	NA
LEAD-214	NE	NE	NA	NA	NA	NA	NA	NA
NET ALPHA	15	15	0.983095 J	0.7449	1.720775 J	1.6537 J	**82.2225 J**	-0.3869 J
PROTACTINIUM-234M	NE	NE	NA	NA	NA	NA	NA	NA
RADIUM-226	NE	NE	0.454+/-0.282	0.0445+/-0.259 U	0.527+/-0.303	1.13+/-0.461	0.916+/-0.328	0.524+/-0.234
RADIUM-226+228	5	5	1.154	0.27275 U	0.8255	1.539	1.366	1.109
RADIUM-228	NE	NE	1.4+/-1.39 U	0.501+/-0.643 U	0.597+/-0.446 U	0.818+/-0.485 U	0.9+/-0.518 U	1.17+/-1.42 U
THALLIUM-208	NE	NE	NA	NA	NA	NA	NA	NA
THORIUM-228	NE	NE	0.135+/-0.125 UJ	0.0958+/-0.0823 U	0.0957+/-0.196 U	-0.0763+/-0.172 U	1.02+/-0.366	0.024+/-0.066 J
THORIUM-230	NE	NE	0.104+/-0.0794 UJ	0.148+/-0.242 U	0.364+/-0.184	0.0234+/-0.0613 U	0.797+/-0.289	0.174+/-0.0862
THORIUM-232	NE	NE	0.0148+/-0.021 UJ	-0.0234+/-0.0644 U	0.0572+/-0.0819 U	0.0078+/-0.0353 U	0.925+/-0.313	0.0079+/-0.0274 J
THORIUM-234	NE	NE	NA	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/L)	30	30	0.154+/-0.304 J	0.217+/-0.176	-0.101+/-0.192 U	0.067+/-0.174 U	0.838+/-0.584	-0.007+/-5.95 U
URANIUM-233/234	NE	NE	0.0962+/-0.122 UJ	0.0644+/-0.0749 U	0.0793+/-0.0989 U	0.0455+/-0.107 U	0.754+/-0.323 J	0.118+/-0.137 UJ
URANIUM-235/236	NE	NE	-0.00839+/-0.0168 U	0.101+/-0.0846 U	-0.00825+/-0.0426 U	-0.0421+/-0.0348 U	0.121+/-0.147 U	-0.0162+/-0.023 U
URANIUM-238	NE	NE	0.053+/-0.102 J	0.0574+/-0.0577	-0.0326+/-0.0643 U	0.0292+/-0.0584 U	0.263+/-0.195	0+/-2 UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NA - Not Analyzed
NE - Not Established.
Boxed results indicate an exceedance in standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-20
Summary of Bedrock Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW11D 2001/05/18 REG AB33857 WATER µg/L		URSMW11D 2002/01/02 DUP AB49464 WATER µg/L		URSMW11D 2002/01/02 REG AB49462 WATER µg/L		URSMW1D 2001/05/14 REG AB33492 WATER µg/L		URSMW1D 2001/12/19 REG AB48978 WATER µg/L	
1,1-DICHLOROETHANE	70	50	NE	5	R	5	U	5	U	5	R	5	UJ
1,2-DICHLOROETHANE	2	2	5	5	R	5	U	5	U	5	R	5	UJ
BROMOMETHANE	10	10	NE	5	R	5	U	5	U	5	R	5	UJ
CARBON DISULFIDE	800	NE	NE	5	R	5	U	5	U	2.93	R	5	UJ
CARBON TETRACHLORIDE	2	2	5	5	R	5	U	5	U	5	R	5	UJ
CHLOROFORM	6	6	NE	5	R	5	U	5	U	5	R	5	UJ
ISOPROPYL ETHER	NE	NE	NE	5	R	5	U	5	U	5	R	5	UJ
METHYL-T-BUTYL ETHER	NE	70	NE	1	R	1.17		1	UJ	1	R	1	UJ
TERT-BUTYL ALCOHOL	NE	NE	NE	10	R	10	U	10	U	10	R	10	UJ
TRICHLOROETHENE	1	1	5	5	R	5	U	5	U	5	R	5	UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.

Table 5-20
Summary of Bedrock Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW20D 2002/01/04 REG AB49603 WATER µg/L		URSMW20D 2002/10/03 REG 210048-003-007-1/3 WATER µg/L		URSMW2D 2001/05/15 REG AB33605 WATER µg/L		URSMW2D 2001/12/20 REG AB49076 WATER µg/L		URSMW3D 2001/05/17 REG AB33849 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
1,1-DICHLOROETHANE	70	50	NE	5	U	5	U	5	UJ	5	U	5	U
1,2-DICHLOROETHANE	2	2	5	5	U	5	U	1.33	J	1.31	J	5	U
BROMOMETHANE	10	10	NE	5	U	1.2	J	5	UJ	5	U	5	U
CARBON DISULFIDE	800	NE	NE	5	U	5	U	5	UJ	5	U	5	U
CARBON TETRACHLORIDE	2	2	5	5	U	5	U	**46.2**	**J**	**35.4**		5	U
CHLOROFORM	6	6	NE	5	U	5	U	**22.4**	**J**	**19.4**		5	U
ISOPROPYL ETHER	NE	NE	NE	5	U	5	U	5	UJ	5	U	1.94	J
METHYL-T-BUTYL ETHER	NE	70	NE	1	U	5	U	2.94	J	2.25		**213**	
TERT-BUTYL ALCOHOL	NE	NE	NE	10	U	20	U	10	UJ	10	U	2.14	J
TRICHLOROETHENE	1	1	5	5	U	5	U	29.1	R	**35.7**		5	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.

Table 5-20
Summary of Bedrock Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW3D 2001/12/21 REG AB49164 WATER µg/L		URSMW5D 2001/05/21 REG AB34100 WATER µg/L		URSMW5D 2001/12/20 DUP AB49080 WATER µg/L		URSMW5D 2001/12/20 REG AB49078 WATER µg/L		URSMW9D 2001/06/01 DUP AB34827 WATER µg/L	
1,1-DICHLOROETHANE	70	50	NE	1.72	J	5	U	5	U	5	U	25	U
1,2-DICHLOROETHANE	2	2	5	5	U	5	U	5	U	5	U	25	U
BROMOMETHANE	10	10	NE	5	U	5	U	5	U	5	U	25	U
CARBON DISULFIDE	800	NE	NE	5	U	2	J	5	U	5	U	25	U
CARBON TETRACHLORIDE	2	2	5	5	U	5	U	5	U	5	U	25	U
CHLOROFORM	6	6	NE	5	U	5	U	5	U	5	U	25	U
ISOPROPYL ETHER	NE	NE	NE	1.22	J	5	U	5	U	5	U	25	U
METHYL-T-BUTYL ETHER	NE	70	NE	**227**		2.86		1.54		1.76		**586**	
TERT-BUTYL ALCOHOL	NE	NE	NE	10	U	10	UJ	10	U	10	U	436	
TRICHLOROETHENE	1	1	5	5	R	5	U	5	U	5	U	25	UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.

Table 5-20
Summary of Bedrock Analytical Results - Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Date Collected: / Analysis Type: / Lab Sample ID: / Matrix: / Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW9D 2001/06/01 REG AB34826 WATER µg/L		URSMW9D 2001/12/21 REG AB49160 WATER µg/L	
Analyte	µg/L	µg/L	µg/L				
1,1-DICHLOROETHANE	70	50	NE	25	U	5	U
1,2-DICHLOROETHANE	2	2	5	25	U	5	U
BROMOMETHANE	10	10	NE	25	U	5	U
CARBON DISULFIDE	800	NE	NE	25	U	1.03	J
CARBON TETRACHLORIDE	2	2	5	25	U	5	U
CHLOROFORM	6	6	NE	25	U	5	U
ISOPROPYL ETHER	NE	NE	NE	25	U	5	U
METHYL-T-BUTYL ETHER	NE	70	NE	**623**		**185**	
TERT-BUTYL ALCOHOL	NE	NE	NE	470		434	
TRICHLOROETHENE	1	1	5	25	UJ	5	R

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.

Table 5-21
Summary of Bedrock Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW11D 2001/05/18 REG AB33857 WATER µg/L		URSMW11D 2002/01/02 DUP AB49464 WATER µg/L		URSMW11D 2002/01/02 REG AB49462 WATER µg/L		URSMW1D 2001/05/14 REG AB33492 WATER µg/L		URSMW1D 2001/12/19 REG AB48978 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	6.86	U	10	U	2.46	J	2.28	U	10	U
DIETHYL PHTHALATE	5000	5000	NE	10	U	10	U	10	U	10	U	10	U
DI-N-BUTYL PHTHALATE	900	900	NE	10	U	10	U	10	U	10	U	10	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	10	U	10	U	10	U	10	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
$\boxed{\textbf{Boxed results}}$ - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-21
Summary of Bedrock Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW20D 2002/01/04 REG AB49603 WATER µg/L		URSMW20D 2002/10/03 REG 210048-003-016-1/2 WATER µg/L		URSMW2D 2001/05/15 REG AB33605 WATER µg/L		URSMW2D 2001/12/20 REG AB49076 WATER µg/L		URSMW3D 2001/05/17 REG AB33849 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	**68.9**		**11**		32	UJ	11	U	10	U
DIETHYL PHTHALATE	5000	5000	NE	11	U	11	U	10	UJ	11	U	10	U
DI-N-BUTYL PHTHALATE	900	900	NE	11	U	1.4	J	10	UJ	11	U	10	U
DI-N-OCTYL PHTHALATE	100	100	NE	11	U	11	U	10	UJ	11	U	10	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-21
Summary of Bedrock Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW3D 2001/12/21 REG AB49164 WATER µg/L		URSMW5D 2001/05/21 REG AB34100 WATER µg/L		URSMW5D 2001/12/20 DUP AB49080 WATER µg/L		URSMW5D 2001/12/20 REG AB49078 WATER µg/L		URSMW9D 2001/06/01 DUP AB34827 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	2.64	J	10	U	11	U	11	U	10	U
DIETHYL PHTHALATE	5000	5000	NE	10	U	20.8		2.03	J	1.98	J	6.16	J
DI-N-BUTYL PHTHALATE	900	900	NE	10	U	10	U	11	U	11	U	10	UJ
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	10	U	11	U	11	U	1.32	J

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-21
Summary of Bedrock Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW9D 2001/06/01 REG AB34826 WATER µg/L		URSMW9D 2001/12/21 REG AB49160 WATER µg/L	
Analyte	µg/L	µg/L	µg/L				
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	3.08	J	4.65	J
DIETHYL PHTHALATE	5000	5000	NE	6.58	J	3.33	J
DI-N-BUTYL PHTHALATE	900	900	NE	10	UJ	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	UJ	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-22
Summary of Bedrock Analytical Results - METALS
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW11D(UNFIL) 2001/05/18 REG AB33857 WATER µg/L		URSMW11D (UNFIL) 2002/01/02 DUP AB49464 WATER µg/L		URSMW11D (UNFIL) 2002/01/02 REG AB49462 WATER µg/L		URSMW1D (UNFIL) 2001/05/14 REG AB33492 WATER µg/L		URSMW1D (UNFIL) 2001/12/19 REG AB48978 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
ALUMINUM	200	NE	NE	180	U	180	U	180	U	180	U	180	U
BARIUM	2000	2000	2000	467		473		436		115		128	
CALCIUM	NE	NE	NE	110000	J	115000		105000		52800		53400	
IRON	300	NE	NE	**3410**	**J**	**1230**		**1480**		**306**		**817**	
MAGNESIUM	NE	NE	NE	14100		14900		13600		7270		7610	
MANGANESE	50	NE	NE	40	U	40	U	40	U	40	U	40	U
POTASSIUM	NE	NE	NE	2000	U	2000	U	2000	U	2000	U	2000	U
SODIUM	50000	NE	NE	16100		17000		15000		13600		14900	
VANADIUM	NE	NE	NE	50	U	50	U	50	U	50	U	50	U
ZINC	5000	NE	NE	50	U	50	U	50	U	50	U	50	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-22
Summary of Bedrock Analytical Results - METALS
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW20D (UNFIL) 2002/01/04 REG AB49603 WATER µg/L		URSMW20D (FIL) 2002/01/04 REG AB49604 WATER µg/L		URSMW20D (UNFIL) 2002/10/03 REG 210048-003-020-1/1 WATER µg/L		URSMW2D (UNFIL) 2001/05/15 REG AB33605 WATER µg/L		URSMW2D (FIL) 2001/05/15 REG AB33606 WATER µg/L	
ALUMINUM	200	NE	NE	180	U	180	U	89.2		180	U	180	U
BARIUM	2000	2000	2000	888		893		925		130		119	
CALCIUM	NE	NE	NE	118000		118000		125000		62900		62700	
IRON	300	NE	NE	**14500**		**12700**		**13800**		**1870**		280	U
MAGNESIUM	NE	NE	NE	12900		12900		12900		8040		8120	
MANGANESE	50	NE	NE	**1530**		**1440**		**992**		**65.2**		**54**	
POTASSIUM	NE	NE	NE	2000	U	2000	U	1250		2000	U	2000	U
SODIUM	50000	NE	NE	21500		21600		21300		14200		12500	
VANADIUM	NE	NE	NE	50	U	50	U	0.71		50	U	50	U
ZINC	5000	NE	NE	50	U	50	U	4.2		50	U	50	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-22
Summary of Bedrock Analytical Results - METALS
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW2D (UNFIL) 2001/12/20 REG AB49076 WATER µg/L		URSMW2D (FIL) 2001/12/20 REG AB49077 WATER µg/L		URSMW3D (UNFIL) 2001/05/17 REG AB33849 WATER µg/L		URSMW3D (FIL) 2001/05/17 REG AB33850 WATER µg/L		URSMW3D (UNFIL) 2001/12/21 REG AB49164 WATER µg/L	
ALUMINUM	200	NE	NE	180	U	180	U	180	U	180	U	180	U
BARIUM	2000	2000	2000	142		127		299		257		427	
CALCIUM	NE	NE	NE	60600		58000		53300		46000		70700	
IRON	300	NE	NE	**3690**		275	U	**2750**	**J**	**1040**	**J**	**587**	
MAGNESIUM	NE	NE	NE	8150		7840		8470		7250		10800	
MANGANESE	50	NE	NE	40	U	40	U	**207**		**185**		**261**	
POTASSIUM	NE	NE	NE	2000	U	2000	U	2000	U	2000	U	2000	U
SODIUM	50000	NE	NE	13700	J	13300	J	14900		13000		16200	
VANADIUM	NE	NE	NE	50	U	50	U	50	U	50	U	50	U
ZINC	5000	NE	NE	50	U	50	U	50	U	50	U	50	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-22
Summary of Bedrock Analytical Results - METALS
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Date Collected: / Analysis Type: / Lab Sample ID: / Matrix: / Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	URSMW5D (UNFIL) 2001/05/21 REG AB34100 WATER µg/L		URSMW5D (UNFIL) 2001/12/20 DUP AB49080 WATER µg/L		URSMW5D (FIL) 2001/12/20 DUP AB49081 WATER µg/L		URSMW5D (UNFIL) 2001/12/20 REG AB49078 WATER µg/L		URSMW5D (FIL) 2001/12/20 REG AB49079 WATER µg/L	
Analyte	µg/L	µg/L	µg/L										
ALUMINUM	200	NE	NE	180	U	180	U	180	U	180	U	180	U
BARIUM	2000	2000	2000	583	J	601		546		519		514	
CALCIUM	NE	NE	NE	115000		114000		108000		97900		101000	
IRON	300	NE	NE	**4620**		**2180**		**704**		**1890**		**314**	
MAGNESIUM	NE	NE	NE	13700		13000		12400		11700		11800	
MANGANESE	50	NE	NE	**422**		**119**		**112**		**102**		**105**	
POTASSIUM	NE	NE	NE	2000	U	2000	U	2000	U	2000	U	2000	U
SODIUM	50000	NE	NE	21100		21200	J	20200	J	19400	J	19300	J
VANADIUM	NE	NE	NE	50	U	50	U	50	U	50	U	50	U
ZINC	5000	NE	NE	50	U	50	U	50	U	50	U	50	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-22
Summary of Bedrock Analytical Results - METALS
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	URSMW9D (UNFIL) 2001/06/01 DUP AB34827 WATER µg/L		URSMW9D (UNFIL) 2001/06/01 REG AB34826 WATER µg/L		URSMW9D (UNFIL) 2001/12/21 REG AB49160 WATER µg/L	
ALUMINUM	200	NE	NE	180	U	180	U	180	U
BARIUM	2000	2000	2000	437	J	453	J	382	
CALCIUM	NE	NE	NE	81400		83700		66300	
IRON	300	NE	NE	**2700**		**2800**		**1250**	
MAGNESIUM	NE	NE	NE	17200		17700		13400	
MANGANESE	50	NE	NE	**881**	**J**	**905**	**J**	**886**	
POTASSIUM	NE	NE	NE	2000	U	2000	U	2000	U
SODIUM	50000	NE	NE	18300		18700		17400	
VANADIUM	NE	NE	NE	50	U	50	U	50	U
ZINC	5000	NE	NE	50	U	50	U	50	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-23
Summary of Bedrock Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	URSMW11D 2001/05/18 REG WATER pCi/L		URSMW11D 2002/01/02 DUP WATER pCi/L		URSMW11D 2002/01/02 REG WATER pCi/L		URSMW1D 2001/05/14 REG WATER pCi/L		URSMW1D 2001/12/19 REG WATER pCi/L	
Analyte	pCi/L	pCi/L										
GROSS ALPHA	NE	NE	4.44+/-1.21		2.58+/-0.77		2.93+/-0.911		6.47+/-2.09	J	4.75+/-0.844	
GROSS BETA	NE	NE	0.878+/-1.01	U	3.6+/-0.786		1.86+/-0.975		3.57+/-0.997		5.58+/-0.934	
NET ALPHA	15	15	2.06265		-0.187		0.72445		1.828	J	-0.9635	
RADIUM-226	NE	NE	0.892+/-0.514		0.286+/-0.244	U	0.205+/-0.172	U	5.17+/-0.943		0.273+/-0.226	U
RADIUM-226+228	5	5	1.805		0.12915	U	3.00E-03	U	**5.3525**		0.274	U
RADIUM-228	NE	NE	0.913+/-0.499		-0.0277+/-0.592	U	-0.199+/-0.516	U	0.365+/-0.467	U	0.275+/-0.52	U
THORIUM-228	NE	NE	0.0885+/-0.0838	U	0.489+/-0.198		0.131+/-0.161	U	0.178+/-0.0982		0.0866+/-0.141	U
THORIUM-230	NE	NE	0.0173+/-0.0548	U	0.172+/-0.107	J	0.0957+/-0.0754	U	0.0676+/-0.0677	U	0.268+/-0.134	J
THORIUM-232	NE	NE	0.00865+/-0.0173	U	0.0283+/-0.0467	U	0.0112+/-0.0224	U	0.0171+/-0.0458	U	-0.00923+/-0.0613	U
TOTAL URANIUM (µg/L)	30	30	1.35+/-0.543		1.52+/-0.863		1.26+/-0.727		5.99+/-1.21		6.71+/-1.85	
URANIUM-233/234	NE	NE	1.9+/-0.404		2.21+/-0.639		1.76+/-0.535		2.51+/-0.476		3.38+/-0.808	
URANIUM-235/236	NE	NE	0.0647+/-0.0864	U	0.134+/-0.175	U	0.0611+/-0.0998	U	0.142+/-0.0965		0.227+/-0.21	U
URANIUM-238	NE	NE	0.445+/-0.182		0.49+/-0.289		0.415+/-0.244		1.99+/-0.405		2.22+/-0.622	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NE - Not Established.
Boxed results indicate an exceedance in standards.

Table 5-23
Summary of Bedrock Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	URSMW20D 2002/01/07 REG WATER pCi/L		URSMW20D 2002/10/03 REG WATER pCi/L		URSMW2D 2001/05/15 REG WATER pCi/L		URSMW2D 2001/12/20 REG WATER pCi/L		URSMW3D 2001/05/17 REG WATER pCi/L	
Analyte	pCi/L	pCi/L										
GROSS ALPHA	NE	NE	1.32+/-0.975	U	1.08+/-0.729	UJ	66.1+/-5.51	J	1.38+/-0.633		0.523+/-0.76	U
GROSS BETA	NE	NE	1.77+/-0.555		1.63+/-0.472		10.5+/-1.3		3.14+/-0.94		1.09+/-0.822	U
NET ALPHA	15	15	0.39025		-3.80E-02	J	**64.84325**	**J**	1.00E-02	J	-0.8853	
RADIUM-226	NE	NE	1.02+/-0.408	J	0.514+/-0.295		4.87+/-0.854		0.694+/-0.331		0.972+/-0.558	
RADIUM-226+228	5	5	1.418	J	1.454	J	**5.1925**		1.072		1.0845	
RADIUM-228	NE	NE	0.796+/-0.55	U	0.94+/-0.57	J	0.645+/-0.453	U	0.756+/-0.623	U	0.225+/-0.569	U
THORIUM-228	NE	NE	0.129+/-0.112	U	0.134+/-0.174	J	0.066+/-0.0912	U	0.122+/-0.115	U	-0.103+/-0.12	U
THORIUM-230	NE	NE	0.155+/-0.12	U	-0.0161+/-0.0588	J	0.163+/-0.0862	J	0.0314+/-0.0628	U	0.0754+/-0.0737	U
THORIUM-232	NE	NE	-0.00629+/-0.0571	U	0.00774+/-0.0351	J	0.00494+/-0.0339	U	0+/-2	UJ	0.0251+/-0.0376	U
TOTAL URANIUM (µg/L)	30	30	0.379+/-0.348		0.929+/-0.696		0.421+/-0.296		0.915+/-0.652		0.675+/-0.483	
URANIUM-233/234	NE	NE	0.775+/-0.313		0.756+/-0.363		1.09+/-0.302		0.935+/-0.394	J	1.16+/-0.383	
URANIUM-235/236	NE	NE	0.0795+/-0.101	U	0.059+/-0.139	J	0.0735+/-0.0837	U	0.151+/-0.153		0.0626+/-0.208	U
URANIUM-238	NE	NE	0.115+/-0.116		0.303+/-0.233		0.13+/-0.0986		0.284+/-0.218		0.217+/-0.159	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NE - Not Established.
Boxed results indicate an exceedance in standards.

Table 5-23
Summary of Bedrock Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	URSMW3D 2001/12/21 REG WATER pCi/L		URSMW5D 2001/05/21 REG WATER pCi/L		URSMW5D 2001/12/20 DUP WATER pCi/L		URSMW5D 2001/12/20 REG WATER pCi/L		URSMW9D 2001/05/25 DUP WATER pCi/L	
Analyte	pCi/L	pCi/L										
GROSS ALPHA	NE	NE	5.02+/-0.915		1.07+/-0.878	U	3+/-0.774		2.64+/-0.821		5.52+/-1.48	
GROSS BETA	NE	NE	3.25+/-0.906		5.57+/-1.14		2.77+/-0.842		2.99+/-0.871		-0.068+/-1.58	U
NET ALPHA	15	15	0.925		-0.96385		0.71		6.29E-02		4.309	
RADIUM-226	NE	NE	0.217+/-0.168		0.862+/-0.565		0.56+/-0.273		0.0648+/-0.238	U	0.987+/-0.72	U
RADIUM-226+228	5	5	2.137		1.3585		1.61		2.1824		0.7495	U
RADIUM-228	NE	NE	1.92+/-0.552		0.993+/-0.581	U	1.05+/-0.563		2.15+/-0.595		0.512+/-0.485	U
THORIUM-228	NE	NE	0.0688+/-0.148	U	-0.0356+/-0.0558	U	0.166+/-0.159	U	0.174+/-0.272	U	0.433+/-0.128	
THORIUM-230	NE	NE	0.0516+/-0.0918	U	0.107+/-0.076		0.154+/-0.119	U	0.202+/-0.146	J	0.312+/-0.122	
THORIUM-232	NE	NE	-0.035+/-0.0354	U	0.0115+/-0.023	U	0.0633+/-0.0524		-0.0164+/-0.0752	U	0.306+/-0.117	
TOTAL URANIUM (µg/L)	30	30	3.06+/-1.32		1.14+/-0.469		1.39+/-0.773		1.5+/-0.891		0.748+/-0.486	
URANIUM-233/234	NE	NE	3+/-0.781		1.62+/-0.359		1.78+/-0.544		2.05+/-0.648		0.817+/-0.326	
URANIUM-235/236	NE	NE	0.198+/-0.214	U	0.0917+/-0.0979	U	0.124+/-0.144	U	0.0642+/-0.123	U	0.169+/-0.14	
URANIUM-238	NE	NE	0.996+/-0.441		0.368+/-0.157		0.448+/-0.259		0.495+/-0.299		0.225+/-0.162	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NE - Not Established.
Boxed results indicate an exceedance in standards.

Table 5-23
Summary of Bedrock Analytical Results - Radionuclides
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Matrix: Unit:	New Jersey State Primary Drinking Water Standards MCL	USEPA Safe Drinking Water Act MCL	URSMW9D 2001/05/25 REG WATER pCi/L		URSMW9D 2001/12/21 REG WATER pCi/L	
Analyte	pCi/L	pCi/L				
GROSS ALPHA	NE	NE	0.0337+/-0.574	U	2.14+/-0.57	
GROSS BETA	NE	NE	1.11+/-0.788	U	2.28+/-0.713	
NET ALPHA	15	15	-1.0647		0.45	J
RADIUM-226	NE	NE	0.82+/-0.459		0.0816+/-0.176	U
RADIUM-226+228	5	5	1.92	J	0.4413	U
RADIUM-228	NE	NE	1.1+/-0.506	J	0.801+/-0.541	U
THORIUM-228	NE	NE	1.94E-8+/-0.0538	U	0.111+/-0.129	U
THORIUM-230	NE	NE	0.0597+/-0.0379		0.346+/-0.145	J
THORIUM-232	NE	NE	-0.00497+/-0.00997	U	-0.0259+/-0.0301	U
TOTAL URANIUM (µg/L)	30	30	0.981+/-0.501		1.06+/-0.718	
URANIUM-233/234	NE	NE	0.743+/-0.27		1.2+/-0.459	J
URANIUM-235/236	NE	NE	0.0748+/-0.0867	U	0.157+/-0.158	
URANIUM-238	NE	NE	0.318+/-0.168		0.333+/-0.24	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
pCi/L - Pico Curies per liter
NE - Not Established.
Boxed results indicate an exceedance in standards.

Table 5-24a

Summary of Sediment Analytical Results - METALS BACKGROUND (UPSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type / Lab Sample ID: / Matrix: / Units: / Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sediments mg/kg	SWSD004* 2000/07/06 REG 7037-005-01-1 SD mg/kg	SWSD004* 2000/09/15 REG 9109-012-01-1 SD mg/kg	SWSD004* 2000/12/22 REG 12094-010-01-1/1 SD mg/kg	SWSD004* 2001/03/27 REG 103276-011-01-1/2 SD mg/kg	SWSD004* 2001/06/05 REG AB35182 SD mg/kg	SWSD004* 2001/10/09 REG AB44204 SD mg/kg
ALUMINUM	NE	NE	23600	21600	23600	8000 X	17300	15900 J	14400
ANTIMONY	NE	NE	3.47	1.4 J	0.97 U	1.2 U	1.6 U	3.3 U	2.5
ARSENIC	6.0E+00	9.8E+00	5.02	4.6	1.8	3.8	2.1	3.5	5.02
BARIUM	NE	NE	156	156	141	25.3	117	128 J	116
BERYLLIUM	NE	NE	1.38	0.99	0.36	0.63	0.8	0.99 U	0.75
CADMIUM (Note 1)	6.0E-01	9.9E-01	1.04	0.72	0.14 U	0.29	0.31	0.99 U	0.75
CALCIUM	NE	NE	2000	1820 J	1480	587 J	1710	1970 J	1230
CHROMIUM (Note 1)	2.6E+01	4.3E+01	37.2	34.3	37.2	10.7	28.1	22.4 J	26.2
COBALT	NE	NE	14	14	12.2	7	10.6	9.76 J	9.64
COPPER (Note 1)	1.6E+01	3.2E+01	52.5	52.5	45.4	8.2	39.8	37.3 J	24.8
IRON (Note 1)	2.0E+04	NE	38300	31300	38300	7890	25800	27100 J	27400
LEAD (Note 1)	3.1E+01	3.6E+01	40.4	38.7	38.1	40.4	31.7	37.4 J	23.3
MAGNESIUM	NE	NE	7110	6180 J	7110	1130 J	5360	6080 J	4310
MANGANESE (Note 1)	4.6E+02	NE	441	328	307	36.9 J	261	267 J	268
MERCURY (Note 1)	2.0E-01	1.8E-01	0.28	0.22 J	0.05	0.1	0.05	0.28 U	0.18
NICKEL (Note 1)	1.6E+01	2.3E+01	32.7	32.7	32.5	10.5	26.5	26 J	23.1
POTASSIUM	NE	NE	2550	2390	2550	522 J	1740	1720 J	1670
SELENIUM	NE	NE	3.47	1.2 J	1.2 U	0.72 U	0.41 U	3.3 U	2.5
SILVER	NE	NE	4.33	0.72 U	0.65 U	0.79 U	0.39 U	4.1 UJ	3.1
SODIUM	NE	NE	866	411	319	611	321	820 U	630
VANADIUM	NE	NE	53.7	53.1	53.7	18.8	43.6	39.4 J	39.2
ZINC (Note 1)	1.2E+02	1.2E+02	145	145	109	49	93.1	107 J	74.9

Notes:
Qualifiers
U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
Units
mg/kg - milligrams per kilogram
NE - Not Established
NA - Not Analyzed
* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance
Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance
Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24a

Summary of Sediment Analytical Results - METALS BACKGROUND (UPSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sediments mg/kg		SWSD004* 2001/12/19 REG AB48995 SD mg/kg	SWSD004* 2002/04/08 REG 204055-012-01-1/2 SD mg/kg
ALUMINUM	NE	NE	23600	J	15700 J	16100
ANTIMONY	NE	NE	3.47	U	3.47 UJ	0.52 U
ARSENIC	6.0E+00	9.8E+00	5.02		3.47 UJ	2.7
BARIUM	NE	NE	156	J	118 J	107
BERYLLIUM	NE	NE	1.38	U	1.38	0.91
CADMIUM (Note 1)	6.0E-01	9.9E-01	1.04	U	1.04 U	0.13
CALCIUM	NE	NE	2000	J	2000 J	1820
CHROMIUM (Note 1)	2.6E+01	4.3E+01	37.2		27.8 J	26.2
COBALT	NE	NE	14		12.1 J	10.8
COPPER (Note 1)	1.6E+01	3.2E+01	52.5	J	33.4 J	34.6
IRON (Note 1)	2.0E+04	NE	38300	J	27800	25400
LEAD (Note 1)	3.1E+01	3.6E+01	40.4	J	32.1 J	30.3
MAGNESIUM	NE	NE	7110	J	5880	5660
MANGANESE (Note 1)	4.6E+02	NE	441	J	441 J	392
MERCURY (Note 1)	2.0E-01	1.8E-01	0.28	U	0.24 U	0.06
NICKEL (Note 1)	1.6E+01	2.3E+01	32.7	J	27.8	25.5
POTASSIUM	NE	NE	2550	J	2520	2520
SELENIUM	NE	NE	3.47	U	3.47 U	0.52 U
SILVER	NE	NE	4.33	U	4.33 U	0.13
SODIUM	NE	NE	866	U	866 U	364
VANADIUM	NE	NE	53.7		42.3 J	38.6
ZINC (Note 1)	1.2E+02	1.2E+02	145	J	107 J	99.2

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assu
R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram
NE - Not Established
NA - Not Analyzed
* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance
Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance
Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SDDA01 2001/04/18 REG AB32212 SD mg/kg	SDDA01 2002/01/15 REG AB50287 SD mg/kg	SDDA02 2001/04/18 DUP AB32214 SD mg/kg	SDDA02 2001/04/18 REG AB32213 SD mg/kg	SDDA02 2002/01/15 REG AB50288 SD mg/kg
ALUMINUM	NE	NE	**23,600**	13,000	12,700	11,200	13,800	13,600
ANTIMONY	NE	NE	**3.47**	2.4 UJ	2.83 UJ	2.6 UJ	2.3 UJ	2.83 UJ
ARSENIC	**6.0E+00**	9.8E+00	5.02	3.73	3.84	3.48	4.04	**3.86**
BARIUM	NE	NE	**156**	82.9	76.5	76.3	80.5	81.3
BERYLLIUM	NE	NE	**1.38**	0.71 U	0.849 U	0.77 U	0.68 U	0.849 U
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	0.71 U	0.849 U	0.77 U	0.68 U	0.849 U
CALCIUM	NE	NE	**2,000**	**3,000**	**5,720**	**4,480**	**4,460**	**6,320**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	29.9	25.7	19	24	27.7
COBALT	NE	NE	**14**	**14.7 J**	13.7	12.6 J	13.5 J	**14.5**
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	30.1	39.5	29.9	36.2	48.5
IRON (Note 1)	2.0E+04	NE	**38,300**	26,600 J	25,900	23,100 J	27,200 J	28,900
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	31.2	38.2	33.5	36.3	**42.3**
MAGNESIUM	NE	NE	**7,110**	5,470	**7,250 J**	7,020	6,970	**7,600 J**
MANGANESE	**4.6E+02**	NE	441	**680 J**	**763**	**805 J**	**699 J**	**795**
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	0.17 U	0.196 U	0.18 U	0.16 U	0.213 U
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	25.5	28.2	26.6	27.3	29.1
POTASSIUM	NE	NE	**2,550**	994	1,370	1,380	1,360	1,330
SELENIUM	NE	NE	**3.47**	2.53	2.83 U	2.71	2.47	2.83 U
SILVER	NE	NE	**4.33**	2.9 U	3.54 U	3.2 U	2.8 U	3.54 U
SODIUM	NE	NE	**866**	590 U	707 U	640 U	570 U	708 U
VANADIUM	NE	NE	**53.7**	43.1	40.2	34.1	41.5	48.1
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	81.5 J	141	131 J	109 J	**160**

Note 1: Maximum Background exceeds Sediment Quality Guidance

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram
NE - Not Established
NA - Not Analyzed

shaded results indicate an exceedance of comparative criteria.

* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance
Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance
Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type / Lab Sample ID: / Matrix: / Units: / Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SDDA03 2001/04/18 REG AB32215 SD mg/kg	SDDA03 2002/01/15 DUP AB50299 SD mg/kg	SDDA03 2002/01/15 REG AB50289 SD mg/kg	SDDA04 2001/04/18 REG AB32216 SD mg/kg	SDDA04 2002/01/15 REG AB50292 SD mg/kg
ALUMINUM	NE	NE	**23,600**	15,300	18,700	17,100	11,400	13,800
ANTIMONY	NE	NE	**3.47**	2.4 UJ	2.35 UJ	2.82 UJ	2.8 UJ	2.49 UJ
ARSENIC	**6.0E+00**	9.8E+00	5.02	4.1	3.24	4	2.85	3.62
BARIUM	NE	NE	**156**	88.3	77	78	40.3	89.7
BERYLLIUM	NE	NE	**1.38**	0.73 U	1.03 J	0.845 UJ	0.85 U	1.05
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	0.73 U	0.704 U	0.845 U	0.85 U	0.748 U
CALCIUM	NE	NE	**2,000**	**5,190**	**6,950**	**7,500**	**7,080**	**2,700**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	26.4	27.9	34.7	19.3	26.4
COBALT	NE	NE	**14**	**15 J**	**14.9**	**15.6**	**15.2 J**	**14.4**
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	42	45.8 J	**70.1 J**	**80.7**	38.4
IRON (Note 1)	2.0E+04	NE	**38,300**	29,600 J	30,800	30,700	26,000 J	25,900
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	39.4	35.2	34.9	26	**45.7**
MAGNESIUM	NE	NE	**7,110**	**7,850**	**8,590 J**	**9,230 J**	**9,710**	6,280 J
MANGANESE	**4.6E+02**	NE	441	**788 J**	**671**	**725**	388 J	418
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	0.17 U	0.188 U	0.2 U	0.2 U	0.183 U
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	30.2	29	31.8	**34**	29.5
POTASSIUM	NE	NE	**2,550**	1,460	2,490	1,950	567	**2,880**
SELENIUM	NE	NE	**3.47**	2.94	2.35 U	2.82 U	2.8 U	2.49 U
SILVER	NE	NE	**4.33**	3.34	2.93 U	3.52 U	3.7 U	3.12 U
SODIUM	NE	NE	**866**	610 U	832	**897**	**897**	623 U
VANADIUM	NE	NE	**53.7**	46.9	51.8	53.3	**54.6**	39.9
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	120 J	128	134	**203 J**	**372**

Note 1: Maximum Background exceeds Sediment Quality Guidance
Notes:
Qualifiers
U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie
R - Result regarded as unreliable. Analyte may or may not be present.
Units
mg/kg - milligrams per kilogram
NE - Not Established
NA - Not Analyzed
shaded results indicate an exceedance of comparative criteria.
* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance
Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance
Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SDDA05 2001/04/18 REG AB32217 SD mg/kg	SDDA05 2002/01/15 REG AB50293 SD mg/kg	SDDA06 2001/04/18 REG AB32218 SD mg/kg	SDDA06 2002/01/15 REG AB50294 SD mg/kg	SDDA07 2001/04/18 REG AB32219 SD mg/kg
ALUMINUM	NE	NE	**23,600**	16,000	19,000	19,700	11,300	12,900
ANTIMONY	NE	NE	**3.47**	**12.6 J**	**9.2 UJ**	**12.9 J**	**8.95 UJ**	2.6 UJ
ARSENIC	**6.0E+00**	9.8E+00	5.02	**37.4**	**17.7**	**26.4**	**11.3**	2.6 U
BARIUM	NE	NE	**156**	141	98.7	**162**	60.4	57.2
BERYLLIUM	NE	NE	**1.38**	**2.7 U**	**2.76 U**	**2.5 U**	**2.69 U**	0.78 U
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	**2.8**	**2.76 U**	**2.5 U**	**2.69 U**	0.78 U
CALCIUM	NE	NE	**2,000**	**8,150**	**8,530**	**9,260**	**5,960**	**7,030**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	22 U	29.3	21 U	22.4 U	19.5
COBALT	NE	NE	**14**	**21.4 J**	**17.5**	**23.7 J**	11.2 U	**15.4 J**
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	**258**	**240**	**287**	**127**	**61.2**
IRON (Note 1)	2.0E+04	NE	**38,300**	32,900 J	28,300	36,500 J	17,800	26,000 J
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	**302**	**211**	**323**	**133**	28.1
MAGNESIUM	NE	NE	**7,110**	**9,160**	**7,530 J**	**11,100**	5,430 J	**9,430**
MANGANESE	**4.6E+02**	NE	441	**1080 J**	**894**	**844 J**	362	**550 J**
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	**0.57 U**	**0.684 U**	**0.52 U**	**0.676 U**	0.16 U
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	**57.1**	**46.3**	**66.1**	27.7	31.9
POTASSIUM	NE	NE	**2,550**	1,250	2,420	1,570	1,400	1,000
SELENIUM	NE	NE	**3.47**	**8.9 U**	**9.2 U**	**8.3 U**	**8.95 U**	2.6 U
SILVER	NE	NE	**4.33**	**11 U**	**11.5 U**	**10 U**	**11.2 U**	3.3 U
SODIUM	NE	NE	**866**	**2,200 U**	**2,300 U**	**2,100 U**	**2,240 U**	755
VANADIUM	NE	NE	**53.7**	**84.2**	**76.4**	**94.6**	44.8 U	47.2
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	**3050 J**	**2260**	**2400 J**	**1440**	122 J

Note 1: Maximum Background exceeds Sediment Quality Guidance

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie
R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram
NE - Not Established
NA - Not Analyzed

shaded results indicate an exceedance of comparative criteria.
* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance
Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance
Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SDDA07 2002/01/15 REG AB50295 SD mg/kg	SDDA08 2001/04/19 REG AB32222 SD mg/kg	SDDA08 2002/01/15 REG AB50296 SD mg/kg	SDDA09 2001/04/19 REG AB32221 SD mg/kg	SDDA09 2002/01/15 REG AB50297 SD mg/kg
ALUMINUM	NE	NE	**23,600**	4,730	16,400	17,300	13,500	14,500
ANTIMONY	NE	NE	**3.47**	**5.48 UJ**	2.5 UJ	2.56 UJ	2.5 UJ	2.74 UJ
ARSENIC	**6.0E+00**	9.8E+00	5.02	5.48 U	3.51	4.43	4.56	2.79
BARIUM	NE	NE	**156**	27.4 U	76.3	92.1	95.5	80.1
BERYLLIUM	NE	NE	**1.38**	**1.65 U**	0.74 U	1.23	0.783	0.862
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	**1.65 U**	0.74 U	0.768 U	0.73 U	0.821 U
CALCIUM	NE	NE	**2,000**	**3,210**	**5,860**	**2,900**	**4,130**	**4,730**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	13.7 U	24.4	**40.7**	23.7	29.2
COBALT	NE	NE	**14**	6.85 U	**16.2 J**	14	**16.2 J**	13.2
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	**109**	49.1	20.9	36.8	28.6
IRON (Note 1)	2.0E+04	NE	**38,300**	6,520	31,700 J	33,300	29,100 J	26,600
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	**74.2**	33.4	36.2	37.4	32.4
MAGNESIUM	NE	NE	**7,110**	1,970 J	**9,440**	6,210 J	**7,500**	5,920 J
MANGANESE	**4.6E+02**	NE	441	183	**794 J**	**912**	**1100 J**	**740**
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	**0.455 U**	0.15 U	0.187 U	0.16 U	0.208 U
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	13.7 U	31.5	24.2	29.7	23.9
POTASSIUM	NE	NE	**2,550**	685 U	1,610	2,470	1,740	2,060
SELENIUM	NE	NE	**3.47**	**5.48 U**	2.77	2.56 U	3.25	2.74 U
SILVER	NE	NE	**4.33**	**6.85 U**	3 U	3.2 U	2.9 U	3.42 U
SODIUM	NE	NE	**866**	**1,370 U**	712	640 U	610 U	684 U
VANADIUM	NE	NE	**53.7**	27.4 U	52.7	46.4	42.3	43.4
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	**1030**	99.1 J	110	105 J	104

Note 1: Maximum Background exceeds Sediment Quality Guidance

Notes:

Qualifiers

U - The compound was not detected.

J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie

R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram

NE - Not Established

NA - Not Analyzed

shaded results indicate an exceedance of comparative criteria.

* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance

Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance

Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SDDA10 2001/04/19 REG AB32223 SD mg/kg	SDDA10 2002/01/15 REG AB50298 SD mg/kg	SDDB01 2001/04/18 REG AB31865 SD mg/kg	SDDB01 2002/01/15 REG AB50273 SD mg/kg	SDDB02 2001/04/18 REG AB31866 SD mg/kg
ALUMINUM	NE	NE	**23,600**	12,900	6,120	15,400	10,500	17,800
ANTIMONY	NE	NE	**3.47**	2.7 UJ	2.44 UJ	3.41 J	2.71 UJ	3 UJ
ARSENIC	**6.0E+00**	9.8E+00	5.02	3.64	2.44 U	4.43	2.77	4.93
BARIUM	NE	NE	**156**	82.3	39.8	98.6	80.5	124
BERYLLIUM	NE	NE	**1.38**	0.81 U	0.732 U	0.69 U	0.814 U	0.9 U
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	0.81 U	0.732 U	0.69 U	0.814 U	0.9 U
CALCIUM	NE	NE	**2,000**	**3,450**	**3,530**	1,800	**2,410**	**3,920**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	24.6	11.2	**85.7**	34.6	**56.7**
COBALT	NE	NE	**14**	**14.4 J**	7.67	**19.6**	12.8	**20**
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	34.1	30	26.2 J	23	43.5 J
IRON (Note 1)	2.0E+04	NE	**38,300**	26,300 J	13,700	34,800	22,300	34,400
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	30.7	14.9	23.7 J	25.1	**47.2 J**
MAGNESIUM	NE	NE	**7,110**	6,430	4,380 J	3,980	4,080 J	5,710
MANGANESE	**4.6E+02**	NE	441	**743 J**	386	**778 J**	**696**	**752 J**
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	0.16 U	0.183 U	0.17 U	0.189 U	0.22 U
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	27.1	15.4	24.6	19.1	**39.2**
POTASSIUM	NE	NE	**2,550**	1,520	993	1,230	1,380	1,970
SELENIUM	NE	NE	**3.47**	2.7 U	2.44 U	**3.61**	2.71 U	3.43
SILVER	NE	NE	**4.33**	3.3 U	3.05 U	2.9 U	3.39 U	3.7 U
SODIUM	NE	NE	**866**	670 U	610 U	580 U	678 U	750 U
VANADIUM	NE	NE	**53.7**	42	24.5	**78.5**	43.2	**65.6**
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	85.3 J	57.1	104 J	78.9	115 J

Note 1: Maximum Background exceeds Sediment Quality Guidance

Notes:

Qualifiers

U - The compound was not detected.

J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie

R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram

NE - Not Established

NA - Not Analyzed

shaded results indicate an exceedance of comparative criteria.

* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance

Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance

Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SDDB02 2002/01/15 REG AB50274 SD mg/kg	SDDB03 2001/04/18 REG AB31867 SD mg/kg	SDDB03 2002/01/15 DUP AB50285 SD mg/kg	SDDB03 2002/01/15 REG AB50275 SD mg/kg	SDDB04 2001/04/18 REG AB31868 SD mg/kg
ALUMINUM	NE	NE	**23,600**	9,320	15,300	17,700	13,300	16,000
ANTIMONY	NE	NE	**3.47**	2.72 UJ	2.7 UJ	3.14 UJ	2.81 UJ	2.4 UJ
ARSENIC	**6.0E+00**	9.8E+00	5.02	2.72 U	4.27	4.05	3.57	5.14
BARIUM	NE	NE	**156**	64.8	103	99	92.5	110
BERYLLIUM	NE	NE	**1.38**	0.817 U	0.81 U	0.943 U	0.842 U	0.71 U
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	0.817 U	0.81 U	0.943 U	0.842 U	0.71 U
CALCIUM	NE	NE	**2,000**	1,990	**3,660**	**4,610**	**3,500**	1,930
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	**38.8**	**40.6**	**41.2**	**42.3**	**54**
COBALT	NE	NE	**14**	**14.3**	**20.3**	**17.1**	**19.5**	**20.4**
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	22.8	46.4 J	**53.5**	40.7	34.3 J
IRON (Note 1)	2.0E+04	NE	**38,300**	21,600	27,900	31,500	30,300	29,600
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	22	**60.9 J**	**74.6**	**55.9**	**47.5 J**
MAGNESIUM	NE	NE	**7,110**	3,260 J	5,040	6,250 J	5,780 J	4,030
MANGANESE	**4.6E+02**	NE	441	**761**	**818 J**	**908**	**800**	**646 J**
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	0.196 U	0.18 U	0.224 U	0.211 U	0.18 U
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	16.4	28.9	29.4	27.1	26.6
POTASSIUM	NE	NE	**2,550**	1,080	1,550	2,060 J	1,170 J	1,180
SELENIUM	NE	NE	**3.47**	2.72 U	3.12	3.14 U	2.81 U	2.89
SILVER	NE	NE	**4.33**	3.4 U	3.4 U	3.93 U	3.51 U	3 U
SODIUM	NE	NE	**866**	681 U	670 U	786 U	701 U	590 U
VANADIUM	NE	NE	**53.7**	46.5	53.2	**57.4**	**54.9**	**65.2**
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	64.3	**147 J**	**209 J**	137 J	99.5 J

Note 1: Maximum Background exceeds Sediment Quality Guidance

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie
R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram
NE - Not Established
NA - Not Analyzed

shaded results indicate an exceedance of comparative criteria.

* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance

Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance

Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SDDB04 2002/01/15 REG AB50276 SD mg/kg	SDDB05 2001/04/18 DUP AB31870 SD mg/kg	SDDB05 2001/04/18 REG AB31869 SD mg/kg	SDDB05 2002/01/15 REG AB50277 SD mg/kg	SDDB06 2001/04/18 REG AB31871 SD mg/kg
ALUMINUM	NE	NE	**23,600**	12,300	8,390	9,410	13,200	7,810
ANTIMONY	NE	NE	**3.47**	**5.75 UJ**	2.54 J	2.3 UJ	**5.44 UJ**	**3.51 J**
ARSENIC	**6.0E+00**	9.8E+00	5.02	5.75 U	4.91	3.67	5.44 U	5.1
BARIUM	NE	NE	**156**	106	88.2	99.4	121	99.2
BERYLLIUM	NE	NE	**1.38**	**1.73 U**	0.72 U	0.7 U	**1.63 U**	0.83 U
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	**1.73 U**	**1.34**	0.935	**1.63 U**	**2.21**
CALCIUM	NE	NE	**2,000**	**6,130**	**3,780**	**2,600**	**5,900**	**5,270**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	**43.6**	25.8	24.1	**42.8**	24
COBALT	NE	NE	**14**	12.3	10.9	11.9	12	9.19
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	**150**	**100 J**	**69.7 J**	**167**	**112 J**
IRON (Note 1)	2.0E+04	NE	**38,300**	26,600	19,400	18,900	26,100	17,600
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	**244**	**161 J**	**108 J**	**263**	**154 J**
MAGNESIUM	NE	NE	**7,110**	6,510 J	4,350	4,030	6,200 J	4,540
MANGANESE	**4.6E+02**	NE	441	**492**	292 J	254 J	**506**	319 J
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	**0.425 U**	0.21 U	0.19 U	**0.392 U**	0.21 U
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	**33.7**	29.6	25.6	**34.7**	**41.7**
POTASSIUM	NE	NE	**2,550**	1,010	696	843	1,330	655
SELENIUM	NE	NE	**3.47**	**5.75 U**	2.59	2.3 U	**5.44 U**	2.82
SILVER	NE	NE	**4.33**	**7.19 U**	3.43	2.9 U	**6.81 U**	3.4 U
SODIUM	NE	NE	**866**	**1,440 U**	600 U	580 U	**1,360 U**	690 U
VANADIUM	NE	NE	**53.7**	**56.9**	41.7	33.9	**59.1**	41.9
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	**554**	**382 J**	**237 J**	**631**	**444 J**

Note 1: Maximum Background exceeds Sediment Quality Guidance

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie
R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram
NE - Not Established
NA - Not Analyzed

shaded results indicate an exceedance of comparative criteria.

* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance

Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance

Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type / Lab Sample ID: / Matrix: / Units: / Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SDDB06 2002/01/15 REG AB50278 SD mg/kg	SDDB07 2001/04/18 REG AB31872 SD mg/kg	SDDB07 2002/01/15 REG AB50279 SD mg/kg	SDDB08 2001/04/18 REG AB31873 SD mg/kg	SDDB08 2002/01/15 REG AB50280 SD mg/kg
ALUMINUM	NE	NE	**23,600**	3,850	10,500	6,770	13,300	15,700
ANTIMONY	NE	NE	**3.47**	2.74 UJ	3.08 J	**4.84 UJ**	2.4 UJ	**3.57 UJ**
ARSENIC	**6.0E+00**	9.8E+00	5.02	2.74 U	4.98	4.84 U	4.73	3.81
BARIUM	NE	NE	**156**	42.5	100	73.9	108	89.3
BERYLLIUM	NE	NE	**1.38**	0.823 U	0.81 U	**1.45 U**	0.72 U	1.07 U
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	0.823 U	**1.57**	**1.45 U**	**1.08**	**1.07 U**
CALCIUM	NE	NE	**2,000**	**2,670**	**4,540**	**4,020**	**6,480**	**5,470**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	18.9	29.5	25	33	**40.4**
COBALT	NE	NE	**14**	3.82	12.1	8.67	13.6	**17.8**
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	47.5	**110 J**	**89.3**	**77.2 J**	**73.4**
IRON (Note 1)	2.0E+04	NE	**38,300**	10,500	21,600	14,900	25,800	31,400
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	**61.3**	**204 J**	**142**	**114 J**	**122**
MAGNESIUM	NE	NE	**7,110**	2,460 J	5,060	3,650 J	5,180	**7,820 J**
MANGANESE	**4.6E+02**	NE	441	95.6	432 J	**571**	**796 J**	**959**
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	0.222 U	0.22 U	**0.358 U**	0.25 U	0.253 U
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	11	31.5	19.5	28.8	32.3
POTASSIUM	NE	NE	**2,550**	343 U	851	605 U	1,360	1,420
SELENIUM	NE	NE	**3.47**	2.74 U	2.93	**4.84 U**	3.01	**3.57 U**
SILVER	NE	NE	**4.33**	3.43 U	3.4 U	**6.05 U**	3 U	**4.46 U**
SODIUM	NE	NE	**866**	685 U	670 U	**1,210 U**	600 U	**893 U**
VANADIUM	NE	NE	**53.7**	20	47.8	30.7	50.8	**56.7**
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	**150**	**406 J**	**320**	**252 J**	**229**

Note 1: Maximum Background exceeds Sediment Quality Guidance

Notes:

Qualifiers

U - The compound was not detected.

J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie

R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram

NE - Not Established

NA - Not Analyzed

shaded results indicate an exceedance of comparative criteria.

* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance

Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance

Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SDDB09 2001/04/18 REG AB31875 SD mg/kg	SDDB09 2002/01/15 REG AB50283 SD mg/kg	SDDB10 2001/04/18 REG AB31876 SD mg/kg	SDDB10 2002/01/15 REG AB50284 SD mg/kg	SWSD001* 2000/07/06 REG 7037-006-01-1 SD mg/kg
ALUMINUM	NE	NE	**23,600**	11,000	8,630	13,100	12,300	16,900
ANTIMONY	NE	NE	**3.47**	**3.8 UJ**	2.95 UJ	2.7 UJ	2.45 UJ	1 J
ARSENIC	**6.0E+00**	9.8E+00	5.02	3.96	2.95 U	3.93	3.19	**17.5**
BARIUM	NE	NE	**156**	117	83.2	101	81	155
BERYLLIUM	NE	NE	**1.38**	1.1 U	0.886 U	0.81 U	0.735 U	0.57
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	**1.23**	0.886 U	0.81 U	0.735 U	**3.3**
CALCIUM	NE	NE	**2,000**	**7,180**	**3,110**	**3,590**	1,340	**7,290 J**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	31.5	28.7	**43.6**	**41.3**	**74.1**
COBALT	NE	NE	**14**	13.7	**26.9**	**17.8**	**15.6**	**17.5 J**
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	**73.8 J**	36.7	27.8 J	19.1	**158**
IRON (Note 1)	2.0E+04	NE	**38,300**	23,300	19,700	27,700	28,800	33,000
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	**83.1 J**	35.6	**41.8 J**	22.6	**219**
MAGNESIUM	NE	NE	**7,110**	4,890	4,040 J	4,410	4,140 J	**7,150 J**
MANGANESE	**4.6E+02**	NE	441	**976 J**	**1060**	**1040 J**	**792**	**1290**
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	0.28 U	0.214 U	0.17 U	0.172 U	0.27 J
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	26.4	19.4	25.2	21.4	**44**
POTASSIUM	NE	NE	**2,550**	1,350	1,030	1,670	1,320	1,150
SELENIUM	NE	NE	**3.47**	**3.8 U**	2.95 U	3.5	2.45 U	0.84 J
SILVER	NE	NE	**4.33**	**4.7 U**	3.69 U	3.4 U	3.06 U	0.51
SODIUM	NE	NE	**866**	**950 U**	738 U	670 U	612 U	**1,030**
VANADIUM	NE	NE	**53.7**	49.1	40.8	**57**	50.4	**72.9**
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	**289 J**	98	112 J	74.9	**945**

Note 1: Maximum Background exceeds Sediment Quality Guidance

Notes:

Qualifiers

U - The compound was not detected.

J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie

R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram

NE - Not Established

NA - Not Analyzed

shaded results indicate an exceedance of comparative criteria.

* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance

Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance

Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SWSD001* 2000/09/15 REG 9109-011-01-1 SD mg/kg	SWSD001* 2000/12/22 REG 12094-011-01-1/1 SD mg/kg	SWSD001* 2001/03/27 REG 103276-012-01-1/2 SD mg/kg	SWSD001* 2001/06/05 REG AB35183 SD mg/kg	SWSD001* 2001/10/09 REG AB44205 SD mg/kg
ALUMINUM	NE	NE	**23,600**	19,700	18,100 J	17,200	15,900 J	6,230 J
ANTIMONY	NE	NE	**3.47**	2.1	0.89 U	2.1	**5.82**	2.5 U
ARSENIC	**6.0E+00**	9.8E+00	5.02	1.7	5.3	**14.2**	**14.5**	3.12
BARIUM	NE	NE	**156**	121	112	**174**	111 J	30 J
BERYLLIUM	NE	NE	**1.38**	0.34	1.1	0.47	1.3 U	0.76 U
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	1	**1.2**	**3.7**	**3.29**	0.76 U
CALCIUM	NE	NE	**2,000**	**5,050**	**5,320 J**	**7,360**	**8,630 J**	**4,340 J**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	35.6	**37.9**	**53.4**	19.7 J	8.46
COBALT	NE	NE	**14**	**16.9**	**15.1**	**18.8**	12.2 J	9.53
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	40.3	**56.1**	**190**	**152 J**	46.4 J
IRON (Note 1)	2.0E+04	NE	**38,300**	35,900	30,600	33,900	32,000 J	18,300 J
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	**64.8**	**71.4**	**268**	**212 J**	24.6 J
MAGNESIUM	NE	NE	**7,110**	**8,290**	**7,890 J**	**7,840**	**8,440 J**	4,820 J
MANGANESE	**4.6E+02**	NE	441	**1500**	**1140 J**	**1150**	**780 J**	230 J
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	0.05	0.1	0.28	**0.36 U**	0.18 U
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	**33.9**	**34.2**	**49.4**	**36.1 J**	21.6 J
POTASSIUM	NE	NE	**2,550**	**2,890**	2,250 J	1,200	889 J	618 J
SELENIUM	NE	NE	**3.47**	1.1 U	0.55 U	0.53 U	**4.5 U**	2.5 U
SILVER	NE	NE	**4.33**	1	0.76	2.2	**5.6 UJ**	3.2 U
SODIUM	NE	NE	**866**	556	582	**1,140**	**1,870**	640 U
VANADIUM	NE	NE	**53.7**	50.6	48.3	**74**	51.2 J	43.8
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	**243**	**311**	**1170**	**1110 J**	**414 J**

Note 1: Maximum Background exceeds Sediment Quality Guidance

Notes:

Qualifiers

U - The compound was not detected.

J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie

R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram

NE - Not Established

NA - Not Analyzed

shaded results indicate an exceedance of comparative criteria.

* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance

Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance

Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SWSD001* 2001/12/19 REG AB48996 SD mg/kg	SWSD001* 2002/04/08 REG 204055-013-01-1/2 SD mg/kg	SWSD001* 2002/09/27 REG 209177-003-011-1/2 SD mg/kg	SWSD003* 2000/07/06 REG 7037-002-01-1 SD mg/kg	SWSD003* 2000/09/15 REG 9109-010-01-1 SD mg/kg
ALUMINUM	NE	NE	**23,600**	14,300 J	**35,600**	21,500	6,500	9,660
ANTIMONY	NE	NE	**3.47**	**4.45 UJ**	**5.8**	**5.9 J**	0.53 UJ	1.8
ARSENIC	**6.0E+00**	9.8E+00	5.02	**14.6 J**	**46.4**	**30.8**	0.44	1.5
BARIUM	NE	NE	**156**	133 J	**311**	123	45	156
BERYLLIUM	NE	NE	**1.38**	1.34 U	**1.6**	1	0.37	0.3
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	**1.34 U**	**6.5**	**4.1**	0.27	0.91
CALCIUM	NE	NE	**2,000**	**7,620 J**	**15,400**	**9,340**	**5,760 J**	**6,650**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	**41.5 J**	**99.3**	**59**	17.1	27.5
COBALT	NE	NE	**14**	**17 J**	**35.1**	**20.1**	6.5 J	10
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	**144 J**	**363**	**302**	43.8	**69.5**
IRON (Note 1)	2.0E+04	NE	**38,300**	32,100	**68,400**	32,400	22,900	24,400
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	**205 J**	**483**	**260**	**177 J**	**53.9**
MAGNESIUM	NE	NE	**7,110**	6,690	**15,200**	**8,960 J**	4,170 J	5,780
MANGANESE	**4.6E+02**	NE	441	**1490 J**	**1880**	301	237	246
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	**0.438**	**0.52**	0.27	0.03 UJ	0.04
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	**42.5**	**94.4**	**59.7**	17.8	27.9
POTASSIUM	NE	NE	**2,550**	1,080	**3,290**	2,070 J	495	852
SELENIUM	NE	NE	**3.47**	**4.45 U**	**4.1**	**5.2**	0.44 UJ	1 U
SILVER	NE	NE	**4.33**	**5.57 U**	4	2.2	0.27 U	0.91
SODIUM	NE	NE	**866**	**1,110 U**	**2,230**	**1,130**	514	685
VANADIUM	NE	NE	**53.7**	**63.6 J**	**139**	**90.4**	26.1	37.3
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	**928 J**	**2560**	**3420 U**	97.2	**193**

Note 1: Maximum Background exceeds Sediment Quality Guidance

Notes:

Qualifiers

U - The compound was not detected.

J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie

R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram

NE - Not Established

NA - Not Analyzed

shaded results indicate an exceedance of comparative criteria.

* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance

Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance

Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SWSD003* 2000/12/22 REG 12094-007-01-1/2 SD mg/kg	SWSD003* 2001/03/27 REG 103276-008-01-1/4 SD mg/kg	SWSD003* 2001/06/05 REG AB35177 SD mg/kg	SWSD003* 2001/10/09 REG AB44199 SD mg/kg	SWSD003* 2001/12/19 REG AB48990 SD mg/kg
ALUMINUM	NE	NE	**23,600**	12,700 J	8,330	6,090 J	2,700 J	4,080 J
ANTIMONY	NE	NE	**3.47**	1.2 U	1.8 U	2.4 U	2.6 U	2.47 UJ
ARSENIC	**6.0E+00**	9.8E+00	5.02	**8.8**	**7.5**	2.77	2.6 U	2.64 J
BARIUM	NE	NE	**156**	139	83.3	36.3 J	23.6 J	31.6 J
BERYLLIUM	NE	NE	**1.38**	0.93	0.44	0.73 U	0.77 U	0.741 U
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	**1.2**	0.77	0.73 U	0.77 U	0.741 U
CALCIUM	NE	NE	**2,000**	**5,280 J**	**4,310**	**5,580 J**	**4,150 J**	**3,420 J**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	**50.5**	31.1	13.1 J	12.1	15.3 J
COBALT	NE	NE	**14**	10.9	7.4	5.91 J	4.67	5.95 J
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	**72.7**	**61.6**	**59.3 J**	28 J	**56.4 J**
IRON (Note 1)	2.0E+04	NE	**38,300**	25,800	17,900	20,600 J	12,400 J	17,900
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	**107**	**78.4**	24.1 J	**52.8 J**	20 J
MAGNESIUM	NE	NE	**7,110**	4,320 J	3,100	4,010 J	2,750 J	3,080
MANGANESE	**4.6E+02**	NE	441	**793 J**	400	322 J	148 J	161 J
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	0.11	0.05	0.17 U	0.18 U	0.175 U
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	29.7	21.4	19.2 J	11.5 J	15.1
POTASSIUM	NE	NE	**2,550**	1,260 J	767	331 J	320 U	384
SELENIUM	NE	NE	**3.47**	0.73 U	0.45 U	2.4 U	2.6 U	2.47 U
SILVER	NE	NE	**4.33**	0.87	2.3	3 UJ	3.2 U	3.09 U
SODIUM	NE	NE	**866**	563	758	600 U	640 U	617 U
VANADIUM	NE	NE	**53.7**	41.7	30.1	19.4 J	14.2	16.8 J
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	**333**	**244**	128 J	109 J	112 J

Note 1: Maximum Background exceeds Sediment Quality Guidance

Notes:

Qualifiers

U - The compound was not detected.

J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie

R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram

NE - Not Established

NA - Not Analyzed

shaded results indicate an exceedance of comparative criteria.

* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance

Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance

Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SWSD003* 2002/04/08 DUP 204055-010-01-1/2 SD mg/kg	SWSD003* 2002/04/08 REG 204055-008-01-1/2 SD mg/kg	SWSD003* 2002/10/01 DUP 210018-006-023-1/2 SD mg/kg	SWSD003* 2002/10/01 REG 210018-005-017-1/6 SD mg/kg	SWSD006* 2000/07/06 DUP 7037-003-01-1 SD mg/kg
ALUMINUM	NE	NE	**23,600**	8,230	5,790	9,210	7,510	**23,700**
ANTIMONY	NE	NE	**3.47**	0.35 U	0.44	0.28 UJ	0.27 UJ	1.4 UJ
ARSENIC	**6.0E+00**	9.8E+00	5.02	4	3.4	**6.7**	5.3	**9.1**
BARIUM	NE	NE	**156**	54.7	57.9	65.5 J	62.7 J	**196**
BERYLLIUM	NE	NE	**1.38**	0.64	0.34	0.68	0.47	1.3
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	0.36	0.58	0.63	0.55	0.7
CALCIUM	NE	NE	**2,000**	**5,580**	**4,210**	**2,980 J**	**3,080 J**	**3,330 J**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	21.7	27.2	24.5 J	20.9 J	**37.8**
COBALT	NE	NE	**14**	7.3	5	7.9	7	**17.2 J**
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	**81.6**	43	50.3	46.4	**115**
IRON (Note 1)	2.0E+04	NE	**38,300**	21,400	11,700	17,100	16,000	32,100
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	39.5	**76.8**	**88.3 J**	**92.3 J**	**115**
MAGNESIUM	NE	NE	**7,110**	3,990	2,530	2,760 J	2,780 J	6,580 J
MANGANESE	**4.6E+02**	NE	441	170	123	191 J	136 J	**838**
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	0.03	0.03	0.045	0.027	0.22 UJ
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	21.6	14.5	22.2	17.9	**34.6**
POTASSIUM	NE	NE	**2,550**	788	542	1,080 J	959 J	2,400
SELENIUM	NE	NE	**3.47**	0.35 U	0.37 U	0.4	0.28 J	1.2 J
SILVER	NE	NE	**4.33**	1.2	2.4	2.4	0.45	3.2 J
SODIUM	NE	NE	**866**	437	371	256	322	488
VANADIUM	NE	NE	**53.7**	32.6	22.3	32	25.8	53.3
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	**214**	**155**	136 J	**168 J**	**278**

Note 1: Maximum Background exceeds Sediment Quality Guidance
Notes:
Qualifiers
U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie
R - Result regarded as unreliable. Analyte may or may not be present.
Units
mg/kg - milligrams per kilogram
NE - Not Established
NA - Not Analyzed
shaded results indicate an exceedance of comparative criteria.
* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance
Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance
Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type / Lab Sample ID: / Matrix: / Units: / Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SWSD006* 2000/07/06 REG 7037-004-01-1 SD mg/kg	SWSD006* 2000/09/15 DUP 9109-009-01-1 SD mg/kg	SWSD006* 2000/09/15 REG 9109-014-01-1 SD mg/kg	SWSD006* 2000/12/22 DUP 12094-009-01-1/1 SD mg/kg	SWSD006* 2000/12/22 REG 12094-008-01-1/1 SD mg/kg
ALUMINUM	NE	NE	**23,600**	19,300	23,000	**26,200**	18,800 J	18,300 J
ANTIMONY	NE	NE	**3.47**	0.89 UJ	1.1 U	1.4 U	1.6 U	1.7 U
ARSENIC	**6.0E+00**	9.8E+00	5.02	6	**13.9**	**11.3**	**7.4**	**6.7**
BARIUM	NE	NE	**156**	**165**	**258**	**219**	**190**	**184**
BERYLLIUM	NE	NE	**1.38**	1.1	0.41	0.5	1.2	1.2
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	0.54	**1.2**	**1.5**	**1.7**	**1.2**
CALCIUM	NE	NE	**2,000**	**3,160 J**	**3,790**	**5,160**	**4,730 J**	**4,510 J**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	31.5	**40.7**	**44.8**	31.5	29.4
COBALT	NE	NE	**14**	**14.2**	**15.1**	**17.7**	**15**	**15.3**
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	**78.2 J**	**109**	**121**	**91.8**	**75**
IRON (Note 1)	2.0E+04	NE	**38,300**	28,000	**45,800**	**38,600**	30,500	30,100
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	**83.1**	**93.3**	**87.1**	**72.9**	**58.4**
MAGNESIUM	NE	NE	**7,110**	5,780 J	6,760	**7,700**	5,420 J	5,330 J
MANGANESE	**4.6E+02**	NE	441	**666**	**2090**	**1100**	**2030 J**	**2820 J**
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	0.12 J	0.05	0.09	0.15	0.11
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	31.2	**37**	**41.5**	31.9	30.5
POTASSIUM	NE	NE	**2,550**	1,900	2,270	**2,820**	2,170 J	2,190 J
SELENIUM	NE	NE	**3.47**	0.74 J	1.4 U	1.7 U	0.97 U	1 U
SILVER	NE	NE	**4.33**	0.44 J	1.2	1.5	1.4	1.4
SODIUM	NE	NE	**866**	408	449	602	551	554
VANADIUM	NE	NE	**53.7**	47.1	**56.1**	**63.6**	47.7	43.2
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	**260**	**390**	**367**	**346**	**288**

Note 1: Maximum Background exceeds Sediment Quality Guidance

Notes:

Qualifiers

U - The compound was not detected.

J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie

R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram

NE - Not Established

NA - Not Analyzed

shaded results indicate an exceedance of comparative criteria.

* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance

Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance

Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type Lab Sample ID: Matrix: Units: Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SWSD006* 2001/03/27 DUP 103276-010-01-1/2 SD mg/kg	SWSD006* 2001/03/27 REG 103276-009-01-1/2 SD mg/kg	SWSD006* 2001/06/05 DUP AB35181 SD mg/kg	SWSD006* 2001/06/05 REG AB35180 SD mg/kg	SWSD006* 2001/10/09 DUP AB44203 SD mg/kg
ALUMINUM	NE	NE	**23,600**	22,700	15,500	15,600 J	17,100 J	14,400 J
ANTIMONY	NE	NE	**3.47**	2.5 U	2.3 U	**5.7 U**	**6.6 U**	**7.1 U**
ARSENIC	**6.0E+00**	9.8E+00	5.02	**6.8**	**7.1**	5.78	**6.6 U**	**7.3**
BARIUM	NE	NE	**156**	**230**	**184**	**167 J**	**187 J**	**181 J**
BERYLLIUM	NE	NE	**1.38**	1.2	0.92	**1.7 U**	**2 U**	**2.1 U**
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	**1.5**	**1.4**	**1.7 U**	**2 U**	**2.1 U**
CALCIUM	NE	NE	**2,000**	**4,460**	**4,820**	**8,640 J**	**6,700 J**	**3,930 J**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	**41.5**	28.6	19.8 J	17 U	27
COBALT	NE	NE	**14**	**18.7**	**14.1**	12.7 J	11.9 J	13
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	**122**	**115**	**69.7 J**	**72.4 J**	**80.9 J**
IRON (Note 1)	2.0E+04	NE	**38,300**	35,600	28,400	30,800 J	32,500 J	24,700 J
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	**92.7**	**69.4**	**57.9 J**	**60.9 J**	**58.2 J**
MAGNESIUM	NE	NE	**7,110**	6,590	4,740	5,350 J	5,230 J	4,600 J
MANGANESE	**4.6E+02**	NE	441	**1280**	**2110**	**1640 J**	**1820 J**	**865 J**
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	0.13	0.11	**0.42 U**	**0.47 U**	**0.5 U**
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	**39.6**	30.3	28.1 J	24.9 J	28.8 J
POTASSIUM	NE	NE	**2,550**	2,190	1,610	1,480 J	1,450 J	1,610 J
SELENIUM	NE	NE	**3.47**	0.63 U	0.73	**5.7 U**	**6.6 U**	**7.1 U**
SILVER	NE	NE	**4.33**	1.9	1.4	**7.2 UJ**	**8.3 UJ**	**8.8 U**
SODIUM	NE	NE	**866**	81 U	565	**1,400 U**	**1,700 U**	**1,800 J**
VANADIUM	NE	NE	**53.7**	**57.7**	43.4	40 J	35.6 J	44
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	**377**	**292**	**294 J**	**346 J**	**339 J**

Note 1: Maximum Background exceeds Sediment Quality Guidance

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie
R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram
NE - Not Established
NA - Not Analyzed

shaded results indicate an exceedance of comparative criteria.

* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance

Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance

Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-24b

Summary of Sediment Analytical Results - METALS (DOWNSTREAM)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type / Lab Sample ID: / Matrix: / Units: / Analyte	NJDEP Sediment Quality Guidance mg/kg	EPA Consensus Sediment Quality Guidance mg/kg	Maximum Detect in Background Sedments mg/kg	SWSD006* 2001/10/09 REG AB44202 SD mg/kg	SWSD006* 2001/12/19 DUP AB48994 SD mg/kg	SWSD006* 2001/12/19 REG AB48993 SD mg/kg	SWSD006* 2002/04/08 REG 204055-011-01-1/2 SD mg/kg	SWSD006* 2002/09/27 REG 209177-006-013-1/2 SD mg/kg
ALUMINUM	NE	NE	**23,600**	13,200 J	18,000 J	14,100 J	18,800	20,500
ANTIMONY	NE	NE	**3.47**	**5.9 U**	**5.13 UJ**	**4.41 UJ**	0.72 U	0.39 UJ
ARSENIC	**6.0E+00**	9.8E+00	5.02	**9.69**	**9.26 J**	**9.2 J**	**6.1**	**8.9**
BARIUM	NE	NE	**156**	**160 J**	**172 J**	146 J	152	**165**
BERYLLIUM	NE	NE	**1.38**	**1.8 U**	**1.87**	**1.66**	1.1	**1.4**
CADMIUM (Note 1)	6.0E-01	9.9E-01	**1.04**	**1.97**	**1.54 U**	**1.32 U**	0.63	0.96
CALCIUM	NE	NE	**2,000**	**4,330 J**	**3,780 J**	**3,330 J**	**3,910**	**3,570**
CHROMIUM (Note 1)	2.6E+01	4.3E+01	**37.2**	27.1	34.1 J	27.6 J	30.9	35.4
COBALT	NE	NE	**14**	12.9	**15.8 J**	13.2 J	13.9	13.4
COPPER (Note 1)	1.6E+01	3.2E+01	**52.5**	**107 J**	**95 J**	**88.5 J**	**69.4**	**103**
IRON (Note 1)	2.0E+04	NE	**38,300**	22,600 J	31,300	26,300	30,400	28,900
LEAD (Note 1)	3.1E+01	3.6E+01	**40.4**	**80.3 J**	**102 J**	**111 J**	**58.8**	**122**
MAGNESIUM	NE	NE	**7,110**	4,450 J	5,790	4,950	6,400	5,930 J
MANGANESE	**4.6E+02**	NE	441	**525 J**	**765 J**	**501 J**	**1300**	**525**
MERCURY (Note 1)	2.0E-01	1.8E-01	**0.28**	**0.49 U**	**0.368 U**	**0.323 U**	0.1	0.11
NICKEL (Note 1)	1.6E+01	2.3E+01	**32.7**	28.2 J	32.2	27.4	30.1	**33.4**
POTASSIUM	NE	NE	**2,550**	1,420 J	2,030	1,430	2,100	1,830 J
SELENIUM	NE	NE	**3.47**	**5.9 U**	**5.13 U**	**4.41 U**	0.89	0.65
SILVER	NE	NE	**4.33**	**7.3 U**	**6.41 U**	**5.52 U**	0.81	0.96
SODIUM	NE	NE	**866**	**1,500 U**	**1,280 U**	**1,100 U**	473	340
VANADIUM	NE	NE	**53.7**	48.4	51.8 J	45.4 J	44.9	53.1
ZINC (Note 1)	1.2E+02	1.2E+02	**145**	**294 J**	**303 J**	**258 J**	**252**	**264 U**

Note 1: Maximum Background exceeds Sediment Quality Guidance

Notes:

Qualifiers

U - The compound was not detected.

J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance revie

R - Result regarded as unreliable. Analyte may or may not be present.

Units

mg/kg - milligrams per kilogram

NE - Not Established

NA - Not Analyzed

shaded results indicate an exceedance of comparative criteria.

* denotes samples associated with the Environmental Surveillance Program

NJDEP Sediment Quality Guidance

Guidance For Sediment Quality Evaluations, NJDEP, Site Remediation Program, Nov 1998

EPA Consensus Sediment Quality Guidance

Development and Evaluation of Consensus-Based Sediment Quality Guidelines for
Freshwater Ecosystems Arch. Environ. Contam. Toxicol. 39, 20-31 (2000)
D. D. MacDonald, C. G. Ingersoll, T. A. Berger

Table 5-25a

Summary of Sediment Analytical Results - Radionuclides - Background (Upstream)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type: Matrix: Units: Analyte	MSP SOIL FS PRGs for Single Nuclides pCi/g	Maximum Detect in Background Sediments pCi/g	SWSD004* 2000/07/06 REG SD pCi/g	SWSD004* 2000/09/15 REG SD pCi/g	SWSD004* 2000/12/22 REG SD pCi/g	SWSD004* 2001/03/27 REG SD pCi/g	SWSD004* 2001/06/05 REG SD pCi/g
ACTINIUM-228	NE	1.27	1.27+/-0.24	NA	NA	NA	NA
BISMUTH-212	NE	0.86	0.86+/-0.5 J	NA	NA	NA	NA
BISMUTH-214	6.0	0.95	0.95+/-0.18	NA	NA	NA	NA
CESIUM-137	NE	0.108	NA	0.131+/-0.123 U	0.108+/-0.0527	0.068+/-0.0529	0.0583+/-0.0433
LEAD-212	NE	1.32	1.32+/-0.19	NA	NA	NA	NA
LEAD-214	6.0	0.89	0.89+/-0.18	NA	NA	NA	NA
PROTACTINIUM-234M	20.0	5.8	5.8+/-5.19 J	NA	NA	NA	NA
RADIUM-226	6.0	1.32	NA	1.32+/-0.307	1.17+/-0.133	1.18+/-0.197	1.11+/-0.105
RADIUM-228	NE	1.74	NA	1.53+/-0.523	1.52+/-0.292	1.53+/-0.288	1.74+/-0.243
THALLIUM-208	NE	1.2	1.2+/-0.2	NA	NA	NA	NA
THORIUM-228	NE	1.64	1.32+/-0.45	1.16+/-0.38	0.972+/-0.509	1.55+/-0.464	1.62+/-0.371
THORIUM-230	20.0	2.28	2.28+/-0.66	1.62+/-0.445 B	1.29+/-0.471	1.83+/-0.503	1.6+/-0.36 B
THORIUM-232	NE	1.46	1.38+/-0.46	1.04+/-0.344	0.773+/-0.353	1.46+/-0.427	1.23+/-0.298
THORIUM-234	20.0	4.35	4.35+/-1.45	NA	NA	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	NA	9.24+/-2.97	5.37+/-1.98	5.85+/-1.47	4.99+/-1.34 U
URANIUM-233/234	20.0	2.95	2.95+/-0.85	2.21+/-0.861	1.72+/-0.654	1.84+/-0.476	1.77+/-0.47
URANIUM-235/236	6.0	0.418	0.22+/-0.19 J	0.418+/-0.346	0.285+/-0.111 U	0.0733+/-0.0693 U	0.11+/-0.11 U
URANIUM-238	20.0	3.04	2.18+/-0.68	3.04+/-0.996	1.8+/-0.665	1.96+/-0.494	1.66+/-0.451

Notes:
Qualifiers
U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
B - Indicates that the analyte was found in the associated blank as well as in the sample.

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.
shaded results indicate an exceedance of the Single nuclide Derived Concentration Guidleine Level developed in MSP Soils OU FS or background.
Single nuclide DCGLs include contributions from immediate decay products and allow for background

* denotes samples associated with the Environmental Surveillance Program

Table 5-25a

Summary of Sediment Analytical Results - Radionuclides - Background (Upstream)
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: **Sample Date:** **Analysis Type:** **Matrix:** **Units:** **Analyte**	**MSP SOIL FS PRGs for Single Nuclides** **pCi/g**	**Maximum Detect in Background Sediments** **pCi/g**	**SWSD004*** **2001/10/09** **REG** **SD** **pCi/g**	**SWSD004*** **2001/12/19** **REG** **SD** **pCi/g**
ACTINIUM-228	NE	1.27	NA	NA
BISMUTH-212	NE	0.86	NA	NA
BISMUTH-214	6.0	0.95	NA	NA
CESIUM-137	NE	0.108	0.0229+/-0.045 U	0.0585+/-0.0756
LEAD-212	NE	1.32	NA	NA
LEAD-214	6.0	0.89	NA	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA
RADIUM-226	6.0	1.32	1.12+/-0.206	1.11+/-0.196
RADIUM-228	NE	1.74	1.36+/-0.338	1.19+/-0.285
THALLIUM-208	NE	1.2	NA	NA
THORIUM-228	NE	1.64	1.36+/-0.487	1.64+/-0.45
THORIUM-230	20.0	2.28	1.5+/-0.458	1.71+/-0.443
THORIUM-232	NE	1.46	1.11+/-0.381	1.32+/-0.373
THORIUM-234	20.0	4.35	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	3.72+/-0.863	3.79+/-1.24
URANIUM-233/234	20.0	2.95	1.36+/-0.308	1.51+/-0.464
URANIUM-235/236	6.0	0.418	0.0579+/-0.0713 U	0.0991+/-0.124 U
URANIUM-238	20.0	3.04	1.24+/-0.29	1.26+/-0.416

Notes:
Qualifiers
U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the dat
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.
shaded results indicate an exceedance of the Single nu
Single nuclide DCGLs include contribu

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type: Matrix: Units:	MSP SOIL FS PRGs for Single Nuclides	Maximum Detect in Background Sediments	SDDA01 2002/01/15 REG SD pCi/g	SDDA01* 2001/04/18 REG SD pCi/g	SDDA02 2002/01/15 REG SD pCi/g	SDDA02* 2001/04/18 DUP SD pCi/g	SDDA02* 2001/04/18 REG SD pCi/g
Analyte	**pCi/g**	**pCi/g**					
ACTINIUM-228	NE	**1.27**	NA	NA	NA	NA	NA
BISMUTH-212	NE	0.86	NA	NA	NA	NA	NA
BISMUTH-214	6.0	0.95	NA	NA	NA	NA	NA
CESIUM-137	NE	0.108	0.0954+/-0.0303	0.0505+/-0.0195	0.102+/-0.0338	0.083+/-0.0242	0.0901+/-0.0213
LEAD-212	NE	1.32	NA	NA	NA	NA	NA
LEAD-214	6.0	0.89	NA	NA	NA	NA	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	NA	NA
RADIUM-226	6.0	1.32	1.54+/-0.102	0.862+/-0.121	4.12+/-0.494	1.13+/-0.16	1.28+/-0.171
RADIUM-228	NE	1.74	1.06+/-0.159	1.04+/-0.189	1.03+/-0.21	0.932+/-0.193	0.968+/-0.185
THALLIUM-208	NE	1.2	NA	NA	NA	NA	NA
THORIUM-228	NE	1.64	1.5+/-0.521	1.52+/-0.444	1.24+/-0.469	1.51+/-0.59	1.56+/-0.487
THORIUM-230	20.0	2.28	3.47+/-0.899	2.29+/-0.57	3.1+/-0.79	1.97+/-0.643	1.97+/-0.528
THORIUM-232	NE	1.46	**1.57+/-0.513**	**1.5+/-0.418**	1.35+/-0.442	1.39+/-0.502	1.17+/-0.362
THORIUM-234	20.0	4.35	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	**13.1+/-2.7**	6.87+/-1.65	**12.7+/-2.63**	8.76+/-1.92	8.54+/-1.77
URANIUM-233/234	20.0	2.95	4.44+/-0.925	2.25+/-0.546	4.3+/-0.897	2.65+/-0.613	3.13+/-0.638
URANIUM-235/236	6.0	0.418	0.517+/-0.27	0.131+/-0.124 U	0.381+/-0.229	0.219+/-0.162	0.261+/-0.161
URANIUM-238	20.0	3.04	4.34+/-0.905	2.29+/-0.553	4.21+/-0.884	2.91+/-0.646	2.83+/-0.595

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
B - Indicates that the analyte was found in the associated blank as well as in the sample.

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived Concentration Guideline Levels developed in MSP Soils OU FS or background.
Decay products are associated with near parents - U238 for Th-234, Pa-234m, U-234, Th-230. Ra-226 for Pb-214 and Bi-214.

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type: Matrix: Units:	MSP SOIL FS PRGs for Single Nuclides	Maximum Detect in Background Sediments	SDDA03 2002/01/15 DUP SD pCi/g	SDDA03 2002/01/15 REG SD pCi/g	SDDA03* 2001/04/18 REG SD pCi/g	SDDA04 2002/01/15 REG SD pCi/g	SDDA04* 2001/04/18 REG SD pCi/g
Analyte	**pCi/g**	**pCi/g**					
ACTINIUM-228	NE	**1.27**	NA	NA	NA	NA	NA
BISMUTH-212	NE	0.86	NA	NA	NA	NA	NA
BISMUTH-214	6.0	0.95	NA	NA	NA	NA	NA
CESIUM-137	NE	0.108	0.0323+/-0.0253	0.0326+/-0.0232	0.0987+/-0.0359	0.0193+/-0.0528 U	0.0258+/-0.0188
LEAD-212	NE	1.32	NA	NA	NA	NA	NA
LEAD-214	6.0	0.89	NA	NA	NA	NA	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	NA	NA
RADIUM-226	6.0	1.32	0.809+/-0.116	0.905+/-0.13	1.71+/-0.262	3.26+/-0.465	1.91+/-0.238
RADIUM-228	NE	1.74	0.631+/-0.163	0.792+/-0.174	1.21+/-0.264	1.18+/-0.282	0.649+/-0.155
THALLIUM-208	NE	1.2	NA	NA	NA	NA	NA
THORIUM-228	NE	1.64	1.08+/-0.361	1.26+/-0.468	1.36+/-0.577	**3.36+/-0.82**	1.26+/-0.482
THORIUM-230	20.0	2.28	8.21+/-1.59	2.22+/-0.639	3.64+/-1.07	7.9+/-1.63	2.5+/-0.722
THORIUM-232	NE	1.46	1.2+/-0.373	0.785+/-0.328	1.2+/-0.468	**1.9+/-0.534**	1.01+/-0.381
THORIUM-234	20.0	4.35	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	**10.8+/-2.57**	7.36+/-2.01	8.59+/-1.84	**244+/-34.8**	**51.3+/-7.53**
URANIUM-233/234	20.0	2.95	4.04+/-0.944	2.77+/-0.729	2.96+/-0.633	**75+/-10.9**	17+/-2.51
URANIUM-235/236	6.0	0.418	0.925+/-0.411	0.211+/-0.191 U	0.182+/-0.135	**7.36+/-1.63**	0.948+/-0.361
URANIUM-238	20.0	3.04	3.48+/-0.861	2.44+/-0.675	2.86+/-0.618	**81+/-11.7**	17.1+/-2.53

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the dat
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived C
Decay products are associated with nea

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type: Matrix: Units:	MSP SOIL FS PRGs for Single Nuclides	Maximum Detect in Background Sediments	SDDA05 2002/01/15 REG SD pCi/g	SDDA05* 2001/04/18 REG SD pCi/g	SDDA06 2002/01/15 REG SD pCi/g	SDDA06* 2001/04/18 REG SD pCi/g	SDDA07 2002/01/15 REG SD pCi/g
Analyte	**pCi/g**	**pCi/g**					
ACTINIUM-228	NE	**1.27**	NA	NA	NA	NA	NA
BISMUTH-212	NE	0.86	NA	NA	NA	NA	NA
BISMUTH-214	6.0	0.95	NA	NA	NA	NA	NA
CESIUM-137	NE	0.108	-0.00677+/-0.0616 U	0.0817+/-0.106 U	**0.117+/-0.0443**	**0.201+/-0.0732**	0.156+/-0.0501
LEAD-212	NE	1.32	NA	NA	NA	NA	NA
LEAD-214	6.0	0.89	NA	NA	NA	NA	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	NA	NA
RADIUM-226	6.0	1.32	2.82+/-0.452	**13.3+/-1.71**	**6.04+/-0.778**	**11.7+/-1.4**	**9.01+/-1.1**
RADIUM-228	NE	1.74	0.877+/-0.361	**3.06+/-0.66**	1.72+/-0.428	**3.3+/-0.706**	**2.59+/-0.51**
THALLIUM-208	NE	1.2	NA	NA	NA	NA	NA
THORIUM-228	NE	1.64	**2.82+/-0.715**	**2.68+/-0.602**	**2.79+/-0.696**	**1.84+/-0.54**	**2.18+/-0.481**
THORIUM-230	20.0	2.28	11.1+/-2.19	11.7+/-2.11	8.66+/-1.73	11.1+/-2.37	13.1+/-2.17
THORIUM-232	NE	1.46	**1.69+/-0.482**	1.41+/-0.36	1.21+/-0.382	1.31+/-0.41	**1.6+/-0.383**
THORIUM-234	20.0	4.35	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	**334+/-49.1**	**228+/-28.6**	**289+/-44.9**	**196+/-29.4**	**333+/-53.3 U**
URANIUM-233/234	20.0	2.95	**113+/-16.9**	**76.6+/-9.7**	**93.7+/-14.7**	**63.6+/-9.63**	**113+/-18.3**
URANIUM-235/236	6.0	0.418	**9.29+/-1.99**	5.41+/-0.977	**6.43+/-1.64**	3.4+/-0.9	**6.52+/-1.7**
URANIUM-238	20.0	3.04	**111+/-16.5**	**75.9+/-9.61**	**96.2+/-15.1**	**65.4+/-9.88**	**111+/-17.9**

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the dat
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived C
Decay products are associated with nea

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type: Matrix: Units:	MSP SOIL FS PRGs for Single Nuclides	Maximum Detect in Background Sediments	SDDA07* 2001/04/18 REG SD pCi/g	SDDA08 2002/01/15 REG SD pCi/g	SDDA08* 2001/04/19 REG SD pCi/g	SDDA09 2002/01/15 REG SD pCi/g	SDDA09* 2001/04/19 REG SD pCi/g
Analyte	**pCi/g**	**pCi/g**					
ACTINIUM-228	NE	**1.27**	NA	NA	NA	NA	NA
BISMUTH-212	NE	0.86	NA	NA	NA	NA	NA
BISMUTH-214	6.0	0.95	NA	NA	NA	NA	NA
CESIUM-137	NE	0.108	0.0281+/-0.0169	0.0592+/-0.0311	0.0371+/-0.0176	0.0907+/-0.0391	0.083+/-0.0252
LEAD-212	NE	1.32	NA	NA	NA	NA	NA
LEAD-214	6.0	0.89	NA	NA	NA	NA	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	NA	NA
RADIUM-226	6.0	1.32	1.55+/-0.0788	0.83+/-0.142	0.527+/-0.0561	0.7+/-0.138	0.675+/-0.0634
RADIUM-228	NE	1.74	0.632+/-0.105	1.2+/-0.222	0.549+/-0.081	0.991+/-0.186	0.97+/-0.131
THALLIUM-208	NE	1.2	NA	NA	NA	NA	NA
THORIUM-228	NE	1.64	0.574+/-0.277	**1.75+/-0.604**	1.04+/-0.415	1.2+/-0.426	0.943+/-0.351
THORIUM-230	20.0	2.28	1.88+/-0.514	1.32+/-0.494	1.09+/-0.402	0.846+/-0.334	0.913+/-0.309
THORIUM-232	NE	1.46	0.427+/-0.205	1.39+/-0.503	0.68+/-0.293	0.753+/-0.31	0.931+/-0.313
THORIUM-234	20.0	4.35	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	**58.2+/-8.12**	5.02+/-1.58	3.32+/-1	4.85+/-1.46	3.33+/-1.02
URANIUM-233/234	20.0	2.95	18.6+/-2.63	1.51+/-0.509	1.44+/-0.394	1.44+/-0.466	1.34+/-0.386
URANIUM-235/236	6.0	0.418	1.1+/-0.365	0.246+/-0.195	0.11+/-0.0993	0.387+/-0.233	0.115+/-0.104
URANIUM-238	20.0	3.04	19.4+/-2.73	1.65+/-0.529	1.1+/-0.336	1.57+/-0.489	1.1+/-0.343

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the dat
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived (
Decay products are associated with nea

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: **Sample Date:** **Analysis Type:** **Matrix:** **Units:**	**MSP SOIL FS PRGs for Single Nuclides**	**Maximum Detect in Background Sediments**	**SDDA10** **2002/01/15** **REG** **SD** **pCi/g**	**SDDA10*** **2001/04/19** **REG** **SD** **pCi/g**	**SDDB01** **2002/01/15** **REG** **SD** **pCi/g**	**SDDB01*** **2001/04/18** **REG** **SD** **pCi/g**	**SDDB02** **2002/01/15** **REG** **SD** **pCi/g**
Analyte	**pCi/g**	**pCi/g**					
ACTINIUM-228	NE	**1.27**	NA	NA	NA	NA	NA
BISMUTH-212	NE	0.86	NA	NA	NA	NA	NA
BISMUTH-214	6.0	0.95	NA	NA	NA	NA	NA
CESIUM-137	NE	0.108	0.0608+/-0.0315	0.0426+/-0.0306	0.0784+/-0.0332	0.0722+/-0.0413	-0.0019+/-0.0396 U
LEAD-212	NE	1.32	NA	NA	NA	NA	NA
LEAD-214	6.0	0.89	NA	NA	NA	NA	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	NA	NA
RADIUM-226	6.0	1.32	0.725+/-0.113	0.709+/-0.107	0.704+/-0.122	0.868+/-0.151	0.838+/-0.211
RADIUM-228	NE	1.74	0.829+/-0.172	0.965+/-0.188	1.27+/-0.259	1.31+/-0.253	1.11+/-0.275
THALLIUM-208	NE	1.2	NA	NA	NA	NA	NA
THORIUM-228	NE	1.64	1.34+/-0.491	1.02+/-0.322	1.19+/-0.319	1.07+/-0.245	1.56+/-0.383
THORIUM-230	20.0	2.28	1.36+/-0.457	0.825+/-0.263	0.616+/-0.209	0.824+/-0.196	1.14+/-0.305
THORIUM-232	NE	1.46	1+/-0.385	0.861+/-0.27	1.03+/-0.272	1.08+/-0.228	**1.53+/-0.366**
THORIUM-234	20.0	4.35	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	4.83+/-1.61	3.78+/-1.06	1.47+/-0.76	2.72+/-0.744	2.69+/-1.08
URANIUM-233/234	20.0	2.95	1.78+/-0.574	1.45+/-0.387	0.616+/-0.303	0.828+/-0.239	1.12+/-0.409
URANIUM-235/236	6.0	0.418	0.155+/-0.177 U	0.142+/-0.113	0.0859+/-0.109 U	0.0528+/-0.0592 U	0.0249+/-0.0675 U
URANIUM-238	20.0	3.04	1.6+/-0.539	1.25+/-0.356	0.482+/-0.255	0.905+/-0.25	0.9+/-0.362

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the dat
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived (
Decay products are associated with nea

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: **Sample Date:** **Analysis Type:** **Matrix:** **Units:**	**MSP SOIL FS PRGs for Single Nuclides**	**Maximum Detect in Background Sediments**	**SDDB02*** **2001/04/18** **REG** **SD** **pCi/g**	**SDDB03** **2002/01/15** **DUP** **SD** **pCi/g**	**SDDB03** **2002/01/15** **REG** **SD** **pCi/g**	**SDDB03*** **2001/04/18** **REG** **SD** **pCi/g**	**SDDB04** **2002/01/15** **REG** **SD** **pCi/g**
Analyte	**pCi/g**	**pCi/g**					
ACTINIUM-228	NE	**1.27**	NA	NA	NA	NA	NA
BISMUTH-212	NE	0.86	NA	NA	NA	NA	NA
BISMUTH-214	6.0	0.95	NA	NA	NA	NA	NA
CESIUM-137	NE	0.108	0+/-0.0688 U	0.0592+/-0.0251	0.0576+/-0.0224	0.0417+/-0.0257	0.0928+/-0.0478
LEAD-212	NE	1.32	NA	NA	NA	NA	NA
LEAD-214	6.0	0.89	NA	NA	NA	NA	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	NA	NA
RADIUM-226	6.0	1.32	1.04+/-0.181	0.83+/-0.122	0.944+/-0.15	0.881+/-0.143	2.07+/-0.274
RADIUM-228	NE	1.74	1.39+/-0.303	1.25+/-0.237	1.27+/-0.266	0.966+/-0.215	0.819+/-0.212
THALLIUM-208	NE	1.2	NA	NA	NA	NA	NA
THORIUM-228	NE	1.64	1.2+/-0.283	**1.76+/-0.441**	1.56+/-0.411	1.39+/-0.303	1.09+/-0.315
THORIUM-230	20.0	2.28	1.16+/-0.28	1.78+/-0.428	1.07+/-0.313	1.15+/-0.26	1.65+/-0.37
THORIUM-232	NE	1.46	1.26+/-0.275	1.34+/-0.35	1.37+/-0.365	1.16+/-0.263	0.811+/-0.242
THORIUM-234	20.0	4.35	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	3.2+/-0.804	4.11+/-1.3	4.4+/-1.45	3.77+/-0.869	**30.9+/-4.7**
URANIUM-233/234	20.0	2.95	0.954+/-0.255	1.3+/-0.427	1.56+/-0.506	1.24+/-0.29	9.18+/-1.45
URANIUM-235/236	6.0	0.418	0.107+/-0.0808	0.0157+/-0.0639 U	0.126+/-0.146 U	0.0432+/-0.0546 U	0.652+/-0.298
URANIUM-238	20.0	3.04	1.06+/-0.27	1.38+/-0.438	1.46+/-0.487	1.26+/-0.292	10.3+/-1.58

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived C
Decay products are associated with near

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type: / Matrix: / Units:	MSP SOIL FS PRGs for Single Nuclides	Maximum Detect in Background Sediments	SDDB04* 2001/04/18 REG SD pCi/g	SDDB05 2002/01/15 REG SD pCi/g	SDDB05* 2001/04/18 DUP SD pCi/g	SDDB05* 2001/04/18 REG SD pCi/g	SDDB06 2002/01/15 REG SD pCi/g
Analyte	**pCi/g**	**pCi/g**					
ACTINIUM-228	NE	**1.27**	NA	NA	NA	NA	NA
BISMUTH-212	NE	0.86	NA	NA	NA	NA	NA
BISMUTH-214	6.0	0.95	NA	NA	NA	NA	NA
CESIUM-137	NE	0.108	0.056+/-0.0382	**0.124+/-0.0535**	0.0102+/-0.0149 U	0.0322+/-0.0293 U	0.0115+/-0.0147 U
LEAD-212	NE	1.32	NA	NA	NA	NA	NA
LEAD-214	6.0	0.89	NA	NA	NA	NA	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	NA	NA
RADIUM-226	6.0	1.32	0.939+/-0.178	2.05+/-0.29	1+/-0.137	1.3+/-0.196	0.522+/-0.075
RADIUM-228	NE	1.74	1.08+/-0.241	1.02+/-0.287	1.12+/-0.22	1.07+/-0.223	0.374+/-0.0932
THALLIUM-208	NE	1.2	NA	NA	NA	NA	NA
THORIUM-228	NE	1.64	1.47+/-0.311	1.12+/-0.283	1.12+/-0.239	1.05+/-0.246	0.538+/-0.198
THORIUM-230	20.0	2.28	1.05+/-0.244	1.89+/-0.389	1.11+/-0.236	1.1+/-0.245	0.276+/-0.13
THORIUM-232	NE	1.46	1.24+/-0.27	0.822+/-0.224	0.921+/-0.208	0.897+/-0.212	0.374+/-0.144
THORIUM-234	20.0	4.35	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	3.57+/-0.922	**43.4+/-6.19**	14+/-2.26	19.6+/-2.75	2.68+/-1.09
URANIUM-233/234	20.0	2.95	1.07+/-0.293	14.4+/-2.07	5.17+/-0.817	6.51+/-0.93	0.907+/-0.365
URANIUM-235/236	6.0	0.418	0.0103+/-0.0343 U	0.558+/-0.267	0.139+/-0.0984	0.754+/-0.222	0.00926+/-0.0716 U
URANIUM-238	20.0	3.04	1.2+/-0.31	14.5+/-2.08	4.68+/-0.758	6.47+/-0.925	0.899+/-0.365

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the dat
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.
shaded results indicate an exceedance of the Derived C
Decay products are associated with nea

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type: Matrix: Units:	MSP SOIL FS PRGs for Single Nuclides	Maximum Detect in Background Sediments	SDDB06* 2001/04/18 REG SD pCi/g	SDDB07 2002/01/15 REG SD pCi/g	SDDB07* 2001/04/18 REG SD pCi/g	SDDB08 2002/01/15 REG SD pCi/g	SDDB08* 2001/04/18 REG SD pCi/g
Analyte	**pCi/g**	**pCi/g**					
ACTINIUM-228	NE	**1.27**	NA	NA	NA	NA	NA
BISMUTH-212	NE	0.86	NA	NA	NA	NA	NA
BISMUTH-214	6.0	0.95	NA	NA	NA	NA	NA
CESIUM-137	NE	0.108	0.06+/-0.0354	0.0661+/-0.0549	0.0526+/-0.0497	0.0454+/-0.0246	0.069+/-0.0341
LEAD-212	NE	1.32	NA	NA	NA	NA	NA
LEAD-214	6.0	0.89	NA	NA	NA	NA	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	NA	NA
RADIUM-226	6.0	1.32	0.947+/-0.141	1.31+/-0.188	1.44+/-0.159	0.822+/-0.164	0.987+/-0.107
RADIUM-228	NE	1.74	0.571+/-0.168	0.787+/-0.229	0.918+/-0.285	0.842+/-0.176	1.01+/-0.196
THALLIUM-208	NE	1.2	NA	NA	NA	NA	NA
THORIUM-228	NE	1.64	0.536+/-0.159	1.36+/-0.32	0.866+/-0.226	1.13+/-0.304	1.02+/-0.248
THORIUM-230	20.0	2.28	0.999+/-0.232	1.93+/-0.419	1.16+/-0.275	1.43+/-0.338	1.17+/-0.273
THORIUM-232	NE	1.46	0.406+/-0.132	1.01+/-0.249	0.839+/-0.214	0.85+/-0.232	0.991+/-0.232
THORIUM-234	20.0	4.35	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	16.9+/-2.48	15.5+/-2.94	11.8+/-2.03	3.69+/-1.19	3.87+/-0.92
URANIUM-233/234	20.0	2.95	5.62+/-0.831	5.14+/-0.981	3.58+/-0.636	1.49+/-0.447	1.36+/-0.319
URANIUM-235/236	6.0	0.418	0.224+/-0.12	0.236+/-0.174	0.187+/-0.118	0.186+/-0.154	0.0676+/-0.0664 U
URANIUM-238	20.0	3.04	5.63+/-0.832	5.19+/-0.989	3.95+/-0.682	1.21+/-0.398	1.29+/-0.309

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived C
Decay products are associated with near

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Sample Date: / Analysis Type: / Matrix: / Units:	MSP SOIL FS PRGs for Single Nuclides	Maximum Detect in Background Sediments	SDDB09	SDDB09*	SDDB10	SDDB10*	SWSD001*	
			2002/01/15	2001/04/18	2002/01/15	2001/04/18	2000/07/06	
			REG	REG	REG	REG	REG	
			SD	SD	SD	SD	SD	
Analyte	**pCi/g**	**pCi/g**	**pCi/g**	**pCi/g**	**pCi/g**	**pCi/g**	**pCi/g**	
ACTINIUM-228	NE	**1.27**	NA	NA	NA	NA	1.24+/-0.26	
BISMUTH-212	NE	0.86	NA	NA	NA	NA	**1.8+/-0.74**	
BISMUTH-214	6.0	0.95	NA	NA	NA	NA	**7.1+/-0.58**	
CESIUM-137	NE	0.108	0.0469+/-0.0396	0.0775+/-0.0355	0.0577+/-0.0383	0.0938+/-0.0539	NA	
LEAD-212	NE	1.32	NA	NA	NA	NA	1.05+/-0.18	
LEAD-214	6.0	0.89	NA	NA	NA	NA	**6.83+/-0.64**	
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	NA	**20.66+/-12.25**	**J**
RADIUM-226	6.0	1.32	0.566+/-0.103	0.893+/-0.14	0.761+/-0.115	0.9+/-0.177	NA	
RADIUM-228	NE	1.74	0.61+/-0.183	1.03+/-0.258	1.22+/-0.229	1.07+/-0.344	NA	
THALLIUM-208	NE	1.2	NA	NA	NA	NA	0.85+/-0.21	
THORIUM-228	NE	1.64	**1.71+/-0.419**	1.1+/-0.361	1.28+/-0.345	0.937+/-0.363	1.42+/-0.49	
THORIUM-230	20.0	2.28	1.55+/-0.37	1.11+/-0.331	1.04+/-0.286	1.45+/-0.418	6.68+/-1.58	
THORIUM-232	NE	1.46	1.11+/-0.296	0.868+/-0.278	1.18+/-0.305	0.702+/-0.277	0.83+/-0.35	
THORIUM-234	20.0	4.35	NA	NA	NA	NA	**20.57+/-3.21**	
TOTAL URANIUM (µg/g)	NE	9.24	4.84+/-1.43	3.62+/-1.05	1.99+/-0.817	3.77+/-1.18	NA	
URANIUM-233/234	20.0	2.95	1.24+/-0.418	0.804+/-0.28	0.979+/-0.344	0.704+/-0.287	**30.25+/-6.57**	
URANIUM-235/236	6.0	0.418	0.0456+/-0.0874 U	0.0538+/-0.0757 U	0.106+/-0.107	-0.0124+/-0.0176 U	1.25+/-0.52	
URANIUM-238	20.0	3.04	1.62+/-0.481	1.21+/-0.353	0.654+/-0.274	1.27+/-0.398	**30.7+/-6.67**	

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived C
Decay products are associated with neai

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type: Matrix: Units: Analyte	MSP SOIL FS PRGs for Single Nuclides pCi/g	Maximum Detect in Background Sediments pCi/g	SWSD001* 2000/09/15 REG SD pCi/g	SWSD001* 2000/12/22 REG SD pCi/g	SWSD001* 2001/03/27 REG SD pCi/g	SWSD001* 2001/06/05 REG SD pCi/g	SWSD001* 2001/10/09 REG SD pCi/g
ACTINIUM-228	NE	**1.27**	NA	NA	NA	NA	NA
BISMUTH-212	NE	0.86	NA	NA	NA	NA	NA
BISMUTH-214	6.0	0.95	NA	NA	NA	NA	NA
CESIUM-137	NE	0.108	0.0583+/-0.0321	0.074+/-0.0409	**0.168+/-0.042**	**0.162+/-0.0549**	0.0297+/-0.0592 U
LEAD-212	NE	1.32	NA	NA	NA	NA	NA
LEAD-214	6.0	0.89	NA	NA	NA	NA	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	NA	NA
RADIUM-226	6.0	1.32	1.23+/-0.213	2.59+/-0.207	**10+/-0.217**	**11.9+/-1.52**	**12.6+/-0.448**
RADIUM-228	NE	1.74	0.893+/-0.223	1.23+/-0.211	1.69+/-0.239	**2.13+/-0.456**	1.28+/-0.459
THALLIUM-208	NE	1.2	NA	NA	NA	NA	NA
THORIUM-228	NE	1.64	1.32+/-0.415	0.935+/-0.555 U	**1.86+/-0.486**	**2.46+/-0.522**	1.45+/-0.83
THORIUM-230	20.0	2.28	3.41+/-0.728 B	2.64+/-0.759	10.6+/-1.96	12.8+/-2.2 B	14.6+/-4.75
THORIUM-232	NE	1.46	0.86+/-0.308	0.432+/-0.285	1.17+/-0.332	1.45+/-0.345	1.1+/-0.62
THORIUM-234	20.0	4.35	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	**25.1+/-5.69**	**31+/-5.8**	**103+/-14.9**	**149+/-21.4**	**52.1+/-7.44**
URANIUM-233/234	20.0	2.95	8.35+/-1.92	10.7+/-2.01	**34.8+/-5.09**	**48.7+/-7.07**	18.4+/-2.62
URANIUM-235/236	6.0	0.418	0.657+/-0.447 U	0.834+/-0.45	1.67+/-0.543	3.84+/-0.892	0.8+/-0.315
URANIUM-238	20.0	3.04	8.36+/-1.91	10.3+/-1.95	**34.2+/-5.01**	**49.6+/-7.19**	17.4+/-2.5

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the dat
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived C
Decay products are associated with nea

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: **Sample Date:** **Analysis Type:** **Matrix:** **Units:**	**MSP SOIL FS PRGs for Single Nuclides**	**Maximum Detect in Background Sediments**	**SWSD001*** **2001/12/19** **REG** **SD** **pCi/g**	**SWSD001*** **2002/04/08** **REG** **SD** **pCi/g**	**SWSD001*** **2002/09/27** **REG** **SD** **pCi/g**	**SWSD003*** **2000/07/06** **REG** **SD** **pCi/g**	**SWSD003*** **2000/09/15** **REG** **SD** **pCi/g**
Analyte	**pCi/g**	**pCi/g**					
ACTINIUM-228	NE	**1.27**	NA	NA	NA	0.34+/-0.16 J	NA
BISMUTH-212	NE	0.86	NA	NA	NA	0.47+/-0.27 J	NA
BISMUTH-214	6.0	0.95	NA	NA	NA	0.32+/-0.11	NA
CESIUM-137	NE	0.108	**0.153+/-0.0434**	**0.16+/-0.0461**	0.0799+/-0.0467	NA	0.0355+/-0.0289 U
LEAD-212	NE	1.32	NA	NA	NA	0.47+/-0.1	NA
LEAD-214	6.0	0.89	NA	NA	NA	0.28+/-0.11	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	0.77+/-2.93 U	NA
RADIUM-226	6.0	1.32	**8.6+/-1**	**8.93+/-1.12**	**6.46+/-0.759**	NA	0.559+/-0.126
RADIUM-228	NE	1.74	1.61+/-0.313	**2.4+/-0.445**	1.29+/-0.304	NA	0.693+/-0.169
THALLIUM-208	NE	1.2	NA	NA	NA	0.4+/-0.13	NA
THORIUM-228	NE	1.64	1.44+/-0.353	**2.38+/-0.411**	**3.91+/-1.33**	0.35+/-0.2 J	0.677+/-0.387 U
THORIUM-230	20.0	2.28	8.65+/-1.46	12+/-1.6	19+/-5.42	0.7+/-0.28 J	0.59+/-0.277 B
THORIUM-232	NE	1.46	1.05+/-0.275	1.33+/-0.274	**2.32+/-0.851**	0.47+/-0.22	0.402+/-0.222
THORIUM-234	20.0	4.35	NA	NA	NA	0.77+/-1.09 U	NA
TOTAL URANIUM (µg/g)	NE	9.24	**82.9+/-11.7**	**274+/-38.7**	**328+/-50**	NA	3.73+/-1.69
URANIUM-233/234	20.0	2.95	**27.9+/-3.97**	**91.6+/-13.1**	**109+/-16.8**	0.67+/-0.29	1.14+/-0.552
URANIUM-235/236	6.0	0.418	1.74+/-0.533	**6.38+/-1.47**	**7.46+/-1.6**	0+/-0 J	0.316+/-0.271 U
URANIUM-238	20.0	3.04	**27.6+/-3.93**	**91+/-13**	**109+/-16.8**	1.07+/-0.38	1.21+/-0.566

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the dat
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived C
Decay products are associated with nea

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type: Matrix: Units:	MSP SOIL FS PRGs for Single Nuclides	Maximum Detect in Background Sediments	SWSD003* 2000/12/22 REG SD pCi/g	SWSD003* 2001/03/27 REG SD pCi/g	SWSD003* 2001/06/05 REG SD pCi/g	SWSD003* 2001/10/09 REG SD pCi/g	SWSD003* 2001/12/19 REG SD pCi/g
Analyte	**pCi/g**	**pCi/g**					
ACTINIUM-228	NE	**1.27**	NA	NA	NA	NA	NA
BISMUTH-212	NE	0.86	NA	NA	NA	NA	NA
BISMUTH-214	6.0	0.95	NA	NA	NA	NA	NA
CESIUM-137	NE	0.108	0.0363+/-0.0235	0.0546+/-0.0213	0.0105+/-0.0203 U	0.0476+/-0.0285 U	0.0154+/-0.0209 U
LEAD-212	NE	1.32	NA	NA	NA	NA	NA
LEAD-214	6.0	0.89	NA	NA	NA	NA	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	NA	NA
RADIUM-226	6.0	1.32	0.682+/-0.114	0.748+/-0.114	0.551+/-0.107	0.629+/-0.141	0.503+/-0.0907
RADIUM-228	NE	1.74	0.694+/-0.15	0.793+/-0.177	0+/-0.144 U	0.513+/-0.174	0.481+/-0.132
THALLIUM-208	NE	1.2	NA	NA	NA	NA	NA
THORIUM-228	NE	1.64	0.634+/-0.358	0.555+/-0.248	0.258+/-0.166	0.435+/-0.361 U	0.487+/-0.17
THORIUM-230	20.0	2.28	1.07+/-0.412	0.625+/-0.222	0.325+/-0.11 B	0.874+/-0.377	0.548+/-0.153
THORIUM-232	NE	1.46	0.641+/-0.304	0.382+/-0.17	0.173+/-0.0798	0.269+/-0.188	0.392+/-0.125
THORIUM-234	20.0	4.35	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	4.49+/-1.8	2.47+/-0.861	1.75+/-0.801	2.65+/-0.792	1.41+/-0.807
URANIUM-233/234	20.0	2.95	1.89+/-0.706	0.994+/-0.327	0.476+/-0.253	0.585+/-0.212	0.862+/-0.374
URANIUM-235/236	6.0	0.418	0.442+/-0.124 U	0.159+/-0.122	0.216+/-0.172	0.0684+/-0.0813 U	0.028+/-0.0757 U
URANIUM-238	20.0	3.04	1.51+/-0.606	0.806+/-0.289	0.556+/-0.268	0.881+/-0.266	0.468+/-0.271

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived C
Decay products are associated with near

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type: Matrix: Units:	MSP SOIL FS PRGs for Single Nuclides	Maximum Detect in Background Sediments	SWSD003* 2002/04/08 REG SD pCi/g	SWSD003* 2002/10/01 DUP SD pCi/g	SWSD003* 2002/10/01 REG SD pCi/g	SWSD006* 2000/07/06 DUP SD pCi/g	SWSD006* 2000/07/06 REG SD pCi/g
Analyte	**pCi/g**	**pCi/g**					
ACTINIUM-228	NE	**1.27**	NA	NA	NA	1.25+/-0.32	**1.44+/-0.36**
BISMUTH-212	NE	0.86	NA	NA	NA	0.67+/-0.97 U	0.83+/-0.84 U
BISMUTH-214	6.0	0.95	NA	NA	NA	1.66+/-0.27	2.05+/-0.29
CESIUM-137	NE	0.108	0.00926+/-0.0225 U	0.0153+/-0.0222 U	0.0316+/-0.0151	NA	NA
LEAD-212	NE	1.32	NA	NA	NA	**1.47+/-0.24**	**1.63+/-0.26**
LEAD-214	6.0	0.89	NA	NA	NA	1.77+/-0.26	2.54+/-0.41
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	14.94+/-10.05 J	4.39+/-8.34 U
RADIUM-226	6.0	1.32	0.533+/-0.119	0.946+/-0.122	0.928+/-0.121	NA	NA
RADIUM-228	NE	1.74	0.49+/-0.182	0.83+/-0.161	0.756+/-0.151	NA	NA
THALLIUM-208	NE	1.2	NA	NA	NA	**1.4+/-0.31**	**1.29+/-0.26**
THORIUM-228	NE	1.64	0.629+/-0.174	0.374+/-0.261 U	0.635+/-0.334	**1.81+/-0.55**	1.28+/-0.43
THORIUM-230	20.0	2.28	0.542+/-0.142	1.17+/-0.431	2.36+/-0.7	2.26+/-0.64	3.79+/-0.96
THORIUM-232	NE	1.46	0.423+/-0.132	0.271+/-0.181	0.881+/-0.351	1.43+/-0.47	1.27+/-0.43
THORIUM-234	20.0	4.35	NA	NA	NA	8.84+/-2.31	9.06+/-2.49
TOTAL URANIUM (µg/g)	NE	9.24	4.06+/-1.36	2.33+/-0.944	7.29+/-1.88	NA	NA
URANIUM-233/234	20.0	2.95	1.37+/-0.457	0.947+/-0.351	2.5+/-0.641	7.06+/-1.62	8.14+/-1.86
URANIUM-235/236	6.0	0.418	0.0336+/-0.0672 U	0.0714+/-0.117 U	0.00825+/-0.0638 U	0.23+/-0.18 J	0.38+/-0.23
URANIUM-238	20.0	3.04	1.36+/-0.457	0.773+/-0.317	2.45+/-0.632	6.09+/-1.43	6.98+/-1.62

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the data
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived C
Decay products are associated with near

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: **Sample Date:** **Analysis Type:** **Matrix:** **Units:**	**MSP SOIL FS PRGs for Single Nuclides**	**Maximum Detect in Background Sediments**	**SWSD006*** **2000/09/15** **DUP** **SD** **pCi/g**	**SWSD006*** **2000/09/15** **REG** **SD** **pCi/g**	**SWSD006*** **2000/12/22** **DUP** **SD** **pCi/g**	**SWSD006*** **2000/12/22** **REG** **SD** **pCi/g**	**SWSD006*** **2001/03/27** **DUP** **SD** **pCi/g**
Analyte	**pCi/g**	**pCi/g**					
ACTINIUM-228	NE	**1.27**	NA	NA	NA	NA	NA
BISMUTH-212	NE	0.86	NA	NA	NA	NA	NA
BISMUTH-214	6.0	0.95	NA	NA	NA	NA	NA
CESIUM-137	NE	0.108	**0.113+/-0.0638 U**	**0.122+/-0.0826 U**	**0.13+/-0.0497**	**0.112+/-0.0292**	**0.112+/-0.0294**
LEAD-212	NE	1.32	NA	NA	NA	NA	NA
LEAD-214	6.0	0.89	NA	NA	NA	NA	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	NA	NA
RADIUM-226	6.0	1.32	1.4+/-0.309	1.74+/-0.331	1.53+/-0.154	1.18+/-0.0853	1.75+/-0.237
RADIUM-228	NE	1.74	1.71+/-0.505	1.03+/-0.563	1.38+/-0.283	1.33+/-0.135	1.49+/-0.265
THALLIUM-208	NE	1.2	NA	NA	NA	NA	NA
THORIUM-228	NE	1.64	1.43+/-0.45	1.68+/-0.534	1.22+/-0.437	**2.09+/-0.738**	1.58+/-0.442
THORIUM-230	20.0	2.28	1.41+/-0.395 B	1.48+/-0.463 B	0.88+/-0.342	1.46+/-0.515	1.83+/-0.468
THORIUM-232	NE	1.46	1.06+/-0.329	1.34+/-0.433	0.618+/-0.279	0.944+/-0.403	1.06+/-0.32
THORIUM-234	20.0	4.35	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	**30.9+/-5.8**	**35.6+/-6.73**	**20.5+/-4.46**	**19.5+/-4.23**	**16.7+/-2.87**
URANIUM-233/234	20.0	2.95	10.6+/-1.99	12+/-2.3	6.3+/-1.43	5.59+/-1.29	5.36+/-0.937
URANIUM-235/236	6.0	0.418	0.6+/-0.369	0.591+/-0.389 U	0.536+/-0.312 U	0.326+/-0.186 U	0.255+/-0.157
URANIUM-238	20.0	3.04	10.3+/-1.95	11.9+/-2.26	6.86+/-1.5	6.55+/-1.42	5.57+/-0.963

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the dat
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived C
Decay products are associated with neai

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Sample Date: Analysis Type: Matrix: Units:	MSP SOIL FS PRGs for Single Nuclides	Maximum Detect in Background Sediments	SWSD006* 2001/03/27 REG SD pCi/g	SWSD006* 2001/06/05 DUP SD pCi/g	SWSD006* 2001/06/05 REG SD pCi/g	SWSD006* 2001/10/09 DUP SD pCi/g	SWSD006* 2001/10/09 REG SD pCi/g
Analyte	**pCi/g**	**pCi/g**					
ACTINIUM-228	NE	**1.27**	NA	NA	NA	NA	NA
BISMUTH-212	NE	0.86	NA	NA	NA	NA	NA
BISMUTH-214	6.0	0.95	NA	NA	NA	NA	NA
CESIUM-137	NE	0.108	**0.113+/-0.0254**	**0.161+/-0.0523**	0.103+/-0.0478	**0.142+/-0.21**	**0.154+/-0.0671**
LEAD-212	NE	1.32	NA	NA	NA	NA	NA
LEAD-214	6.0	0.89	NA	NA	NA	NA	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	NA	NA
RADIUM-226	6.0	1.32	1.42+/-0.19	1.58+/-0.171	1.52+/-0.262	1.59+/-0.389	1.74+/-0.254
RADIUM-228	NE	1.74	1.54+/-0.271	1.61+/-0.24	1.51+/-0.419	**1.98+/-0.622**	0+/-0.4 U
THALLIUM-208	NE	1.2	NA	NA	NA	NA	NA
THORIUM-228	NE	1.64	**1.8+/-0.512**	1.56+/-0.356	1.46+/-0.383	1.52+/-0.81	**1.66+/-0.765**
THORIUM-230	20.0	2.28	1.76+/-0.472	1.45+/-0.333 B	1.24+/-0.327 B	2.02+/-0.851	2.05+/-0.883
THORIUM-232	NE	1.46	1.1+/-0.341	1.38+/-0.321	1.21+/-0.325	0.826+/-0.527	1.04+/-0.561
THORIUM-234	20.0	4.35	NA	NA	NA	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	**15.7+/-2.77**	**11.7+/-2.41**	**12.1+/-2.21**	**21.1+/-2.95**	**20.9+/-3.01**
URANIUM-233/234	20.0	2.95	4.88+/-0.887	4.55+/-0.911	4.04+/-0.746	6.66+/-0.948	6.61+/-0.963
URANIUM-235/236	6.0	0.418	0.331+/-0.184	0.823+/-0.331	0.404+/-0.189	0.3+/-0.144	0.227+/-0.13
URANIUM-238	20.0	3.04	5.22+/-0.93	3.81+/-0.807	4.02+/-0.742	7.05+/-0.99	7+/-1.01

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the dat
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived C
Decay products are associated with nea

* denotes samples associated with the Environmental Surveillance Program

Table 5-25b

Summary of Sediment Analytical Results - Radionuclides - Downstream
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: **Sample Date:** **Analysis Type:** **Matrix:** **Units:**	**MSP SOIL FS PRGs for Single Nuclides**	**Maximum Detect in Background Sediments**	**SWSD006*** **2001/12/19** **DUP** **SD** **pCi/g**	**SWSD006*** **2001/12/19** **REG** **SD** **pCi/g**	**SWSD006*** **2002/04/08** **REG** **SD** **pCi/g**	**SWSD006*** **2002/09/27** **REG** **SD** **pCi/g**
Analyte	**pCi/g**	**pCi/g**				
ACTINIUM-228	NE	**1.27**	NA	NA	NA	NA
BISMUTH-212	NE	0.86	NA	NA	NA	NA
BISMUTH-214	6.0	0.95	NA	NA	NA	NA
CESIUM-137	NE	0.108	**0.154+/-0.0301**	**0.123+/-0.028**	0.0989+/-0.029	**0.14+/-0.0379**
LEAD-212	NE	1.32	NA	NA	NA	NA
LEAD-214	6.0	0.89	NA	NA	NA	NA
PROTACTINIUM-234M	20.0	5.8	NA	NA	NA	NA
RADIUM-226	6.0	1.32	1.73+/-0.229	1.7+/-0.221	1.11+/-0.167	1.38+/-0.201
RADIUM-228	NE	1.74	1.37+/-0.256	1.29+/-0.242	1.33+/-0.23	1.55+/-0.327
THALLIUM-208	NE	1.2	NA	NA	NA	NA
THORIUM-228	NE	1.64	1.21+/-0.359	**1.68+/-0.394**	**1.66+/-0.399**	1.15+/-0.508
THORIUM-230	20.0	2.28	2.16+/-0.481	2.34+/-0.483	2.08+/-0.438	1.84+/-0.662
THORIUM-232	NE	1.46	**1.48+/-0.369**	1.28+/-0.316	1.12+/-0.285	1.09+/-0.458
THORIUM-234	20.0	4.35	NA	NA	NA	NA
TOTAL URANIUM (µg/g)	NE	9.24	**17.3+/-3.21**	**18.4+/-3.51**	**12.1+/-2.53**	**15.3+/-3.3**
URANIUM-233/234	20.0	2.95	5.75+/-1.08	6.38+/-1.22	3.45+/-0.788	5.55+/-1.18
URANIUM-235/236	6.0	0.418	0.214+/-0.17	0.577+/-0.307	0.54+/-0.303	0.133+/-0.144 U
URANIUM-238	20.0	3.04	5.78+/-1.08	6.09+/-1.18	3.97+/-0.85	5.11+/-1.11

Notes:

Qualifiers

U - The compound was not detected.
J - Result is regarded as estimated due to limitations identified during the dat
B - Indicates that the analyte was found in the associated blank as well as in t

Units
pCi/g - Pico Curies per gram
µg/g - micrograms per gram
NA - Not Analyzed
NE - Not Established.

shaded results indicate an exceedance of the Derived C
Decay products are associated with near

* denotes samples associated with the Environmental Surveillance Program

Table 5-26

Summary of Surface Water Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	SDDSG01 2002/01/14 DUP AB50266 SW µg/L		SDDSG01 2002/01/14 REG AB50260 SW µg/L		SDDSG02 2002/01/14 REG AB50258 SW µg/L		SWSD001* 2000/07/06 REG 7037-012-02-1 SW µg/L	
BENZO(A)ANTHRACENE	NE	NE	NE	11	U	11	U	11	U	12	U
BENZO(B)FLUORANTHENE	NE	NE	NE	11	U	11	U	11	U	12	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	11	U	11	U	11	U	3	J
CHRYSENE	NE	NE	NE	11	U	11	U	11	U	12	U
DI-N-OCTYL PHTHALATE	100	100	NE	11	U	11	U	11	U	12	U
FLUORANTHENE	300	300	NE	11	U	11	U	11	U	12	U
PHENANTHRENE	NE	NE	NE	11	U	11	U	11	U	12	U
PYRENE	200	200	NE	11	U	11	U	11	U	12	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-26

Summary of Surface Water Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	SWSD001* 2000/09/15 REG 9109-007-01-1 SW µg/L		SWSD001* 2000/12/22 REG 12094-005-01-1/2 SW µg/L		SWSD001* 2001/03/27 REG 103276-006-01-1/2 SW µg/L		SWSD001* 2001/06/05 REG AB35171 SW µg/L	
BENZO(A)ANTHRACENE	NE	NE	NE	11	U	12	U	11	U	10	U
BENZO(B)FLUORANTHENE	NE	NE	NE	11	U	12	U	11	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	11	U	12	U	11	U	10	U
CHRYSENE	NE	NE	NE	11	U	12	U	11	U	10	U
DI-N-OCTYL PHTHALATE	100	100	NE	11	U	12	U	11	U	10	U
FLUORANTHENE	300	300	NE	11	U	12	U	1	J	10	U
PHENANTHRENE	NE	NE	NE	11	U	12	U	11	U	10	U
PYRENE	200	200	NE	11	U	12	U	11	U	10	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-26

Summary of Surface Water Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	SWSD001* 2001/10/09 REG AB44212 SW µg/L		SWSD001* 2001/12/19 REG AB48988 SW µg/L		SWSD001* 2002/04/08 REG 204055-006-01-1/2 SW µg/L		SWSD001* 2002/09/27 REG 209177-004-001-1/2 SW µg/L	
BENZO(A)ANTHRACENE	NE	NE	NE	11	U	10	U	0.74	J	11	UJ
BENZO(B)FLUORANTHENE	NE	NE	NE	11	U	10	U	2	J	11	UJ
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	11	U	10	U	11	U	11	UJ
CHRYSENE	NE	NE	NE	11	U	10	U	1.7	J	11	UJ
DI-N-OCTYL PHTHALATE	100	100	NE	11	U	10	U	11	U	11	UJ
FLUORANTHENE	300	300	NE	11	U	10	U	2.3	J	11	UJ
PHENANTHRENE	NE	NE	NE	11	U	10	U	0.91	J	11	UJ
PYRENE	200	200	NE	11	U	10	U	2.5	J	11	UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-26

Summary of Surface Water Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	SWSD003* 2000/07/06 REG 7037-007-02-1 SW µg/L		SWSD003* 2000/09/15 REG 9109-001-01-1 SW µg/L		SWSD003* 2000/12/22 REG 12094-001-01-1/4 SW µg/L		SWSD003* 2001/03/27 REG 103276-001-01-1/4 SW µg/L	
BENZO(A)ANTHRACENE	NE	NE	NE	10.6	U	11	U	12	U	11	U
BENZO(B)FLUORANTHENE	NE	NE	NE	10.6	U	11	U	12	U	11	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10.6	U	11	U	12	U	11	U
CHRYSENE	NE	NE	NE	10.6	U	11	U	12	U	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	10.6	U	11	U	12	U	11	U
FLUORANTHENE	300	300	NE	10.6	U	11	U	12	U	11	U
PHENANTHRENE	NE	NE	NE	10.6	U	11	U	12	U	11	U
PYRENE	200	200	NE	10.6	U	11	U	12	U	11	U

Notes:

Qualifiers

U - The compound was not detected above the laboratory method detection limit.

J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.

µg/L - micrograms per liter

NA - Not Analyzed

NE - Not Established.

Boxed results - indicate an exceedance in applicable standards.

* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-26

Summary of Surface Water Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	SWSD003* 2001/06/05 REG AB35165 SW µg/L		SWSD003* 2001/10/09 REG AB44207 SW µg/L		SWSD003* 2001/12/19 REG AB48982 SW µg/L		SWSD003* 2002/04/08 DUP 204055-003-01-1/2 SW µg/L	
BENZO(A)ANTHRACENE	NE	NE	NE	10	U	13	U	10	U	13	U
BENZO(B)FLUORANTHENE	NE	NE	NE	10	U	13	U	10	U	13	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	U	13	U	10	U	**60**	**J**
CHRYSENE	NE	NE	NE	10	U	13	U	10	U	13	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	13	U	10	U	13	U
FLUORANTHENE	300	300	NE	10	U	13	U	10	U	13	U
PHENANTHRENE	NE	NE	NE	10	U	13	U	10	U	13	U
PYRENE	200	200	NE	10	U	13	U	10	U	13	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-26

Summary of Surface Water Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	SWSD003* 2002/04/08 REG 204055-001-01-1/2 SW µg/L		SWSD003* 2002/10/01 DUP 210018-002-007-1/2 SW µg/L		SWSD003* 2002/10/01 REG 210018-001-001-1/6 SW µg/L		SWSD004* 2000/07/06 REG 7037-011-02-1 SW µg/L	
BENZO(A)ANTHRACENE	NE	NE	NE	12	U	11	U	11	U	11.2	U
BENZO(B)FLUORANTHENE	NE	NE	NE	12	U	11	U	11	U	11.2	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	12	UJ	11	U	11	U	11.2	U
CHRYSENE	NE	NE	NE	12	U	11	U	11	U	11.2	U
DI-N-OCTYL PHTHALATE	100	100	NE	12	U	11	U	11	U	11.2	U
FLUORANTHENE	300	300	NE	12	U	11	U	11	U	11.2	U
PHENANTHRENE	NE	NE	NE	12	U	11	U	11	U	11.2	U
PYRENE	200	200	NE	12	U	11	U	11	U	11.2	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-26

Summary of Surface Water Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	SWSD004* 2000/09/15 REG 9109-004-01-1 SW µg/L		SWSD004* 2000/12/22 REG 12094-004-01-1/2 SW µg/L		SWSD004* 2001/03/27 REG 103276-004-01-1/2 SW µg/L		SWSD004* 2001/06/05 REG AB35170 SW µg/L	
BENZO(A)ANTHRACENE	NE	NE	NE	10	U	11	U	11	U	10	U
BENZO(B)FLUORANTHENE	NE	NE	NE	10	U	11	U	11	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	U	11	U	11	U	12	U
CHRYSENE	NE	NE	NE	10	U	11	U	11	U	10	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	11	U	11	U	1.48	J
FLUORANTHENE	300	300	NE	10	U	11	U	11	U	10	U
PHENANTHRENE	NE	NE	NE	10	U	11	U	11	U	10	U
PYRENE	200	200	NE	10	U	11	U	11	U	10	U

Notes:

Qualifiers

U - The compound was not detected above the laboratory method detection limit.

J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.

µg/L - micrograms per liter

NA - Not Analyzed

NE - Not Established.

Boxed results - indicate an exceedance in applicable standards.

* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-26

Summary of Surface Water Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	SWSD004* 2001/12/19 REG AB48987 SW µg/L		SWSD004* 2002/04/08 REG 204055-005-01-1/2 SW µg/L		SWSD006* 2000/07/06 DUP 7037-010-02-1 SW µg/L		SWSD006* 2000/07/06 REG 7037-009-02-1 SW µg/L	
BENZO(A)ANTHRACENE	NE	NE	NE	10	U	11	U	10.6	U	10.4	U
BENZO(B)FLUORANTHENE	NE	NE	NE	10	U	11	U	10.6	U	10.4	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	U	11	U	10.6	U	10.4	U
CHRYSENE	NE	NE	NE	10	U	11	U	10.6	U	10.4	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	11	U	10.6	U	10.4	U
FLUORANTHENE	300	300	NE	10	U	11	U	10.6	U	10.4	U
PHENANTHRENE	NE	NE	NE	10	U	11	U	10.6	U	10.4	U
PYRENE	200	200	NE	10	U	11	U	10.6	U	10.4	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-26

Summary of Surface Water Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	SWSD006* 2000/09/15 DUP 9109-006-01-1 SW µg/L		SWSD006* 2000/09/15 REG 9109-003-01-1 SW µg/L		SWSD006* 2000/12/22 DUP 12094-003-01-1/2 SW µg/L		SWSD006* 2000/12/22 REG 12094-002-01-1/2 SW µg/L	
BENZO(A)ANTHRACENE	NE	NE	NE	10	U	10	U	11	U	11	U
BENZO(B)FLUORANTHENE	NE	NE	NE	10	U	10	U	11	U	11	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	10	U	10	U	11	U	11	U
CHRYSENE	NE	NE	NE	10	U	10	U	11	U	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	10	U	10	U	11	U	11	U
FLUORANTHENE	300	300	NE	10	U	10	U	11	U	11	U
PHENANTHRENE	NE	NE	NE	10	U	10	U	11	U	11	U
PYRENE	200	200	NE	10	U	10	U	11	U	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-26

Summary of Surface Water Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	SWSD006* 2001/03/27 DUP 103276-003-01-1/2 SW µg/L		SWSD006* 2001/03/27 REG 103276-002-01-1/2 SW µg/L		SWSD006* 2001/06/05 DUP AB35169 SW µg/L		SWSD006* 2001/06/05 REG AB35168 SW µg/L	
BENZO(A)ANTHRACENE	NE	NE	NE	11	U	11	U	10	U	10	U
BENZO(B)FLUORANTHENE	NE	NE	NE	11	U	11	U	10	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	11	U	11	U	20	U	10	U
CHRYSENE	NE	NE	NE	11	U	11	U	10	U	10	U
DI-N-OCTYL PHTHALATE	100	100	NE	11	U	11	U	2.68	J	10	U
FLUORANTHENE	300	300	NE	11	U	11	U	10	U	10	U
PHENANTHRENE	NE	NE	NE	11	U	11	U	10	U	10	U
PYRENE	200	200	NE	11	U	11	U	10	U	10	U

Notes:

Qualifiers

U - The compound was not detected above the laboratory method detection limit.

J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.

µg/L - micrograms per liter

NA - Not Analyzed

NE - Not Established.

Boxed results - indicate an exceedance in applicable standards.

* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-26

Summary of Surface Water Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	SWSD006* 2001/10/09 DUP AB44211 SW µg/L		SWSD006* 2001/10/09 REG AB44210 SW µg/L		SWSD006* 2001/12/19 DUP AB48986 SW µg/L		SWSD006* 2001/12/19 REG AB48985 SW µg/L	
BENZO(A)ANTHRACENE	NE	NE	NE	13	U	13	U	10	U	10	U
BENZO(B)FLUORANTHENE	NE	NE	NE	13	U	13	U	10	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	13	U	13	U	10	U	10	U
CHRYSENE	NE	NE	NE	13	U	13	U	10	U	10	U
DI-N-OCTYL PHTHALATE	100	100	NE	13	U	13	U	10	U	10	U
FLUORANTHENE	300	300	NE	13	U	13	U	10	U	10	U
PHENANTHRENE	NE	NE	NE	13	U	13	U	10	U	10	U
PYRENE	200	200	NE	13	U	13	U	10	U	10	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-26

Summary of Surface Water Analytical Results - Semi-Volatile Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit: Analyte	NJDEP CLASS IIA GW QUALITY STANDARDS µg/L	NJ STATE PRIMARY DRINKING WATER STANDARDS µg/L	USEPA NATIONAL PRIMARY DRINKING WATER REGS µg/L	SWSD006* 2002/04/08 REG 204055-004-01-1/2 SW µg/L		SWSD006* 2002/09/27 REG 209177-005-003-1/2 SW µg/L	
BENZO(A)ANTHRACENE	NE	NE	NE	12	U	11	U
BENZO(B)FLUORANTHENE	NE	NE	NE	12	U	11	U
BIS(2-ETHYLHEXYL)PHTHALATE	30	30	6	12	U	11	U
CHRYSENE	NE	NE	NE	12	U	11	U
DI-N-OCTYL PHTHALATE	100	100	NE	12	U	11	U
FLUORANTHENE	300	300	NE	12	U	11	U
PHENANTHRENE	NE	NE	NE	12	U	11	U
PYRENE	200	200	NE	12	U	11	U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program

Table 5-27

Summary of Surface Water Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	SDDSG01 (UNFIL) 2002/01/14 DUP AB50266 SW µg/L	SDDSG01 (FIL) 2002/01/14 DUP AB50267 SW µg/L	SDDSG01 (UNFIL) 2002/01/14 REG AB50260 SW µg/L	SDDSG01 (FIL) 2002/01/14 REG AB50261 SW µg/L
Analyte	µg/L	µg/L	µg/L				
ALUMINUM	200	NE	NE	180 U	180 U	180 U	180 U
ANTIMONY	20	6	6	15 U	15 U	15 U	15 U
ARSENIC	8	10	NE	7.5 U	7.5 U	7.5 U	7.5 U
BARIUM	2000	2000	2000	95 J	67.3 J	50 UJ	50 UJ
BERYLLIUM	20	4	4	15 U	15 U	15 U	15 U
CADMIUM	4	5	5	3.5 U	3.5 U	3.5 U	3.5 U
CALCIUM	NE	NE	NE	26200	27400	30900	26600
CHROMIUM	100	100	100	50 U	50 U	50 U	50 U
COBALT	NE	NE	NE	20 U	20 U	20 U	20 U
COPPER	1000	1300*	1300*	50 U	50 U	50 U	50 U
IRON	300	NE	NE	275 U	275 U	275 U	275 U
LEAD	10	15*	15*	8 U	8 U	8 U	8 U
MAGNESIUM	NE	NE	NE	10500 J	7040	7480 J	6490
MANGANESE	50	NE	NE	40 U	40 U	40 U	40 U
NICKEL	100	NE	NE	**143 J**	50 U	50 UJ	50 U
POTASSIUM	NE	NE	NE	2360 J	2930 J	2240	2000 UJ
SELENIUM	50	50	50	40 U	40 U	40 U	40 U
SILVER	NE	NE	NE	20 U	20 U	20 U	20 U
SODIUM	50000	NE	NE	**61100 J**	**51900 J**	21000 J	18100 UJ
VANADIUM	NE	NE	NE	50 U	50 U	50 U	50 U
ZINC	5000	NE	NE	514 J	73.7 J	235 J	184 UJ

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-27

Summary of Surface Water Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	SDDSG02 (UNFIL) 2002/01/14 REG AB50258 SW µg/L		SDDSG02 (FIL) 2002/01/14 REG AB50259 SW µg/L		SWSD001* (UNFIL) 2000/07/06 REG 7037-012-01-1 SW µg/L		SWSD001* (UNFIL) 2000/09/15 REG 9109-007-03-1 SW µg/L	
Analyte	µg/L	µg/L	µg/L								
ALUMINUM	200	NE	NE	180	U	180	U	150		165	
ANTIMONY	20	6	6	15	U	15	U	3.7	U	6	
ARSENIC	8	10	NE	7.5	U	7.5	U	3.2	U	3.2	U
BARIUM	2000	2000	2000	100		50	U	31.7	R	29.3	R
BERYLLIUM	20	4	4	15	U	15	U	0.1	U	0.1	U
CADMIUM	4	5	5	3.5	U	3.5	U	0.4	U	0.4	U
CALCIUM	NE	NE	NE	27300		27700		33600		29400	R
CHROMIUM	100	100	100	50	U	50	U	0.862		50	
COBALT	NE	NE	NE	20	U	20	U	0.9	U	0.9	U
COPPER	1000	1300*	1300*	50	U	50	U	9.93	R	13.5	R
IRON	300	NE	NE	275	U	275	U	**602**		382	R
LEAD	10	15*	15*	8	U	8	U	5.71		3	
MAGNESIUM	NE	NE	NE	10800		6680		7810		6000	
MANGANESE	50	NE	NE	40	U	40	U	**91.5**		24.3	
NICKEL	100	NE	NE	**167**		50	U	2	U	2	U
POTASSIUM	NE	NE	NE	2470		2000	U	3040		2780	
SELENIUM	50	50	50	40	U	40	U	2.3	U	2.3	U
SILVER	NE	NE	NE	20	U	20	U	0.7	U	3	
SODIUM	50000	NE	NE	**66000**		18500		19100		15000	
VANADIUM	NE	NE	NE	50	U	50	U	2.03		5	
ZINC	5000	NE	NE	512	J	188		143		175	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-27

Summary of Surface Water Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Date Collected: / Analysis Type: / Lab Sample ID: / Matrix: / Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	SWSD001* (UNFIL) 2000/12/22 REG 12094-005-03-1/1 SW µg/L		SWSD001* (UNFIL) 2001/03/27 REG 103276-006-03-1/1 SW µg/L		SWSD001* (UNFIL) 2001/06/05 REG AB35171 SW µg/L		SWSD001* (UNFIL) 2001/10/09 REG AB44212 SW µg/L	
Analyte	µg/L	µg/L	µg/L								
ALUMINUM	200	NE	NE	23.1	U	**525**		180	U	180	U
ANTIMONY	20	6	6	3.7	U	5		15	U	15	U
ARSENIC	8	10	NE	3.2	U	4.1	U	7.5	U	7.5	U
BARIUM	2000	2000	2000	20.3		28.3		50	U	50	U
BERYLLIUM	20	4	4	0.1	U	0.2	U	15	U	15	U
CADMIUM	4	5	5	0.4	U	0.47		3.5	U	3.5	U
CALCIUM	NE	NE	NE	24300		28600		37900	J	32100	
CHROMIUM	100	100	100	0.8	U	0.9	U	50	U	50	U
COBALT	NE	NE	NE	0.9	U	0.8	U	20	U	20	U
COPPER	1000	1300*	1300*	5.4		13.7		50	U	50	U
IRON	300	NE	NE	91.1		**853**		280	R	**345**	
LEAD	10	15*	15*	1.5	U	**10.6**		8	U	8	U
MAGNESIUM	NE	NE	NE	5530		6140		7380		7230	
MANGANESE	50	NE	NE	23.9		49		45.3		**50.8**	
NICKEL	100	NE	NE	2	U	1.1	U	50	U	50	U
POTASSIUM	NE	NE	NE	1820		2050		2700		2620	
SELENIUM	50	50	50	2.3	U	3.4	U	40	U	40	U
SILVER	NE	NE	NE	1.2		1.4	U	20	UJ	20	U
SODIUM	50000	NE	NE	16000	J	23100		20400		18500	
VANADIUM	NE	NE	NE	1.2		2.3		50	U	50	U
ZINC	5000	NE	NE	173		234		123		176	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-27

Summary of Surface Water Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: / Date Collected: / Analysis Type: / Lab Sample ID: / Matrix: / Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	SWSD001* (UNFIL) 2001/12/19 REG AB48988 SW µg/L		SWSD001* (UNFIL) 2002/04/08 REG 204055-006-03-1/1 SW µg/L		SWSD001* (UNFIL) 2002/09/27 REG 209177-004-007-1/1 SW µg/L		SWSD003* (UNFIL) 2000/07/06 REG 7037-007-01-1 SW µg/L	
Analyte	µg/L	µg/L	µg/L								
ALUMINUM	200	NE	NE	180	U	**303**		**250**		164	J
ANTIMONY	20	6	6	15	U	2.5	U	2.5	U	3.7	U
ARSENIC	8	10	NE	7.5	U	3.4	U	3.4	U	4.59	
BARIUM	2000	2000	2000	50	UJ	28.8		14.1		35.3	R
BERYLLIUM	20	4	4	15	U	0.2	U	0.1	U	0.1	U
CADMIUM	4	5	5	3.5	U	0.3	U	0.3	U	0.4	U
CALCIUM	NE	NE	NE	30800		30900		13700		26300	
CHROMIUM	100	100	100	50	U	2		1.3	U	1.11	
COBALT	NE	NE	NE	20	U	0.6	U	0.6	U	0.9	U
COPPER	1000	1300*	1300*	50	U	13.2		6.3		9.13	R
IRON	300	NE	NE	**318**		**953**		204		**828**	
LEAD	10	15*	15*	8	U	9.4		1.6	U	2.93	
MAGNESIUM	NE	NE	NE	6950		7040		2360		6830	
MANGANESE	50	NE	NE	45.1		**155**		11.3		**127**	
NICKEL	100	NE	NE	50	U	1.8		1.1	U	2.64	R
POTASSIUM	NE	NE	NE	2000	U	2360		1360		2250	
SELENIUM	50	50	50	40	U	3.5	U	3.5	U	2.3	U
SILVER	NE	NE	NE	20	U	0.6	U	0.6	U	0.7	U
SODIUM	50000	NE	NE	17000		15700		10700		20600	
VANADIUM	NE	NE	NE	50	U	3		2		1.45	
ZINC	5000	NE	NE	242		297		130		20.2	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-27

Summary of Surface Water Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	SWSD003* (UNFIL) 2000/09/15 REG 9109-001-03-1 SW µg/L	SWSD003* (UNFIL) 2000/12/22 REG 12094-001-05-1/2 SW µg/L	SWSD003* (UNFIL) 2001/03/27 REG 103276-001-05-1/2 SW µg/L	SWSD003* (UNFIL) 2001/06/05 REG AB35165 SW µg/L
Analyte	µg/L	µg/L	µg/L				
ALUMINUM	200	NE	NE	**5470**	**301**	**331**	**203 J**
ANTIMONY	20	6	6	6	3.7 U	4.5 U	15 U
ARSENIC	8	10	NE	5	3.2 U	4.1 U	7.5 U
BARIUM	2000	2000	2000	59.8 R	38.9	44.6	50 U
BERYLLIUM	20	4	4	1	0.1 U	0.2 U	15 U
CADMIUM	4	5	5	0.4 U	0.4 U	0.4 U	3.5 U
CALCIUM	NE	NE	NE	19800 R	22900	24200	28800 J
CHROMIUM	100	100	100	5	1.2	0.9 U	50 U
COBALT	NE	NE	NE	5	0.9 U	0.8 U	20 U
COPPER	1000	1300*	1300*	15.2 R	6.7	7.4	50 U
IRON	300	NE	NE	**5180 J**	297	**429**	**341 J**
LEAD	10	15*	15*	3	1.5 U	2.1	8 U
MAGNESIUM	NE	NE	NE	5280	6060	6250	7060
MANGANESE	50	NE	NE	**89.8**	17.2	**64.7**	**79.8**
NICKEL	100	NE	NE	5	2 U	1.1 U	50 U
POTASSIUM	NE	NE	NE	3690	2070	1870	2000 U
SELENIUM	50	50	50	2.3 U	2.3 U	3.4 U	40 U
SILVER	NE	NE	NE	3	0.7 U	1.4 U	20 UJ
SODIUM	50000	NE	NE	12900	18100 J	33100	23700
VANADIUM	NE	NE	NE	10.8	0.9 U	1.2 U	50 U
ZINC	5000	NE	NE	23.6	12.1	16.4	50 U

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-27

Summary of Surface Water Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	SWSD003* (UNFIL) 2001/10/09 REG AB44207 SW µg/L		SWSD003* (UNFIL) 2001/12/19 REG AB48982 SW µg/L		SWSD003* (UNFIL) 2002/04/08 DUP 204055-003-03-1/1 SW µg/L		SWSD003* (UNFIL) 2002/04/08 REG 204055-001-03-1/1 SW µg/L	
Analyte	µg/L	µg/L	µg/L								
ALUMINUM	200	NE	NE	**445**		**262**		58.1		70.9	
ANTIMONY	20	6	6	15	U	15	U	2.5	U	2.5	U
ARSENIC	8	10	NE	7.5	U	7.5	U	3.4	U	3.4	U
BARIUM	2000	2000	2000	50	U	50	UJ	36		36.5	
BERYLLIUM	20	4	4	15	U	15	U	0.2	U	0.2	U
CADMIUM	4	5	5	3.5	U	3.5	U	0.3	U	0.3	U
CALCIUM	NE	NE	NE	30600		24500		26500		26600	
CHROMIUM	100	100	100	50	U	50	U	1.3	U	1.9	
COBALT	NE	NE	NE	20	U	20	U	0.6	U	0.6	U
COPPER	1000	1300*	1300*	50	U	50	U	4.5		4.3	
IRON	300	NE	NE	**1110**		275	U	106		106	
LEAD	10	15*	15*	8.11		8	U	1.6	U	1.6	U
MAGNESIUM	NE	NE	NE	8570		6380		7100		7180	
MANGANESE	50	NE	NE	**60.2**		40	U	7.8		8.2	
NICKEL	100	NE	NE	50	U	50	U	1.6		2.1	
POTASSIUM	NE	NE	NE	2420		2200		1750		1740	
SELENIUM	50	50	50	40	U	40	U	3.5	U	3.5	U
SILVER	NE	NE	NE	20	U	20	U	0.6	U	0.6	U
SODIUM	50000	NE	NE	21000		18900		20200		20200	
VANADIUM	NE	NE	NE	50	U	50	U	0.7	U	1.5	
ZINC	5000	NE	NE	65.9		50	U	9.5		11.8	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-27

Summary of Surface Water Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	SWSD003* (UNFIL) 2002/10/01 DUP 210018-002-014-1/1 SW µg/L		SWSD003* (UNFIL) 2002/10/01 REG 210018-001-011-1/3 SW µg/L		SWSD004* (UNFIL) 2000/07/06 REG 7037-011-01-1 SW µg/L		SWSD004* (UNFIL) 2000/09/15 REG 9109-004-03-1 SW µg/L	
Analyte	µg/L	µg/L	µg/L								
ALUMINUM	200	NE	NE	166		186		**6960**		**10900**	
ANTIMONY	20	6	6	2.5	U	2.5	U	3.7	U	3.7	U
ARSENIC	8	10	NE	3.4	U	3.4	U	3.2	U	5	
BARIUM	2000	2000	2000	40.3		41.4		93		97.9	
BERYLLIUM	20	4	4	0.1	U	0.1	U	0.287		1	
CADMIUM	4	5	5	0.3	U	0.3	U	0.732		0.4	U
CALCIUM	NE	NE	NE	30300		29700		12000		17400	R
CHROMIUM	100	100	100	1.3	U	1.3	U	10.1		16	
COBALT	NE	NE	NE	0.6	U	0.6	U	4.73		5	
COPPER	1000	1300*	1300*	1	U	1	U	24.6	R	26.1	R
IRON	300	NE	NE	214		219		**11000**		**13100**	**J**
LEAD	10	15*	15*	1.6	U	1.6	U	**16.1**		**16.1**	
MAGNESIUM	NE	NE	NE	7390		7330		4720		6680	
MANGANESE	50	NE	NE	12.6		15.9		**358**		**267**	
NICKEL	100	NE	NE	1.1	U	1.1	U	11.5	R	13.7	
POTASSIUM	NE	NE	NE	3250		3280		1490		3480	
SELENIUM	50	50	50	3.5	U	3.5	U	2.3	U	2.3	U
SILVER	NE	NE	NE	0.6	U	0.6	U	0.7	U	3	
SODIUM	50000	NE	NE	20700		20200		9250		15400	
VANADIUM	NE	NE	NE	0.7	U	0.7	U	18.2		21.5	
ZINC	5000	NE	NE	8.4		8.8		71.7		49.2	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-27

Summary of Surface Water Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	SWSD004* (UNFIL) 2000/12/22 REG 12094-004-03-1/1 SW µg/L		SWSD004* (UNFIL) 2001/03/27 REG 103276-004-03-1/1 SW µg/L		SWSD004* (UNFIL) 2001/06/05 REG AB35170 SW µg/L		SWSD004* (UNFIL) 2001/12/19 REG AB48987 SW µg/L	
Analyte	µg/L	µg/L	µg/L								
ALUMINUM	200	NE	NE	**3780**		**8920**		**945**	**J**	**6170**	
ANTIMONY	20	6	6	3.7	U	4.5	U	15	U	15	U
ARSENIC	8	10	NE	3.2	U	4.1	U	7.5	U	7.5	U
BARIUM	2000	2000	2000	64.2		93		91.6		86.4	J
BERYLLIUM	20	4	4	0.18		0.2	U	15	U	15	U
CADMIUM	4	5	5	0.4	U	0.4	U	3.5	U	3.5	U
CALCIUM	NE	NE	NE	22500		15900		21800	J	14600	
CHROMIUM	100	100	100	5.3		9.5		50	U	50	U
COBALT	NE	NE	NE	1.9		5.1		20	U	20	U
COPPER	1000	1300*	1300*	12.5		19		50	U	50	U
IRON	300	NE	NE	**4470**		**11400**		**3740**	**J**	**8930**	
LEAD	10	15*	15*	5.2		**14.2**		8	U	**15.3**	
MAGNESIUM	NE	NE	NE	6450		7370		6730		6020	
MANGANESE	50	NE	NE	**95.2**		**331**		**2080**		**311**	
NICKEL	100	NE	NE	4.6		7.5		50	U	50	U
POTASSIUM	NE	NE	NE	2080		2630		2000	U	2870	
SELENIUM	50	50	50	2.3	U	3.4	U	40	U	40	U
SILVER	NE	NE	NE	0.75		1.4	U	20	UJ	20	U
SODIUM	50000	NE	NE	22600	J	18800		12800		10300	
VANADIUM	NE	NE	NE	7.6		19.9		50	U	50	U
ZINC	5000	NE	NE	24.8		52.7		50	U	92.1	

Notes:

Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-27

Summary of Surface Water Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	SWSD004* (UNFIL) 2002/04/08 REG 204055-005-03-1/1 SW µg/L		SWSD006* (UNFIL) 2000/07/06 DUP 7037-010-01-1 SW µg/L		SWSD006* (UNFIL) 2000/07/06 REG 7037-009-01-1 SW µg/L		SWSD006* (UNFIL) 2000/09/15 DUP 9109-006-03-1 SW µg/L	
Analyte	µg/L	µg/L	µg/L								
ALUMINUM	200	NE	NE	**1660**		66.6		42.4		**1880**	
ANTIMONY	20	6	6	2.5	U	3.7	U	3.7	U	3.7	U
ARSENIC	8	10	NE	3.4	U	3.2	U	3.44		3.2	U
BARIUM	2000	2000	2000	67.5		39.7	R	39.7	R	43.3	R
BERYLLIUM	20	4	4	0.2	U	0.1	U	0.1	U	1	
CADMIUM	4	5	5	0.3	U	0.4	U	0.4	U	0.4	U
CALCIUM	NE	NE	NE	20000		27400		27600		19200	R
CHROMIUM	100	100	100	2.3		0.8	U	0.8	U	5	
COBALT	NE	NE	NE	2.4		0.9	U	0.9	U	0.9	U
COPPER	1000	1300*	1300*	9.3		4.6	R	4.21	R	10.5	R
IRON	300	NE	NE	**4030**		**763**		**738**		**2480**	**J**
LEAD	10	15*	15*	4.1		1.5	U	2.66		3	
MAGNESIUM	NE	NE	NE	6900		7230		7270		4860	
MANGANESE	50	NE	NE	**1030**		**602**		**600**		**72.1**	
NICKEL	100	NE	NE	5.6		2	U	2	U	5	
POTASSIUM	NE	NE	NE	1970		2420		2580		3020	
SELENIUM	50	50	50	3.5	U	2.77		2.3	U	2.3	U
SILVER	NE	NE	NE	0.6	U	0.7	U	0.7	U	0.7	U
SODIUM	50000	NE	NE	18600		21500		22000		17100	
VANADIUM	NE	NE	NE	4.6		1.64		1.46		5	
ZINC	5000	NE	NE	23.4		10.9		15		11.1	

Notes:

Qualifiers

U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.

Boxed results - indicate an exceedance in applicable standards.

* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-27

Summary of Surface Water Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	SWSD006* (UNFIL) 2000/09/15 REG 9109-003-03-1 SW µg/L		SWSD006* (UNFIL) 2000/12/22 DUP 12094-003-03-1/1 SW µg/L		SWSD006* (UNFIL) 2000/12/22 REG 12094-002-03-1/1 SW µg/L		SWSD006* (UNFIL) 2001/03/27 DUP 103276-003-03-1/1 SW µg/L	
Analyte	µg/L	µg/L	µg/L								
ALUMINUM	200	NE	NE	**2300**		130		106		**342**	
ANTIMONY	20	6	6	3.7	U	3.7	U	3.7	U	4.5	U
ARSENIC	8	10	NE	3.2	U	3.2	U	3.2	U	4.1	U
BARIUM	2000	2000	2000	45.9	R	43.5		42.3		44.7	
BERYLLIUM	20	4	4	1		0.1	U	0.1	U	0.2	U
CADMIUM	4	5	5	0.4	U	0.4	U	0.4	U	0.4	U
CALCIUM	NE	NE	NE	19700	R	20900		20300		21400	
CHROMIUM	100	100	100	5		1		0.85		0.9	U
COBALT	NE	NE	NE	5		0.9	U	0.9	U	0.8	U
COPPER	1000	1300*	1300*	10.6	R	6.4		6.2		7.3	
IRON	300	NE	NE	**2480**	**J**	142		147		**890**	
LEAD	10	15*	15*	3		1.5	U	1.5	U	1.5	U
MAGNESIUM	NE	NE	NE	5050		5860		5660		5810	
MANGANESE	50	NE	NE	**72.8**		28.6		28.1		**57.4**	
NICKEL	100	NE	NE	5		2	U	2	U	1.1	U
POTASSIUM	NE	NE	NE	3170		2000		1930		1930	
SELENIUM	50	50	50	2.3	U	3		2.3	U	3.4	U
SILVER	NE	NE	NE	0.7	U	0.7	U	1.4		1.4	U
SODIUM	50000	NE	NE	17600		16800	J	16500	J	31800	
VANADIUM	NE	NE	NE	5		0.9	U	0.9	U	1.8	
ZINC	5000	NE	NE	10.7		11.3		11.7		11.7	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-27

Summary of Surface Water Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	SWSD006* (UNFIL) 2001/03/27 REG 103276-002-03-1/1 SW µg/L		SWSD006* (UNFIL) 2001/06/05 DUP AB35169 SW µg/L		SWSD006* (UNFIL) 2001/06/05 REG AB35168 SW µg/L		SWSD006* (UNFIL) 2001/10/09 DUP AB44211 SW µg/L	
Analyte	µg/L	µg/L	µg/L								
ALUMINUM	200	NE	NE	**307**		180	U	180	U	**1200**	
ANTIMONY	20	6	6	4.5	U	15	U	15	U	15	U
ARSENIC	8	10	NE	4.1	U	7.5	U	7.5	U	7.5	U
BARIUM	2000	2000	2000	44.4		57.6		50	U	63	
BERYLLIUM	20	4	4	0.2	U	15	U	15	U	15	U
CADMIUM	4	5	5	0.4	U	3.5	U	3.5	U	3.5	U
CALCIUM	NE	NE	NE	21400		27000	J	24400	J	32600	
CHROMIUM	100	100	100	8.8		50	U	50	U	50	U
COBALT	NE	NE	NE	0.8	U	20	U	20	U	20	U
COPPER	1000	1300*	1300*	6.4		50	U	50	U	50	U
IRON	300	NE	NE	**364**		280	R	280	R	**2200**	
LEAD	10	15*	15*	1.5	U	8	U	8	U	8	U
MAGNESIUM	NE	NE	NE	5780		6950		6310		9390	
MANGANESE	50	NE	NE	**57.8**		**94.4**		**84.7**		**332**	
NICKEL	100	NE	NE	25.2		50	U	50	U	50	U
POTASSIUM	NE	NE	NE	1990		2000	U	2000	U	2580	
SELENIUM	50	50	50	3.4	U	40	U	40	U	40	U
SILVER	NE	NE	NE	1.4	U	20	UJ	20	UJ	20	U
SODIUM	50000	NE	NE	31600		26800		24300		20800	
VANADIUM	NE	NE	NE	1.2	U	50	U	50	U	50	U
ZINC	5000	NE	NE	11		50	U	50	U	50.3	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 5-27

Summary of Surface Water Analytical Results - Metals
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Location ID: Date Collected: Analysis Type: Lab Sample ID: Matrix: Unit:	NJDEP CLASS IIA GW QUALITY STANDARDS	NJ STATE PRIMARY DRINKING WATER STANDARDS	USEPA NATIONAL PRIMARY DRINKING WATER REGS	SWSD006* (UNFIL) 2001/10/09 REG AB44210 SW µg/L		SWSD006* (UNFIL) 2001/12/19 DUP AB48986 SW µg/L		SWSD006* (UNFIL) 2001/12/19 REG AB48985 SW µg/L		SWSD006* (UNFIL) 2002/04/08 REG 204055-004-03-1/1 SW µg/L		SWSD006* (UNFIL) 2002/09/27 REG 209177-005-008-1/1 SW µg/L	
Analyte	µg/L	µg/L	µg/L										
ALUMINUM	200	NE	NE	**705**		**421**		**413**		91.4		**1530**	
ANTIMONY	20	6	6	15	U	15	U	15	U	2.5	U	2.5	U
ARSENIC	8	10	NE	7.5	U	7.5	U	7.5	U	3.4	U	3.4	U
BARIUM	2000	2000	2000	55.8		50	UJ	50	UJ	36.9		35.4	
BERYLLIUM	20	4	4	15	U	15	U	15	U	0.2	U	0.19	
CADMIUM	4	5	5	3.5	U	3.5	U	3.5	U	0.3	U	0.3	U
CALCIUM	NE	NE	NE	31000		22700		24600		23500		16800	
CHROMIUM	100	100	100	50	U	50	U	50	U	1.3	U	2.4	
COBALT	NE	NE	NE	20	U	20	U	20	U	0.6	U	0.6	U
COPPER	1000	1300*	1300*	50	U	50	U	50	U	4.4		9.3	
IRON	300	NE	NE	**1530**		**572**		**588**		208		**1470**	
LEAD	10	15*	15*	8	U	8	U	8	U	1.6	U	2	
MAGNESIUM	NE	NE	NE	8790		6250		6760		6510		4150	
MANGANESE	50	NE	NE	**252**		40	U	40	U	41.1		31.7	
NICKEL	100	NE	NE	50	U	50	U	50	U	1.6		1.5	
POTASSIUM	NE	NE	NE	2360		2150		2300		1750		3250	
SELENIUM	50	50	50	40	U	40	U	40	U	3.5	U	3.5	U
SILVER	NE	NE	NE	20	U	20	U	20	U	0.6	U	0.6	U
SODIUM	50000	NE	NE	20000		18400		19800		18900		14800	
VANADIUM	NE	NE	NE	50	U	50	U	50	U	1.2		3.6	
ZINC	5000	NE	NE	50	U	50	U	50	U	10.7		20.1	

Notes:
Qualifiers
U - The compound was not detected above the laboratory method detection limit.
J - Result is regarded as estimated due to limitations identified during the data validation/quality assurance review.
R - Result regarded as unreliable. Analyte may or may not be present.
µg/L - micrograms per liter
NA - Not Analyzed
NE - Not Established.
Boxed results - indicate an exceedance in applicable standards.
* denotes groundwater samples associated with the Environmental Surveillance Program
FIL denotes results are from a Filtered sample
UNFIL denotes results are from an Unfiltered sample

Table 6-1

Physical and Chemical Properties of Select Contaminants at the Middlesex Sampling Plant
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Contaminant of Concern	Density (mg/L)	Molecular Weight (g/mol)	Solubility at 25°C (mg/L)	Henry's Constant (atm-$m^3/mol*10^{-5}$)	Estimated Half-Life (yrs)	Koc (mL/g)	Kow (mL/g)	Kd (mL/g)
Inorganics/Metals								
Aluminum	NA	NA	NA	NA	NA	NA	NA	--
Beryllium	NA	NA	NA	NA	NA	NA	NA	1,300
Iron	NA	NA	NA	NA	NA	NA	NA	170
Manganese	NA	NA	NA	NA	NA	NA	NA	180
Uranium	NA	NA	NA	NA	NA	NA	NA	5 to 50
SVOCs								
Bis(2-ethylhexyl)phthalate	0.9861	391	0.4	1.1	10 to 389 days	100,000	540,000,000	410,000
VOCs								
Carbon Tetrachloride (CTET)	1.59	154	800	3,000	12	220	440	0.33
Chloroform	1.48	119	9,600	340	0.2 to 5	44	93	0.07
Methyl tertiary-butyl ether (MTBE)	0.741	88	50,000	0.02	0.5 to 90 days	11.4	15.8	0.014
Trichloroethylene (TCE)	1.46	131	1,100	1,200	1 to 5	110	200	0.15
Radionuclides								
Uranium-238	NA	238	NA	NA	$4.5x10^9$	NA	NA	5 to 50
Uranium-234	NA	234	NA	NA	244,000	NA	NA	5 to 50
Thorium-232	NA	232	NA	NA	$1.41x10^{10}$	NA	NA	6,000 to 60,000
Thorium-234	NA	234	NA	NA	24.5 days	NA	NA	6,000 to 60,000
Radium-226	NA	226	NA	NA	1,622	NA	NA	7 to 70
Radium-228	NA	228	NA	NA	6.7	NA	NA	7 to 70

Note: Majority of data taken from Montgomery and Welkom (1989)

Table 6-2

Summary of Model Input Parameters
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Data Type	Parameter	Overburden	Bedrock	Source of Information
Hydrogeology	Hydraulic Conductivity	*3.0 ft/day*	*0.60 ft/day*	Based on slug test data reported in Appendix K
	Hydraulic Gradient	*0.01 to 0.02*	*0.008 to 0.012*	Approximated from potentiometric surface maps (Figures 3-15 to 3-18)
	Porosity	*0.20*	*0.10*	Average values from literature (Fetter, 1994)
Dispersion	Longitudinal Dispersivity	*32.8 ft*	*100 ft*	Based on estimated plume length (Pickens and Grisak, 1981; Xu and Eckstein, 1995)
	Transverse Dispersivity	*3.3 ft*	*10 ft*	
	Vertical Dispersivity	*0.001 ft*	*0.001 ft*	
Adsorption	Retardation Factor	*Variable*	*Variable*	Calculated from $R=1+(K_{oc}*f_{oc}*\rho_b)/f$ or $R=1+(K_d*\rho_b)/f$
	Soil Bulk Density (ρ_b)	*1.7 kg/L*	*2.2 kg/L*	Assumed as typical value (Brady and Weil, 1999)
	f_{oc}	*0.0012*	*0.0012*	McCarty *et al.*, 1981
	K_{oc}	*Variable*	*Variable*	See Table 6-1
Biodegradation	Half-Life	*Variable*	*Variable*	See Table 6-1

Table 6-3

Sensitivity Analysis of BioScreen Model Parameters
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

		DISTANCE TRAVELED TO COMPARISON CRITERION					
		VARIED PARAMETERS					
Time	**Nominal**	**Porosity**		**Foc**		**Half-Life (yr)**	
(years)	(ft)	0.15	0.25	0.0009	0.0015	3.4E+09	5.6E+09
0	1,070	1,365	900	1,105	1,050	1,070	1,070
1	1,095	1,390	920	1,135	1,075	1,095	1,095
5	1,175	1,490	975	1,205	1,150	1,175	1,175
10	1,275	1,610	1,050	1,300	1,245	1,275	1,275

Nominal Parameter Values

Effective Porosity	0.2
Fraction of Organic Carbon (Foc)	0.0012
Half-Life (yr)	4.50E+09

The values of these parameters listed above are the upper (+25% and lower -25%) values

Table 6-4

Estimated Contaminant Migration Distances of Iso-Concentration Contour of Regulatory Limits
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Time (yrs from present)	U-238[1] Overburden (5 pCi/L)	U-234[1] Overburden (5 pCi/L)	Ra-226 + Ra-228		Total U[1] Overburden (30 mg/L)	CTET[3] Bedrock (2 mg/L)	TCE[3] Bedrock (2 mg/L)	$CHCl_3$[3] Bedrock (6 mg/L)	MTBE	
			Overburden[1] (5 pCi/L)	Bedrock[2] (5 pCi/L)					Overburden[4] (70 mg/L)	Bedrock[5] (70 mg/L)
0	1,070	1,070	920	120[6]	1,145	165	165	350	185	170
1	1,095	1,095	940	-	1,160	165	165	355	180	170
5	1,175	1,175	1,015	-	1,250	170	170	375	160	165
10	1,275	1,275	1,105	-	1,350	175	170	400	135	160
---	**Distance (ft) from Source Area to Simulated Contaminant Concentration**									

Note: "-" indicates that by this distance, the entire plume has attenuated to below documented regulatory limit. Based on no remedial action occurring.

[1] Source area is presumed to be located in the vicinity of B18W24S. Contaminant is interpreted to migrate approximately due north, but hydrogeologic data indicates potential flow to the northeast or northwest. The northern property boundary is less than 100 feet from the presumed source zone.

[2] Source area is presumed to be located in the vicinity of URSMW2D. Contaminant is interpreted to migrate north-northeast and south-southeast diverging from a groundwater divide. The property boundary to the southeast is located approximately 600 feet from the source zone. The northern property boundary is less than 100 feet from the presumed source zone.

[3] Source area is presumed to be located in the vicinity of URSMW2D and within the vicinity of the garage. Contaminant is interpreted to migrate in all directions, diverging from a groundwater divide. The property boundary is generally 200 feet away in all directions from the source zone.

[4] Source area is presumed to be located along the southwestern boundary of the MSP. Contaminant is interpreted to migrate east-southeast across the site. The opposite property boundary is approximately 500 feet away. Depending upon seasonal groundwater gradients, this plume may be directed to the South Drainage Ditch.

[5] Source area is presumed to be located along the southwestern boundary of the MSP. Contaminant is interpreted to migrate eastward in an accurate pattern across the site. The opposite property boundary is approximately 500 feet away.

[6]Two samples approximately 120 ft from the presumed source zone were observed above the regulatory limit (URSMW1D – 5.35 pCi/L and URSMW2D – 5.19 piC/L) during the first round of sampling. Follow-up sampling and simulation of plume behavior calibrated to average activities predicts attenuation is presently occurring.

Table 7-1

Groundwater COPC Screening
Groundwater Operable Unit Remidial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Analyte	Number of On-Site Detects	Maximum Detect On-Site (ug/L)	Maximum Background Detect (ug/L)	Background 95% UTL (ug/L)	Region IX Tap Water PRG (ug/L)
Below Background					
BARIUM	84	583	925		2600
IRON	71	13800	14500		11000
DI-N-BUTYL PHTHALATE	2	1.1	1.4		3600
THORIUM-230		0.919	0.459	1.8	
THORIUM-232		0.232	0.209	2.1	
Above Background but Below PRG					
Below Frequency of Detection Screen					
ANTIMONY	2	6.9			15
BERYLLIUM	3	0.26			73
MERCURY	1	0.1			11
1,2,4-TRICHLOROBENZENE	4	11			190
1,3-DICHLOROBENZENE	4	1.19			5.5
DIETHYL PHTHALATE	5	70			29000
DI-N-OCTYL PHTHALATE	4	7.7			1500
1,1-DICHLOROETHANE	2	1.72			810
1,2-DICHLOROBENZENE	1	0.51			370
ACETONE	2	4			610
BROMOMETHANE	1	2.2	1.2		8.8
CHLOROBENZENE	5	4			110
CIS-1,2-DICHLOROETHENE	1	1.23			61
TOLUENE	1	1.69			720
TRANS-1,2-DICHLOROETHENE	1	1			120
Exceed Frequency of Detection Screen					
ALUMINUM	35	2690	137		36000
CHROMIUM	18	2190			55000
COBALT	8	12.9			730
COPPER	22	40.8	2.1		1500
NICKEL	19	479	3.7		730
SELENIUM	8	22.2			180
SILVER	11	3.7			180
VANADIUM	17	5.7	0.71		260
ZINC	26	482	16.1		11000
PHENOL	6	5.1	3.4		22000
CARBON DISULFIDE	10	4.5			1000
Above Background and PRG					
ARSENIC	4	5.6			0.045
LEAD	5	4.6			
MANGANESE	79	6610	1530		880
TOTAL URANIUM	87	761	0.929	1.8	7.3
1,4-DICHLOROBENZENE	2	1.16			0.5
1,2-DICHLOROETHANE	2	1.33			0.12
CARBON TETRACHLORIDE	2	46.2			0.17
CHLOROFORM	2	22.4			6.2
CHLOROMETHANE	1	5.4			1.5
TRICHLOROETHENE	1	35.7			0.028
ACTINIUM-228		27.52			
BISMUTH-212		58.88			
RADIUM-226		6.16	1.02	2.6	
RADIUM-228		4.35	0.94	2.4	
THORIUM-228		2.91	0.533	1.4	
THORIUM-234		432.3			
URANIUM-233/234		261	0.775	2.0	
URANIUM-235/236		17.9	0.059	NC	
URANIUM-238		253	0.303	0.6	

Table 7-2

Surface Water COPC Screening
Groundwater Operable Unit Remidial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Analytes Detected in SW **At or below Background**	Number of On-site detects	Maximum Detect in Surf Water (ug/L)	Maximum Background Detect (ug/L)	Background 95% UTL (ug/L)	Tap Water PRG (ug/L)
ALUMINUM	22	5470	10900	18,000	36000
ARSENIC	3	5	5	7.4	0.045
BARIUM	14	100	97.9	130	2600
BERYLLIUM	3	1	1	370	73
CADMIUM	1	0.47	0.732	NC	18
COBALT	2	5	5.1	17	730
COPPER	11	13.7	19	48	1500
IRON	23	5180	13100	22,000	11000
LEAD	11	10.6	16.1	NC	
MANGANESE	25	600	2080	12,000	880
SILVER	4	3	3	240	180
VANADIUM	13	10.8	21.5	45	260
RADIUM-228	10	1.18	1.21	2.1	
THORIUM-230	13	1.53	1.06	1.7	
THORIUM-232	8	0.133	0.82	2.5	
Above BG but Below Tap Water PRG					
Below Frequency of Detection Screen					
CHRYSENE	1	1.7			9.2
FLUORANTHENE	2	2.3			1500
PYRENE	1	2.5			180
Exceed Frequency of Detection Screen					
ANTIMONY	3	6			15
CHROMIUM	11	50	16	44	55000
NICKEL	8	167	13.7	49	730
ZINC	24	512	92.1	140	11000
Above BG and Above PRG					
TOTAL URANIUM	26	135	4.58	6.6	7.3
BENZO(A)ANTHRACENE	1	0.74			0.092
BENZO(B)FLUORANTHENE	1	2			0.092
PHENANTHRENE	1	0.91			
BISMUTH-212	1	53.55			
LEAD-212	1	16.75			
LEAD-214	1	18.84			
RADIUM-226	17	3.79	1.79	2.5	
THORIUM-228	7	0.807	0.5	0.75	
URANIUM-233/234	26	46.7	1.31	1.9	
URANIUM-235/236	13	3.45	0.231	0.66	
URANIUM-238	25	45.1	1.49	2.2	

NC = Not Calculated due to data distribution

Table 7-3

Sediment COPEC Screening
Groundwater Operable Unit Remidial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Number of On-Site Detections	Maximum Detect in Sediment (mg/kg)	Maximum Background Detect (mg/kg)	Background 95% UTL (mg/kg)
Below 95% UTL				
BERYLLIUM	23	1.66	1.38	1.9
IRON	64	38600	38300	58000
Above 95% UTL				
ALUMINUM	67	35600	23600	32000
ANTIMONY	11	12.9	0.74	2.8
ARSENIC	53	37.4	5.02	7.8
BARIUM	63	219	156	
CADMIUM	26	6.5	0.31	0.81
CHROMIUM	59	85.7	37.2	56
COBALT	65	35.1	14	17
COPPER	67	363	52.4	80
LEAD	67	483	40.4	52
MANGANESE	64	2820	441	690
MERCURY	19	0.52	0.22	0.29
NICKEL	63	66.1	32.7	51
SELENIUM	21	5.2	0	
SILVER	15	3.34	0	
TOTAL URANIUM	63	334	9.24	13
VANADIUM	65	139	53.7	76
ZINC	62	3050	145	200
ACTINIUM-228	3	1.44	1.27	
BISMUTH-212	2	1.8	0.86	
BISMUTH-214	3	7.1	0.95	
CESIUM-137	51	0.201	0.108	0.18
LEAD-212	3	1.63	1.32	
LEAD-214	3	6.83	0.89	
PROTACTINIUM-234M	1	20.66	5.8	
RADIUM-226	64	13.3	1.32	1.5
RADIUM-228	62	3.3	1.74	2.1
THALLIUM-208	3	1.29	1.2	
THORIUM-228	64	3.91	1.64	2.1
THORIUM-230	61	19	2.28	3
THORIUM-232	67	2.32	1.46	1.9
THORIUM-234	2	20.57	4.35	
URANIUM-233/234	67	113	2.95	3.6
URANIUM-235/236	48	9.29	0.418	1.9
URANIUM-238	67	111	3.04	3.7

Table 7-4

Contaminants of Potential Concern
Groundwater Operable Unit Remidial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Groundwater	Surface Water	Sediment
METALS		
ALUMINUM CHROMIUM COBALT COPPER LEAD MANGANESE NICKEL SELENIUM SILVER URANIUM VANADIUM ZINC	ANTIMONY CHROMIUM NICKEL URANIUM ZINC	ALUMINUM ANTIMONY ARSENIC BARIUM CADMIUM CHROMIUM COBALT COPPER LEAD MANGANESE MERCURY NICKEL SELENIUM SILVER URANIUM VANADIUM ZINC
SVOCs		
1,4-DICHLOROBENZENE PHENOL	BENZO(A)ANTHRACENE BENZO(B)FLUORANTHENE PHENANTHRENE	
VOCs		
1,2-DICHLOROETHANE CARBON DISULFIDE CARBON TETRACHLORIDE CHLOROFORM CHLOROMETHANE TRICHLOROETHENE		
NUCLIDES		
ACTINIUM-228 BISMUTH-212 RADIUM-226 RADIUM-228 THORIUM-228 THORIUM-234 URANIUM-233/234 URANIUM-235/236 URANIUM-238	BISMUTH-212 LEAD-212 LEAD-214 RADIUM-226 THORIUM-228 URANIUM-233/234 URANIUM-235/236 URANIUM-238	ACTINIUM-228 BISMUTH-212 BISMUTH-214 CESIUM-137 LEAD-212 LEAD-214 PROTACTINIUM-234M RADIUM-226 RADIUM-228 THALLIUM-208 THORIUM-228 THORIUM-230 THORIUM-232 THORIUM-234 URANIUM-233/234 URANIUM-235/236 URANIUM-238

Table 7-5

Organic Dermal Data
Groundwater Operable Unit Remidial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CHEMICAL	CAS No.	Kp (cm/hr)	B	tau (hr)	t* (hr)	FA	DAevent (mg/cm2)/event	DAD (mg/kg/day)	Derm/Oral (%)	Chem Assess?
Benzo-a-anthracene	56553	4.70E-01	2.8	2.03	8.53	1	1.40E-03	1.50E-01	1283%	Y
Benzo-b-fluoranthene	205992	7.00E-01	4.3	2.77	12.03	1	2.50E-03	2.60E-01	2221%	Y
Bromomethane	74839	2.80E-03	0	0.36	0.87	1	3.60E-06	3.80E-04	3%	N
Carbon disulfide	75150	1.70E-02	0.1	0.3	0.72	1	2.00E-05	2.10E-03	18%	Y
Carbon tetrachloride	56235	1.60E-02	0.1	0.78	1.86	1	3.00E-05	3.20E-03	27%	Y
Chlorobenzene	108907	2.80E-02	0.1	0.46	1.09	1	4.00E-05	4.20E-03	36%	Y
Chlorodibromomethane	124481	3.20E-03	0	1.57	3.77	1	8.50E-06	9.00E-04	8%	N
Chloroform	67663	6.80E-03	0	0.5	1.19	1	1.00E-05	1.10E-03	9%	N
Chloromethane	74873	3.30E-03	0	0.2	0.49	1	3.30E-06	3.40E-04	3%	N
Chrysene	218019	4.70E-01	2.8	2.03	8.53	1	1.40E-03	1.50E-01	1283%	Y
Dibutyl phthalate	84742	2.40E-02	0.2	3.86	9.27	0.9	9.00E-05	9.50E-03	81%	Y
Dichlorobenzene, 1,2-	95501	4.10E-02	0.2	0.71	1.71	1	7.40E-05	7.80E-03	66%	Y
Dichlorobenzene,1,3-	541731	5.80E-02	0.3	0.71	1.71	1	1.00E-04	1.10E-02	93%	Y
Dichlorobenzene,1,4-	106467	4.20E-02	0.2	0.71	1.71	1	7.50E-05	7.90E-03	67%	Y
Dichloroethane, 1,1-	75343	6.70E-03	0	0.38	0.92	1	8.80E-06	9.30E-04	8%	N
Dichloroethane,1,2-	107062	4.20E-03	0	0.38	0.92	1	5.50E-06	5.80E-04	5%	N
Dichloroethylene,1,2- trans	540590	7.70E-03	0	0.37	0.89	1	9.90E-06	1.00E-03	9%	N
Diethyl phthalate	84662	3.90E-03	0	1.87	4.5	1	1.10E-05	1.20E-03	10%	Y
Fluoranthene	206440	2.20E-01	1.2	1.45	5.68	1	5.70E-04	6.00E-02	512%	Y
Phenanthrene	85018	1.40E-01	0.7	1.06	4.11	1	3.10E-04	3.30E-02	283%	Y
Phenol	108952	4.30E-03	0	0.36	0.86	1	5.50E-06	5.80E-04	5%	N
Toluene	108883	3.10E-02	0.1	0.35	0.84	1	3.90E-05	4.10E-03	35%	Y
Trichlorobenzene, 1,2,4-	120821	6.60E-02	0.3	1.11	2.66	1	1.50E-04	1.60E-02	133%	Y
Trichloroethylene	79016	1.20E-02	0.1	0.58	1.39	1	1.90E-05	2.00E-03	17%	Y

Reference : RAGS Part E (EPA, 2001a)

TABLE 7 - 6a
Parameters for Exposure to Groundwater-RME
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

		RME	RME	Reference
	Units	**Resident**	**Resident Child**	
Drinking Water Ingestion				
Water Ingestion Rate	L/day	2	1.3	EFH, 1997
Exposure Frequency	days/year	350	350	EFH
Exposure Duration (Note a)	Years	30 (24/6)	6	EFH
Body Weight (Note b)	Kg	70	15	EPA RAGS A
Carcinogenic Averaging Time	Years	70	NA	RAGS A
Non-carcinogenic Averaging Time	Years	30	6	RAGS A
Dermal Contact - Shower				
Skin Area	cm^2	18,000	6,600	RAGS Part E
Exposure Time	Hr/day	0.25	0.25	EFH, Chap 15 Table 15-18
Exposure Frequency	days/year	350	350	EFH, Chap 15 Table 15-18
Exposure Duration	Years	30 (24/6)	6	EFH, Chap 15 Table 15-18
Body Weight	kg	70	15	EPA RAGS A
Carcinogenic Averaging Time	Years	70	NA	RAGS Part A
Non-carcinogenic Averaging Time	Years	30	6	EFH, Chap 15 Table 15-18
Inhalation of VOCs				
Inhalation Rate	m^3/hour	0.63	0.35	EFH Chap 5 Adult – 15.2 m3/day Child – 8.3 m3/day (3-5yr)
Exposure Time	Hours/day	0.33	0.33	EFH, Shower + post-shower time in bathroom (50^{th} percentile)
Mass Loading (VOCs)	ug/m^3 per ug/L	8.8	8.8	Shower model
Exposure Frequency	Days/year	350	350	EFH, Chap 15 Table 15-18
Exposure Duration	Years	30 (24/6)	6	EFH, Chap 15 Table 15-18
Body Weight	kg	70	15	RAGS Part A
Carcinogenic Averaging Time	Years	70	NA	RAGS Part A
Non-carcinogenic Averaging Time	Years	30	6	EFH, Chap 15 Table 15-18

Notes:

a Combination Child (6 years) and Adult (24 years)

TABLE 7 - 6b
Parameters for Exposure to Groundwater-CTA
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

		CTA	CTA	Reference
	Units	**Resident**	**Resident Child**	**(For Parameters different than RME)**
Drinking Water Ingestion				
Water Ingestion Rate	L/day	1.4	0.88	EFH Table 3-30
Exposure Frequency	days/year	350	350	
Exposure Duration	Years	9 (3/6)	6	EFH, Chap 15 Table 15-18
Body Weight	Kg	70	15	
Carcinogenic Averaging Time	Years	70	NA	
Non-carcinogenic Averaging Time	Years	9	6	EFH, Chap 15 Table 15-18
Dermal Contact				
Skin Area	cm^2	18,000	6,600	
Exposure Time	Hr/day	0.25	0.25	
Exposure Frequency	days/year	350	350	
Exposure Duration	Years	9 (3/6)	6	EFH, Chap 15 Table 15-18
Body Weight	Kg	70	15	
Carcinogenic Averaging Time	Years	70	NA	
Non-carcinogenic Averaging Time	Years	9	6	EFH, Chap 15 Table 15-18
Inhalation of VOCs				
Inhalation Rate	m^3/hour	0.63	0.35	
Exposure Time	hours/day	0.33	0.33	
Mass Loading (VOCs)	ug/m^3 per ug/L	8.8	8.8	
Exposure Frequency	days/year	350	350	
Exposure Duration	Years	9 (3/6)	6	EFH, Chap 15 Table 15-18
Body Weight	Kg	70	15	
Carcinogenic Averaging Time	Years	70	NA	
Non-carcinogenic Averaging Time	Years	9	6	EFH, Chap 15 Table 15-18

TABLE 7 - 6c
Parameters for Exposure to Surface Water and Sediments-RME
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

		RME	References
	Units		
Incidental Ingestion			
Sediment Ingestion Rate	mg/day	200	EFH Section 4.7
Incidental Surface Water ingestion	L/day	0.02	Assumption = 1% DW rate
Exposure Frequency	days/year	39	Scenario model
Exposure Duration	Years	9	Scenario model
Body Weight (Age 9)	Kg	24	EFH Table 7-6
Carcinogenic Averaging Time	Years	70	RAGS Part A
Non-carcinogenic Averaging Time	Years	9	Scenario model
Dermal Contact			
Skin Area Sediment (Age 9)	cm^2/event	4,500	EFH Table 6-6, 6-8, Legs, feet, hands
Adherence Factor	mg/cm2 per event	3.3	RAGS Part E, Exhibit C-3 wet soil 95^{th}
Skin Area Surface Water (Age 9)	cm^2	4,500	EFH Table 6-6, 6-8, Legs, feet, hands
Exposure Time	Hr/day	2	Scenario model
Exposure Frequency	days/year	39	Scenario model
Exposure Duration	Years	9	Scenario model
Body Weight (Age 9)	Kg	24	EFH Table 7-6
Carcinogenic Averaging Time	Years	70	RAGS Part A
Non-carcinogenic Averaging Time	Years	9	Scenario model
Radiation Exposure			
Exposure Time	Hr/day	2	Scenario model
Exposure Frequency	days/year	39	Scenario model
Exposure Duration	Years	9	Scenario model

TABLE 7 - 6d
Parameters for Exposure to Surface Water and Sediments-CTA
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

		CTA	References
	Units	**Value**	**(For Parameters different than RME)**
Incidental Ingestion			
Sediment Ingestion Rate	mg/day	100	EFH Table 4-23
Incidental Surface Water ingestion	L/day	0.02	
Exposure Frequency	days/year	39	
Exposure Duration	Years	9	
Body Weight (Age 9)	Kg	24	EFH Table 7-3, Mean
Carcinogenic Averaging Time	Years	70	
Non-carcinogenic Averaging Time	Years	9	
Dermal Contact			
Skin Area Sediment (legs, feet, hands)	Cm^2/event	4,500	
Adherence Factor (Sediment to feet)	mg/cm2 per event	0.2	RAGS Part E Exhibit C-3, Mean
Skin Area Surface Water (legs, feet, hands)	cm^2	4,500	
Exposure Time	Hr/day	2	
Exposure Frequency	days/year	39	
Exposure Duration	Years	9	
Body Weight (Age 6-15)	Kg	24	EFH Table 7-3, Mean
Carcinogenic Averaging Time	Years	70	
Non-carcinogenic Averaging Time	Years	9	
Radiation Exposure			
Exposure Time	Hr/day	2	
Exposure Frequency	days/year	39	
Exposure Duration	Years	9	

TABLE 7- 7

Groundwater Exposure Point Concentrations - Site
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

COPCs in Groundwater	Statistical Method and Mean Value		Statistical Method and 95% UCL of the Mean		Maximum Detection	Background Mean	Background UCL	Background UTL	Net Conc
INORGANIC CHEMICALS						ug/L	ug/L	ug/L	ug/L
ALUMINUM	Bootstrap Mean	2.11E+02	Standard Bootstrap UCL	2.72E+02	2690	137.0	137.0	137.0	135.3
ARSENIC	Bootstrap Mean	3.18E+00	Pivotal Bootstrap UCL	3.34E+00	5.6	-	-	-	3.3
CHROMIUM	Jackknife Mean	4.07E+01	Jackknifed UCL	7.77E+01	2190	-	-	-	77.7
COBALT	Bootstrap Mean	6.85E+00	Pivotal Bootstrap UCL	7.54E+00	12.9	-	-	-	7.5
COPPER	Bootstrap Mean	1.84E+01	Pivotal Bootstrap UCL	2.00E+01	40.8	2.1	2.1	2.1	17.9
LEAD	Bootstrap Mean	2.90E+00	Pivotal Bootstrap UCL	3.15E+00	4.6	-	-	-	3.2
MANGANESE	MVUE of the log-mean	2.07E+03	UCL based on Jackknifed MVUE	2.99E+03	6610	1,530.0	1,530.0	1,530.0	1,460.0
NICKEL	Bootstrap Mean	2.64E+01	Standard Bootstrap UCL	3.61E+01	479	3.7	3.7	3.7	32.4
SELENIUM	Bootstrap Mean	1.40E+01	Pivotal Bootstrap UCL	1.53E+01	22.2	-	-	-	15.3
SILVER	**Bootstrap Mean**	**6.84E+00**	**Pivotal Bootstrap UCL**	**7.51E+00**	**3.7**	-	-	-	7.5
TOTAL URANIUM	MVUE of the log-mean	3.78E+01	UCL based on Jackknifed MVUE	5.97E+01	761	0.6	1.0	1.8	59.1
VANADIUM	**Bootstrap Mean**	**1.63E+01**	**Pivotal Bootstrap UCL**	**1.83E+01**	**5.7**	0.7	0.7	0.7	17.6
ZINC	Bootstrap Mean	2.65E+01	Standard Bootstrap UCL	3.53E+01	482	16.0	16.0	16.0	19.3
SEMIVOLATILE ORGANIC CHEMICALS									
1,4-DICHLORO-BENZENE	**Bootstrap Mean**	**1.02E+00**	**Hall Adjusted Bootstrap**	**1.25E+00**	**0.8**	-	-	-	1.3
PHENOL	**Bootstrap Mean**	**5.36E+00**	**Hall Adjusted Bootstrap**	**5.56E+00**	**5.1**	-	-	-	5.6
VOLATILE ORGANIC CHEMICALS									
1,2-DICHLOROETHANE	**Bootstrap Mean**	**2.10E+00**	**Hall Adjusted Bootstrap**	**2.54E+00**	**1.33**	-	-	-	2.5
CARBON DISULFIDE	Bootstrap Mean	2.17E+00	Hall Adjusted Bootstrap	2.48E+00	4.5	-	-	-	2.5
CARBON TETRACHLORIDE	Bootstrap Mean	2.86E+00	Standard Bootstrap UCL	3.80E+00	46.2	-	-	-	3.8
CHLOROFORM	Bootstrap Mean	2.47E+00	Standard Bootstrap UCL	2.96E+00	22.4	-	-	-	3.0
CHLOROMETHANE	Bootstrap Mean	2.37E+00	Hall Adjusted Bootstrap	2.73E+00	5.4	-	-	-	2.7
TRICHLORO-ETHENE	Bootstrap Mean	2.42E+00	Standard Bootstrap UCL	3.06E+00	35.7	-	-	-	3.1

TABLE 7- 7

Groundwater Exposure Point Concentrations - Site
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

COPCs in Groundwater	Statistical Method and Mean Value		Statistical Method and 95% UCL of the Mean		Maximum Detection	Background Mean	Background UCL	Background UTL	Net Conc
RADIOLOGICAL CHEMICALS						pCi/L	pCi/L	pCi/L	
ACTINIUM-228	Jackknife Mean	-1.68E+01	Jackknifed UCL	1.58E+00	27.52	-	-	-	1.6
BISMUTH-212	Jackknife Mean	-2.24E+01	Jackknifed UCL	-8.42E+00	58.88	-	-	-	(8.4)
RADIUM-226	Bootstrap Mean	9.80E-01	Hall Adjusted Bootstrap	1.24E+00	6.16	0.4	1.1	2.6	0.8
RADIUM-228	Bootstrap Mean	2.20E-01	Hall Adjusted Bootstrap	3.98E-01	4.35	0.7	1.2	2.4	(0.3)
THORIUM-228	Bootstrap Mean	-2.55E-01	Hall Adjusted Bootstrap	-1.48E-01	2.91	0.2	0.6	1.4	(0.4)
THORIUM-234	Jackknife Mean	1.08E+02	Jackknifed UCL	2.48E+02	432.3	-	-	-	248.3
URANIUM-234	Bootstrap Mean	1.52E+01	Standard Bootstrap UCL	2.18E+01	261	0.6	1.0	2.0	21.2
URANIUM-235	Bootstrap Mean	6.36E-01	Standard Bootstrap UCL	1.08E+00	17.9	0.8	1.5	NC	0.3
URANIUM-238	Bootstrap Mean	1.50E+01	Standard Bootstrap UCL	2.10E+01	253	0.2	0.3	0.6	20.8

Table 7-8

Exposure Point Concentration
For Risk by Well Analysis
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	URSMW2D	URSMW2S	B18W24S
Chemical	(ug/L)	(ug/L)	(ug/L)
ALUMINUM			618.5
COBALT			1
COPPER			4.1
MANGANESE	65.2	6610	22.2
NICKEL			3
SELENIUM			19.7
SILVER			1.5
TOTAL URANIUM	0.915	74.4	504.3
VANADIUM			3
ZINC			9.5
PHENOL			23
1,4-DICHLOROBENZENE			39
1,2-DICHLOROETHANE	1.33		
CARBON DISULFIDE			2.1
CARBON TETRACHLORIDE	46.2		
CHLOROFORM	22.4		
TRICHLOROETHENE	35.7		
Radiological	(pCi/L)	(pCi/L)	(pCi/L)
RADIUM-226	4.87	2.46	0.37
RADIUM-228		1.14	
THORIUM-230	0.163	0.102	
THORIUM-232		0.0279	
URANIUM-233/234	1.09	25.8	168.5
URANIUM-235/236	0.151	1.42	10.9
URANIUM-238	0.284	24.8	166.8

TABLE 7- 9

Surface Water Exposure Point Concentration
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling

Chemical in Surface Water	Statistical Method and Mean Value		Statistical Method and 95% UCL of the Mean		Maximum Detection	Background Mean	Background UCL	Background UTL	Net Conc
INORGANIC CHEMICALS						ug/L	ug/L	ug/L	ug/L
ANTIMONY	Bootstrap Mean	4.29E+00	Pivotal Bootstrap UCL	5.28E+00	6	-	-	-	5.28E+00
CHROMIUM	Bootstrap Mean	1.24E+01	Pivotal Bootstrap UCL	1.72E+01	50	13.3	21.7	44.1	-4.48E+00
NICKEL	Bootstrap Mean	1.68E+01	Standard Bootstrap UCL	2.66E+01	167	13.6	23.4	48.5	3.15E+00
TOTAL URANIUM	Bootstrap Mean	3.27E+01	Pivotal Bootstrap UCL	4.93E+01	135	1.5	2.3	4.3	4.70E+01
ZINC	Bootstrap Mean	9.66E+01	Standard Bootstrap UCL	1.33E+02	512	48.4	72.9	138.4	6.02E+01
SEMIVOLATILE ORGANIC CHEMICALS									
BENZO (A) ANTHRACENE	**Bootstrap Mean**	**5.36E+00**	**Standard Bootstrap UCL**	**5.65E+00**	**0.74**	-	-	-	5.65E+00
BENZO (B) FLUORANTHENE	**Bootstrap Mean**	**5.39E+00**	**Pivotal Bootstrap UCL**	**5.60E+00**	**2**	-	-	-	5.60E+00
PHENANTHRENE	**Bootstrap Mean**	**5.36E+00**	**Pivotal Bootstrap UCL**	**5.59E+00**	**0.91**	-	-	-	5.59E+00
RADIOLOGICAL CHEMICALS									
BISMUTH-212	Simple Average	1.37E+01	Maximum Detection	5.36E+01	53.55	-	-	-	5.36E+01
LEAD-212	Simple Average	6.53E+00	Maximum Detection	1.68E+01	16.75	-	-	-	1.68E+01
LEAD-214	Simple Average	4.50E+00	Maximum Detection	1.88E+01	18.84	-	-	-	1.88E+01
RADIUM-226	Bootstrap Mean	7.23E-01	Pivotal Bootstrap UCL	1.17E+00	3.79	1.0	1.4	2.5	-2.34E-01
THORIUM-228	Bootstrap Mean	-2.31E-01	Standard Bootstrap UCL	-1.17E-01	0.807	0.3	0.4	0.7	-5.38E-01
URANIUM-234	Bootstrap Mean	1.07E+01	Hall Adjusted Bootstrap	1.68E+01	46.7	0.6	0.9	1.9	1.59E+01
URANIUM-235	Bootstrap Mean	3.90E-01	Hall Adjusted Bootstrap	8.57E-01	3.45	0.1	0.2	0.7	6.83E-01
URANIUM-238	Bootstrap Mean	1.08E+01	Pivotal Bootstrap UCL	1.70E+01	45.1	0.6	1.0	2.2	1.60E+01

TABLE 7- 10

Sediment Exposure Point Concentration
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling

Chemical in Sediment	Statistical Method and Mean Value		Statistical Method and 95% UCL of the Mean		Maximum Detection	Background Mean	Background UCL	Background UTL	Net UCL Conc
INORGANIC CHEMICALS						mg/kg	mg/kg	mg/kg	mg/kg
ALUMINUM	Bootstrap Mean	1.35E+04	Hall Adjusted Bootstrap	1.47E+04	35600	16,575.0	20,506.9	31,568.5	-5.78E+03
ANTIMONY	Bootstrap Mean	2.10E+00	Standard Bootstrap UCL	2.57E+00	12.9	1.0	1.5	2.8	1.06E+00
ARSENIC	MVUE of the log-mean	6.17E+00	UCL based on Jackknifed MVUE	7.48E+00	37.4	3.2	4.5	7.8	3.01E+00
BARIUM	Normal Mean	1.01E+02	UCL based on t-statistic	1.10E+02	219	114.1	136.3	136.3	-2.61E+01
CADMIUM	Bootstrap Mean	1.00E+00	Standard Bootstrap UCL	1.22E+00	6.5	0.3	0.4	0.8	7.80E-01
CHROMIUM	MVUE of the log-mean	3.14E+01	UCL based on Jackknifed MVUE	3.46E+01	85.7	26.7	34.6	56.0	-3.43E-02
COBALT	Bootstrap Mean	1.40E+01	Pivotal Bootstrap UCL	1.52E+01	35.1	10.8	12.5	17.4	2.69E+00
COPPER	MVUE of the log-mean	8.36E+01	UCL based on H-statistic	9.97E+01	363	32.9	45.6	79.5	5.41E+01
LEAD	MVUE of the log-mean	9.78E+01	UCL based on H-statistic	1.22E+02	483	34.0	38.8	52.2	8.31E+01
MANGANESE	MVUE of the log-mean	7.64E+02	UCL based on Jackknifed MVUE	8.65E+02	2820	272.7	384.9	685.4	4.80E+02
MERCURY	Bootstrap Mean	1.38E-01	Hall Adjusted Bootstrap	1.56E-01	0.52	0.1	0.2	0.3	4.78E-03
NICKEL	Bootstrap Mean	2.95E+01	Hall Adjusted Bootstrap	3.20E+01	66.1	25.6	32.5	51.1	-5.56E-01
SELENIUM	Bootstrap Mean	1.94E+00	Pivotal Bootstrap UCL	2.21E+00	5.2	-	-	-	2.21E+00
SILVER	Bootstrap Mean	2.06E+00	Hall Adjusted Bootstrap	2.34E+00	3.34	-	-	-	2.34E+00
TOTAL URANIUM	MVUE of the log-mean	4.25E+01	UCL based on Jackknifed MVUE	6.42E+01	334	5.1	7.1	12.5	5.72E+01
VANADIUM	Bootstrap Mean	4.86E+01	Hall Adjusted Bootstrap	5.33E+01	139	41.1	50.1	75.5	3.23E+00
ZINC	MVUE of the log-mean	3.82E+02	UCL based on Jackknifed MVUE	4.94E+02	3050	97.9	125.7	200.4	3.69E+02

TABLE 7- 10

Sediment Exposure Point Concentration
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling

Chemical in Sediment	Statistical Method and Mean Value		Statistical Method and 95% UCL of the Mean		Maximum Detection	Background Mean	Background UCL	Background UTL	Net UCL Conc
RADIOLOGICAL CHEMICALS						pCi/g	pCi/g	pCi/g	
ACTINIUM-228	Simple Average	1.01E+00	Maximum Detection	1.44E+00	1.44	1.3	1.3	1.3	1.70E-01
BISMUTH-212	Simple Average	8.95E-01	Maximum Detection	1.44E+00	1.8	0.9	0.9	0.9	5.80E-01
BISMUTH-214	Simple Average	3.16E+00	Maximum Detection	7.10E+00	7.1	1.0	1.0	1.0	6.15E+00
CESIUM-137	Bootstrap Mean	-3.22E-02	Pivotal Bootstrap UCL	1.14E-02	0.201	0.1	0.1	0.2	-8.40E-02
LEAD-212	Simple Average	1.05E+00	Maximum Detection	1.63E+00	1.63	1.3	1.3	1.3	3.10E-01
LEAD-214	Simple Average	3.22E+00	Maximum Detection	6.83E+00	6.83	0.9	0.9	0.9	5.94E+00
PROTACTINIUM-234M	Simple Average	7.75E+00	Maximum Detection	2.07E+01	20.66	5.8	5.8	5.8	1.49E+01
RADIUM-226	Bootstrap Mean	2.57E+00	Hall Adjusted Bootstrap	3.43E+00	13.3	1.1	1.2	1.5	2.19E+00
RADIUM-228	Bootstrap Mean	1.11E+00	Hall Adjusted Bootstrap	1.25E+00	3.3	1.5	1.6	2.1	-3.71E-01
THALLIUM-208	Simple Average	8.47E-01	Maximum Detection	1.29E+00	1.29	1.2	1.2	1.2	9.00E-02
THORIUM-228	Bootstrap Mean	1.37E+00	Hall Adjusted Bootstrap	1.51E+00	3.91	1.4	1.6	2.1	-5.16E-02
THORIUM-230	MVUE of the log-mean	3.24E+00	UCL based on Jackknifed MVUE	4.17E+00	19	1.7	2.0	3.0	2.12E+00
THORIUM-232	Normal Mean	1.02E+00	UCL based on t-statistic	1.10E+00	2.32	1.2	1.4	1.9	-2.92E-01
THORIUM-234	Simple Average	1.00E+01	Maximum Detection	2.06E+01	20.57	4.4	4.4	4.4	1.62E+01
URANIUM-234	MVUE of the log-mean	1.47E+01	UCL based on Jackknifed MVUE	2.22E+01	113	1.8	2.3	3.6	1.99E+01
URANIUM-235	Bootstrap Mean	9.62E-01	Standard Bootstrap UCL	1.41E+00	9.29	0.1	0.5	1.9	9.43E-01
URANIUM-238	MVUE of the log-mean	1.48E+01	UCL based on Jackknifed MVUE	2.23E+01	111	1.9	2.3	3.7	2.00E+01

Table 7-11

Chemical Slope Factors and Reference Dose Factors
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

													CHEMICAL SPECIFIC PARAMETERS			EPA IX Tap Water PRG
CHEMICAL	SF oral	Ref	SFderma	Adj?	SF inhal	Ref	RfD oral	Ref	RFDderma	Adj	RfD inhal	Ref	Kp water	Soil Abs	GI ABS	(ug/L)
	1/(mg/kg-d)		1/(mg/kg-d)		1/(mg/kg-d)		(mg/kg-d)		(mg/kg-d)		(mg/kg-d)		(cm/hr)			
METALS													(From RAGS Part E)			
Aluminum							1.0E+00	n	1.0E-01	Y			1.0E-03		1.0E-01	36000
Antimony							4.0E-04	i	6.0E-05	Y			1.0E-03		1.5E-01	15
Arsenic	1.5E+00	i	1.5E+00	N			3.0E-04	i	3.0E-04	N			1.0E-03	3.0E-02	9.5E-01	0.045
Barium							7.0E-02	i	4.9E-03	Y			1.0E-03		7.0E-02	2600
Beryllium and compounds							2.0E-03	i	1.4E-05	Y			1.0E-03		7.0E-03	73
Cadmium							5.0E-04	i	1.3E-05	Y			1.0E-03	1.0E-03	2.5E-02	18
Chromium (III)							1.5E+00	i	2.0E-02	Y			1.0E-03		1.3E-02	55000
Cobalt							2.0E-02	h	2.0E-02	N			4.0E-04		8.0E-01	730
Copper							4.0E-02	h	4.0E-02	N			1.0E-03		5.7E-01	1500
Iron							3.0E-01	n	4.5E-02	Y			1.0E-03		1.5E-01	11000
Lead And Compounds									0.0E+00	Y			6.0E-04		1.5E-01	
Manganese							2.4E-02	i	9.6E-04	Y			1.0E-03		4.0E-02	880
Mercury compounds									0.0E+00				1.0E-03		7.0E-02	11
Nickel Soluble Salts							2.0E-02	i	8.0E-04	Y			2.0E-04		4.0E-02	730
Selenium (GW & Sed)							5.0E-03	i	1.5E-03	Y			1.0E-03		3.0E-01	180
Silver							5.0E-03	i	2.0E-04	Y			6.0E-04		4.0E-02	180
Uranium							3.0E-03	i	3.0E-03	N			1.0E-03		8.5E-01	7.3
Vanadium							7.0E-03	h	1.8E-04	Y			1.0E-03		2.6E-02	260
Zinc							3.0E-01	i	3.0E-01	N			6.0E-04			11000
SVOC																
Dibutyl Phthalate							1.0E-01	i	1.0E-01	N						3600
Diethyl Phthalate							8.0E-01	i	8.0E-01	N						29000
Octyl Phthalate, di-N-							4.0E-02	h	4.0E-02	N						1500
Phenol							3.0E-01	i	3.0E-01	N						22000
Trichlorobenzene, 1,2,4-							1.0E-02	i	1.0E-02	N						190
Benzo(a)anthracene	7.3E-01	IX		N											8.9E-01	0.092
Benzo(b)fluoranthene	7.3E-01	IX		N											8.9E-01	0.092
Chrysene	7.3E-03	IX		N											8.9E-01	9.2
Fluoranthene							4.0E-02	i	4.0E-02	N					8.9E-01	1500
VOCs																
Acetone							1.0E-01	i	1.0E-01	N						610
Bromomethane							1.4E-03	i	1.4E-03	N	1.4E-03	i				8.7
Carbon Disulfide							1.0E-01	i	1.0E-01	N	2.0E-01	i				1000
Carbon Tetrachloride	1.3E-01	i	1.3E-01	N	5.3E-01	i	7.0E-04	i	7.0E-04	N						0.17
Chlorobenzene							2.0E-02	i	2.0E-02	N	1.7E-02	n				110
Chloroform	1.0E-02	i	1.0E-02	N	8.0E-02	i	1.0E-02	i	1.0E-02	N	1.4E-02	n				6.2
Chloromethane	1.3E-02	h	1.3E-02	N	6.3E-03	h					8.6E-02	n				1.5
Dichlorobenzene, 1,2-							9.0E-02	i	9.0E-02	N	5.7E-02	h				370
Dichlorobenzene, 1,3-							9.0E-04	n	9.0E-04	N						5.5
Dichlorobenzene, 1,4-	2.4E-02	h	2.4E-02	N	2.2E-03	n					2.3E-01	i				0.05
Dichloroethane, 1,1-							1.0E-01	h	1.0E-01	N	1.4E-01	h				810
Dichloroethane, 1,2-	9.1E-02	i	9.1E-02	N	9.1E-02	i	3.0E-02	n	3.0E-02	N	1.4E-03	h				0.12
Dichloroethylene, 1,2-cis-							1.0E-02	n	1.0E-02	N	1.0E-02	h				61
Dichloroethylene, 1,2-trans-							2.0E-02	i	2.0E-02	N	2.0E-02	h				120
Toluene							2.0E-01	i	2.0E-01	N	1.1E-01	i				720
Trichloroethylene	1.1E-02	W	1.1E-02	W	1.1E-02	W										0.028

References
IRIS i
HEAST h
NCEA Provisional n
EPA TCE Paper E
EPA Region IX value IX
Withdrawn IRIS Value, see text W

Table 7-12

Radiological Slope Factors and Dose Factors
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	RISK FACTORS			DOSE FACTORS	
	Water Ingestion (Risk/pCi)	Soil Ingestion (Risk/pCi)	External Exposure (Risk/y per pCi/g)	Ingestion (mrem/pCi)	External mrem-g/(pCi-yr)
Actinium-228	1.99E-12	5.55E-12	4.53E-06	2.16E-06	5.97E+00
Bismuth-212	7.10E-13	1.78E-12	8.87E-07	1.06E-06	1.17E+00
Bismuth-214	1.92E-13	4.33E-13	7.48E-06	2.83E-07	9.80E+00
Cesium-137	3.04E-11	4.33E-11	2.55E-06	5.00E-05	3.60E+00
Lead-212	2.50E-11	6.70E-11	5.09E-07	4.55E-05	7.04E-01
Lead-214	3.44E-13	8.51E-13	9.82E-07	6.25E-07	1.34E+00
Protactinium-234m	-		6.87E-08		8.96E-02
Radium-226	3.86E-10	7.30E-10	8.49E-06	1.32E-03	3.17E-02
Radium-228	1.04E-09	2.29E-09	4.53E-06	1.44E-03	0.00E+00
Thallium-208	-		1.76E-05		2.30E+01
Thorium-228	3.00E-10	8.09E-10	7.76E-06	3.96E-04	7.93E-03
Thorium-230	9.10E-11	2.02E-10	8.19E-10	5.48E-04	1.21E-03
Thorium-232	1.01E-10	2.31E-10	3.42E-10	2.73E-03	5.21E-04
Thorium-234	2.31E-11	6.70E-11	1.63E-08	1.37E-05	2.41E-02
Uranium-234	7.07E-11	1.58E-10	2.52E-10	2.89E-04	4.01E-04
Uranium-235	7.18E-11	1.63E-10	5.43E-07	2.66E-04	7.21E-01
Uranium-238	8.71E-11	2.10E-10	1.14E-07	2.55E-04	1.03E-04

Table 7-13

Risk and Hazard Summary
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Exposure Point	Model	**Chemical Risk**	**Radiological Risk**	**Total Risk**	**Adult Hazard Index**	**Child Hazard Index**	**Annual Radiation Dose** (mrem/yr)
Site-wide groundwater distribution	RME	2.1E-05	1.0E-04	1E-04	4.6	14	9.9
Surface Water & Sediments	RME	5.2E-06	1.2E-05	2E-05	0.2	NA	1.3
Well B18W24S	RME	0.0E+00	5.7E-04	6E-04	4.8	15	66
Well URSMW2D	RME	1.8E-04	4.2E-05	2E-04	2.2	6.4	4.8
Well URSMW2S	RME	0.0E+00	1.3E-04	1E-04	8.7	26	13
Background Site Groundwater	RME	0.0E+00	4.4E-05	4E-05	1.9	5.5	3
Background Surface Water & Sediments	RME	2.5E-06	5.7E-06	8E-06	0.1	NA	0.5
Site-wide groundwater distribution	CTA	8.4E-06	2.1E-05	3E-05	3.3	9.3	6.9
Well B18W24S	CTA	0.0E+00	1.2E-04	1E-04	3.4	9.9	46
Well URSMW2D	CTA	7.2E-05	8.8E-06	8E-05	1.6	4.5	3.4
Well URSMW2S	CTA	0.0E+00	2.7E-05	3E-05	6.2	18	9.3
Background Site Groundwater	CTA	0.0E+00	9.2E-06	9E-06	1.3	3.8	2.1

NA - Not Applicable

TABLE 7 - 14

BACKGROUND RADIOLOGICAL CONCENTRATIONS
RESIDENT
Groundwater - Risk
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake				Radiological Cancer Risk		
	Concentration		Drinking Water (pCi)	Dermal (Shower) (pCi)	Drinking Water	Dermal (Shower)	TOTAL
RADIUM-226	1.1	pCi/L	2.4E+04	1.3E-01	9.1E-06	5.1E-11	9.1E-06
RADIUM-228	1.2	pCi/L	2.6E+04	1.4E-01	2.7E-05	1.5E-10	2.7E-05
THORIUM-228	0.6	pCi/L	1.2E+04	6.6E-02	3.5E-06	2.0E-11	3.5E-06
URANIUM-234	1.0	pCi/L	2.1E+04	1.2E-01	1.5E-06	8.5E-12	1.5E-06
URANIUM-235	1.5	pCi/L	3.1E+04	1.7E-01	2.2E-06	1.2E-11	2.2E-06
URANIUM-238	0.3	pCi/L	6.6E+03	3.7E-02	5.8E-07	3.2E-12	5.8E-07
TOTAL					4.4E-05	2.4E-10	4.4E-05

TABLE 7 - 15

BACKGROUND CHEMICAL CONCENTRATIONS

RESIDENT
Groundwater - Hazard
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Non-carcinogenic Dose					Hazard Index			
CONTAMINANT	Concentration		Drinking Water (mg/kg/day)	Dermal (Shower) (mg/kg/day)	Inhalation (Shower) (mg/kg/day)	Drinking Water	Dermal (Shower)	Inhalation (Shower)	TOTAL
METALs									
Aluminum	137.0	ug/L	3.8E-03	8.4E-06		3.8E-03	8.4E-05		3.8E-03
Copper	2.1	ug/L	5.8E-05	1.3E-07		1.4E-03	3.2E-06		1.4E-03
Manganese	1,530.0	ug/L	4.2E-02	9.4E-05		1.7E+00	9.8E-02		1.8E+00
Nickel	3.7	ug/L	1.0E-04	4.6E-08		5.1E-03	5.7E-05		5.1E-03
Uranium	1.0	ug/L	2.6E-05	5.9E-08		8.8E-03	2.0E-05		8.8E-03
Vanadium	0.7	ug/L	1.9E-05	4.3E-08		2.7E-03	2.4E-04		3.0E-03
Zinc	16.0	ug/L	4.4E-04	5.9E-07		1.5E-03	2.0E-06		1.5E-03
TOTAL						1.8E+00	9.9E-02		1.9E+00

TABLE 7 - 16

CHEMICAL BACKGROUND CONCENTRATIONS

RESIDENT CHILD
Groundwater - Hazard
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

		Non-carcinogenic Dose			Hazard Index			
CONTAMINANT	Concentration	Drinking Water (mg/kg/day)	Dermal (Shower) (mg/kg/day)	Inhalation (Shower) (mg/kg/day)	Drinking Water	Dermal (Shower)	Inhalation (Shower)	TOTAL
METALs								
Aluminum	137.0 ug/L	1.1E-02	1.4E-05		1.1E-02	1.4E-04		1.2E-02
Copper	2.1 ug/L	1.7E-04	2.2E-07		4.4E-03	5.5E-06		4.4E-03
Manganese	1,530.0 ug/L	1.3E-01	1.6E-04		5.3E+00	1.7E-01		5.5E+00
Nickel	3.7 ug/L	3.1E-04	7.8E-08		1.5E-02	9.8E-05		1.5E-02
Uranium	1.0 ug/L	8.0E-05	1.0E-07		2.7E-02	3.4E-05		2.7E-02
Vanadium	0.7 ug/L	5.8E-05	7.4E-08		8.3E-03	4.1E-04		8.7E-03
Zinc	16.0 ug/L	1.3E-03	1.0E-06		4.4E-03	3.4E-06		4.4E-03
TOTAL					5.4E+00	1.7E-01		5.5E+00

TABLE 7 - 17

SITE WIDE RADIOLOGICAL CONCENTRATIONS

RESIDENT
Groundwater - Risk
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake				Radiological Cancer Risk		
	Concentration		Drinking Water (pCi)	Dermal (Shower) (pCi)	Drinking Water	Dermal (Shower)	TOTAL
ACTINIUM-228	1.6	pCi/L	3.3E+04	1.9E-01	6.6E-08	3.7E-13	6.6E-08
RADIUM-226	1.2	pCi/L	2.5E+04	1.4E-01	9.8E-06	5.5E-11	9.8E-06
RADIUM-228	0.4	pCi/L	8.4E+03	4.7E-02	8.7E-06	4.9E-11	8.7E-06
THORIUM-234	20.9	pCi/L	4.4E+05	2.5E+00	1.0E-05	5.7E-11	1.0E-05
URANIUM-234	21.0	pCi/L	4.4E+05	2.5E+00	3.1E-05	1.8E-10	3.1E-05
URANIUM-235	1.0	pCi/L	2.2E+04	1.2E-01	1.5E-06	8.7E-12	1.5E-06
URANIUM-238	20.9	pCi/L	4.4E+05	2.5E+00	3.8E-05	2.2E-10	3.8E-05
TOTAL					1.0E-04	5.6E-10	1.0E-04

TABLE 7 - 18

SITE WIDE CHEMICAL CONCENTRATIONS

RESIDENT
Groundwater - Risk
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Carcinogenic Dose Drinking Water (mg/kg/day)	Carcinogenic Dose Dermal (Shower) (mg/kg/day)	Carcinogenic Dose Inhalation (Shower) (mg/kg/day)	Carcinogenic Risk Drinking Water	Carcinogenic Risk Dermal (Shower)	Carcinogenic Risk Inhalation (Shower)	Carcinogenic Risk TOTAL
SVOC									
Dichlorobenzene, 1,4-	0.8	ug/L	1.3E-05	4.7E-06		3.2E-07	1.1E-07		4.3E-07
VOCs									
Carbon Tetrachloride	3.8	ug/L	6.3E-05	5.6E-06	5.4E-05	8.2E-06	7.3E-07	2.9E-06	1.2E-05
Chloroform	3.0	ug/L	4.9E-05	1.5E-06	4.2E-05			3.4E-06	3.4E-06
Chloromethane	2.7	ug/L	4.5E-05	4.2E-07	3.9E-05	5.9E-07	5.5E-09	2.4E-07	8.3E-07
Dichloroethane, 1,2-	1.3	ug/L	2.2E-05	3.6E-07	1.9E-05	2.0E-06	3.3E-08	1.7E-06	3.7E-06
Trichloroethylene	3.1	ug/L	5.1E-05	2.9E-06	4.3E-05	5.6E-07	3.2E-08	4.8E-07	1.1E-06
TOTAL						1.2E-05	9.1E-07	8.6E-06	2.1E-05

TABLE 7 - 19

SITE WIDE CHEMICAL CONCENTRATIONS
RESIDENT
Groundwater - Hazard
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Non-carcinogenic Dose: Drinking Water (mg/kg/day)	Non-carcinogenic Dose: Dermal (Shower) (mg/kg/day)	Non-carcinogenic Dose: Inhalation (Shower) (mg/kg/day)	Hazard Index: Drinking Water	Hazard Index: Dermal (Shower)	Hazard Index: Inhalation (Shower)	Hazard Index: TOTAL
METALs									
Aluminum	272.3	ug/L	7.5E-03	1.7E-05		7.5E-03	1.7E-04		7.6E-03
Chromium (III)	77.7	ug/L	2.1E-03	4.8E-06		1.4E-03	2.5E-04		1.7E-03
Cobalt	7.5	ug/L	2.1E-04	1.9E-07		1.0E-02	9.3E-06		1.0E-02
Copper	20.0	ug/L	5.5E-04	1.2E-06		1.4E-02	3.1E-05		1.4E-02
Manganese	2,990.0	ug/L	8.2E-02	1.8E-04		3.4E+00	1.9E-01		3.6E+00
Nickel	36.1	ug/L	9.9E-04	4.5E-07		4.9E-02	5.6E-04		5.0E-02
Selenium	15.3	ug/L	4.2E-04	9.4E-07		8.4E-02	6.3E-04		8.4E-02
Silver	3.7	ug/L	1.0E-04	1.4E-07		2.0E-02	6.8E-04		2.1E-02
Uranium	59.7	ug/L	1.6E-03	3.7E-06		5.5E-01	1.2E-03		5.5E-01
Vanadium	5.7	ug/L	1.6E-04	3.5E-07		2.2E-02	1.9E-03		2.4E-02
Zinc	35.3	ug/L	9.7E-04	1.3E-06		3.2E-03	4.4E-06		3.2E-03
SVOC									
Phenol	5.1	ug/L	1.4E-04	4.5E-06		4.7E-04	1.5E-05		4.8E-04
Dichlorobenzene, 1,4-	0.8	ug/L	2.2E-05	9.6E-06		7.3E-04	3.2E-04		1.1E-03
VOCs									
Carbon Disulfide	2.5	ug/L	6.8E-05	4.9E-06	6.2E-05	6.8E-04	4.9E-05	3.1E-04	1.0E-03
Carbon Tetrachloride	3.8	ug/L	1.0E-04	1.1E-05	9.5E-05	1.5E-01	1.6E-02		1.7E-01
Chloroform	3.0	ug/L	8.1E-05	3.0E-06	7.4E-05	8.1E-03	3.0E-04	5.3E-03	1.4E-02
Chloromethane	2.7	ug/L	7.5E-05	8.6E-07	6.8E-05			7.9E-04	7.9E-04
Dichloroethane, 1,2-	1.3	ug/L	3.6E-05	7.3E-07	3.3E-05	1.2E-03	2.4E-05	2.4E-02	2.5E-02
Trichloroethylene	3.1	ug/L	8.4E-05	6.0E-06	7.7E-05				
TOTAL						4.3E+00	2.1E-01	3.0E-02	4.6E+00

TABLE 7 - 20

SITE WIDE CHEMICAL CONCENTRATIONS

RESIDENT CHILD
Groundwater - Hazard
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Non-carcinogenic Dose: Drinking Water (mg/kg/day)	Non-carcinogenic Dose: Dermal (Shower) (mg/kg/day)	Non-carcinogenic Dose: Inhalation (Shower) (mg/kg/day)	Hazard Index: Drinking Water	Hazard Index: Dermal (Shower)	Hazard Index: Inhalation (Shower)	Hazard Index: TOTAL
METALs									
Aluminum	272.3	ug/L	2.3E-02	2.9E-05		2.3E-02	2.9E-04		2.3E-02
Chromium (III)	77.7	ug/L	6.5E-03	8.2E-06		4.3E-03	4.2E-04		4.7E-03
Cobalt	7.5	ug/L	6.3E-04	3.2E-07		3.1E-02	1.6E-05		3.1E-02
Copper	20.0	ug/L	1.7E-03	2.1E-06		4.2E-02	5.3E-05		4.2E-02
Manganese	2,990.0	ug/L	2.5E-01	3.2E-04		1.0E+01	3.3E-01		1.1E+01
Nickel	36.1	ug/L	3.0E-03	7.6E-07		1.5E-01	9.5E-04		1.5E-01
Selenium	15.3	ug/L	1.3E-03	1.6E-06		2.5E-01	1.1E-03		2.6E-01
Silver	3.7	ug/L	3.1E-04	2.3E-07		6.1E-02	1.2E-03		6.3E-02
Uranium	59.7	ug/L	5.0E-03	6.3E-06		1.7E+00	2.1E-03		1.7E+00
Vanadium	5.7	ug/L	4.7E-04	6.0E-07		6.8E-02	3.3E-03		7.1E-02
Zinc	35.3	ug/L	2.9E-03	2.2E-06		9.8E-03	7.4E-06		9.8E-03
SVOC									
Phenol	5.1	ug/L	4.2E-04	7.7E-06		1.4E-03	2.6E-05		1.4E-03
Dichlorobenzene, 1,4-	0.8	ug/L	6.6E-05	1.7E-05		2.2E-03	5.5E-04		2.8E-03
VOCs									
Carbon Disulfide	2.5	ug/L	2.1E-04	8.4E-06	1.6E-04	2.1E-03	8.4E-05	8.0E-04	2.9E-03
Carbon Tetrachloride	3.8	ug/L	3.2E-04	2.0E-05	2.5E-04	4.5E-01	2.8E-02		4.8E-01
Chloroform	3.0	ug/L	2.5E-04	5.2E-06	1.9E-04	2.5E-02	5.2E-04	1.4E-02	3.9E-02
Chloromethane	2.7	ug/L	2.3E-04	1.5E-06	1.8E-04			2.1E-03	2.1E-03
Dichloroethane, 1,2-	1.3	ug/L	1.1E-04	1.3E-06	8.6E-05	3.7E-03	4.2E-05	6.2E-02	6.5E-02
Trichloroethylene	3.1	ug/L	2.5E-04	1.0E-05	2.0E-04				
TOTAL						1.3E+01	3.7E-01	7.8E-02	1.4E+01

TABLE 7 - 21

WELL B18W24S - RADIOLOGICAL CONCENTRATIONS

RESIDENT
Groundwater - Risk
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake				Radiological Cancer Risk		
	Concentration		Drinking Water (pCi)	Dermal (Shower) (pCi)	Drinking Water	Dermal (Shower)	TOTAL
RADIUM-226	0.4	pCi/L	7.8E+03	4.4E-02	3.0E-06	1.7E-11	3.0E-06
URANIUM-234	168.5	pCi/L	3.5E+06	2.0E+01	2.5E-04	1.4E-09	2.5E-04
URANIUM-235	10.9	pCi/L	2.3E+05	1.3E+00	1.6E-05	9.2E-11	1.6E-05
URANIUM-238	166.8	pCi/L	3.5E+06	2.0E+01	3.1E-04	1.7E-09	3.1E-04
TOTAL					5.7E-04	3.2E-09	5.7E-04

TABLE 7 - 22

WELL B18W24S - CHEMICAL CONCENTRATIONS
RESIDENT
Groundwater - Hazard
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

		Non-carcinogenic Dose			Hazard Index			
CONTAMINANT	Concentration	Drinking Water (mg/kg/day)	Dermal (Shower) (mg/kg/day)	Inhalation (Shower) (mg/kg/day)	Drinking Water	Dermal (Shower)	Inhalation (Shower)	TOTAL
METALs								
Aluminum	618.5 ug/L	1.7E-02	3.8E-05		1.7E-02	3.8E-04		1.7E-02
Cobalt	1.0 ug/L	2.7E-05	2.5E-08		1.4E-03	1.2E-06		1.4E-03
Copper	4.1 ug/L	1.1E-04	2.5E-07		2.8E-03	6.3E-06		2.8E-03
Manganese	22.2 ug/L	6.1E-04	1.4E-06		2.5E-02	1.4E-03		2.7E-02
Nickel	3.0 ug/L	8.3E-05	3.7E-08		4.1E-03	4.7E-05		4.2E-03
Selenium	19.7 ug/L	5.4E-04	1.2E-06		1.1E-01	8.1E-04		1.1E-01
Silver	1.5 ug/L	4.1E-05	5.5E-08		8.2E-03	2.8E-04		8.5E-03
Uranium	504.3 ug/L	1.4E-02	3.1E-05		4.6E+00	1.0E-02		4.6E+00
Vanadium	3.0 ug/L	8.2E-05	1.8E-07		1.2E-02	1.0E-03		1.3E-02
Zinc	9.5 ug/L	2.6E-04	3.5E-07		8.7E-04	1.2E-06		8.7E-04
VOCs								
Carbon Disulfide	2.1 ug/L	5.8E-05	4.2E-06	5.3E-05	5.8E-04	4.2E-05	2.6E-04	8.8E-04
TOTAL					4.8E+00	1.4E-02	2.6E-04	4.8E+00

TABLE 7 - 23

WELL B18W24S - CHEMICAL CONCENTRATIONS

RESIDENT CHILD
Groundwater - Hazard
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Non-carcinogenic Dose: Drinking Water (mg/kg/day)	Non-carcinogenic Dose: Dermal (Shower) (mg/kg/day)	Non-carcinogenic Dose: Inhalation (Shower) (mg/kg/day)	Hazard Index: Drinking Water	Hazard Index: Dermal (Shower)	Hazard Index: Inhalation (Shower)	Hazard Index: TOTAL
METALs									
Aluminum	618.5	ug/L	5.1E-02	6.5E-05		5.1E-02	6.5E-04		5.2E-02
Cobalt	1.0	ug/L	8.3E-05	4.2E-08		4.2E-03	2.1E-06		4.2E-03
Copper	4.1	ug/L	3.4E-04	4.3E-07		8.5E-03	1.1E-05		8.5E-03
Manganese	22.2	ug/L	1.8E-03	2.3E-06		7.7E-02	2.4E-03		7.9E-02
Nickel	3.0	ug/L	2.5E-04	6.4E-08		1.3E-02	8.0E-05		1.3E-02
Selenium	19.7	ug/L	1.6E-03	2.1E-06		3.3E-01	1.4E-03		3.3E-01
Silver	1.5	ug/L	1.2E-04	9.5E-08		2.5E-02	4.7E-04		2.5E-02
Uranium	504.3	ug/L	4.2E-02	5.3E-05		1.4E+01	1.8E-02		1.4E+01
Vanadium	3.0	ug/L	2.5E-04	3.2E-07		3.6E-02	1.7E-03		3.7E-02
Zinc	9.5	ug/L	7.9E-04	6.0E-07		2.6E-03	2.0E-06		2.6E-03
VOCs									
Carbon Disulfide	2.1	ug/L	1.7E-04	7.1E-06	1.4E-04	1.7E-03	7.1E-05	6.8E-04	2.5E-03
TOTAL						1.5E+01	2.5E-02	6.8E-04	1.5E+01

TABLE 7 - 24

WELL URSMW2D - CHEMICAL CONCENTRATIONS
RESIDENT
Groundwater - Risk
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Carcinogenic Dose: Drinking Water (mg/kg/day)	Carcinogenic Dose: Dermal (Shower) (mg/kg/day)	Carcinogenic Dose: Inhalation (Shower) (mg/kg/day)	Carcinogenic Risk: Drinking Water	Carcinogenic Risk: Dermal (Shower)	Carcinogenic Risk: Inhalation (Shower)	Carcinogenic Risk: TOTAL
VOCs									
Carbon Tetrachloride	46.2	ug/L	7.6E-04	6.8E-05	6.5E-04	9.9E-05	8.8E-06	3.5E-05	1.4E-04
Chloroform	22.4	ug/L	3.7E-04	1.1E-05	3.2E-04			2.5E-05	2.5E-05
Dichloroethane, 1,2-	1.3	ug/L	2.2E-05	3.6E-07	1.9E-05	2.0E-06	3.3E-08	1.7E-06	3.7E-06
Trichloroethylene	35.7	ug/L	5.9E-04	3.4E-05	5.1E-04	6.5E-06	3.7E-07	5.6E-06	1.2E-05
TOTAL						1.1E-04	9.3E-06	6.7E-05	1.8E-04

TABLE 7 - 25

WELL URSMW2D - RADIOLOGICAL CONCENTRATIONS

RESIDENT
Groundwater - Risk
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake				Radiological Cancer Risk		
	Concentration		Drinking Water (pCi)	Dermal (Shower) (pCi)	Drinking Water	Dermal (Shower)	TOTAL
RADIUM-226	4.9	pCi/L	1.0E+05	5.7E-01	3.9E-05	2.2E-10	3.9E-05
URANIUM-234	1.1	pCi/L	2.3E+04	1.3E-01	1.6E-06	9.1E-12	1.6E-06
URANIUM-235	0.2	pCi/L	3.2E+03	1.8E-02	2.3E-07	1.3E-12	2.3E-07
URANIUM-238	0.3	pCi/L	6.0E+03	3.3E-02	5.2E-07	2.9E-12	5.2E-07
TOTAL					4.2E-05	2.3E-10	4.2E-05

TABLE 7 - 26

WELL URSMW2D - CHEMICAL CONCENTRATIONS

RESIDENT
Groundwater - Hazard
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Non-carcinogenic Dose: Drinking Water (mg/kg/day)	Non-carcinogenic Dose: Dermal (Shower) (mg/kg/day)	Non-carcinogenic Dose: Inhalation (Shower) (mg/kg/day)	Hazard Index: Drinking Water	Hazard Index: Dermal (Shower)	Hazard Index: Inhalation (Shower)	Hazard Index: TOTAL
METALs									
Manganese	65.2	ug/L	1.8E-03	4.0E-06		7.4E-02	4.2E-03		7.9E-02
Uranium	0.9	ug/L	2.5E-05	5.6E-08		8.4E-03	1.9E-05		8.4E-03
VOCs									
Carbon Tetrachloride	46.2	ug/L	1.3E-03	1.4E-04	1.2E-03	1.8E+00	2.0E-01		2.0E+00
Chloroform	22.4	ug/L	6.1E-04	2.3E-05	5.6E-04	6.1E-02	2.3E-03	4.0E-02	1.0E-01
Dichloroethane, 1,2-	1.3	ug/L	3.6E-05	7.3E-07	3.3E-05	1.2E-03	2.4E-05	2.4E-02	2.5E-02
Trichloroethylene	35.7	ug/L	9.8E-04	6.9E-05	8.9E-04				
TOTAL						2.0E+00	2.1E-01	6.4E-02	2.2E+00

TABLE 7 - 27

WELL URSMW2D - CHEMICAL CONCENTRATIONS

RESIDENT CHILD
Groundwater - Hazard
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

			Non-carcinogenic Dose			Hazard Index			
CONTAMINANT	Concentration		Drinking Water (mg/kg/day)	Dermal (Shower) (mg/kg/day)	Inhalation (Shower) (mg/kg/day)	Drinking Water	Dermal (Shower)	Inhalation (Shower)	TOTAL
METALs									
Manganese	65.2	ug/L	5.4E-03	6.9E-06		2.3E-01	7.2E-03		2.3E-01
Uranium	0.9	ug/L	7.6E-05	9.7E-08		2.5E-02	3.2E-05		2.5E-02
VOCs									
Carbon Tetrachloride	46.2	ug/L	3.8E-03	2.4E-04	3.0E-03	5.5E+00	3.4E-01		5.8E+00
Chloroform	22.4	ug/L	1.9E-03	3.9E-05	1.5E-03	1.9E-01	3.9E-03	1.0E-01	2.9E-01
Dichloroethane, 1,2-	1.3	ug/L	1.1E-04	1.3E-06	8.6E-05	3.7E-03	4.2E-05	6.2E-02	6.5E-02
Trichloroethylene	35.7	ug/L	3.0E-03	1.2E-04	2.3E-03				
TOTAL						5.9E+00	3.5E-01	1.7E-01	6.4E+00

TABLE 7 - 28

WELL URSMW2S - RADIOLOGICAL CONCENTRATIONS

RESIDENT
Groundwater - Risk
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake				Radiological Cancer Risk		
	Concentration		Drinking Water (pCi)	Dermal (Shower) (pCi)	Drinking Water	Dermal (Shower)	TOTAL
RADIUM-226	0.4	pCi/L	7.8E+03	4.4E-02	3.0E-06	1.7E-11	3.0E-06
RADIUM-228	-	pCi/L					
URANIUM-234	168.5	pCi/L	3.5E+06	2.0E+01	2.5E-04	1.4E-09	2.5E-04
URANIUM-235	10.9	pCi/L	2.3E+05	1.3E+00	1.6E-05	9.2E-11	1.6E-05
URANIUM-238	166.8	pCi/L	3.5E+06	2.0E+01	3.1E-04	1.7E-09	3.1E-04
TOTAL					5.7E-04	3.2E-09	5.7E-04

TABLE 7 - 29

WELL URSMW2S - CHEMICAL CONCENTRATIONS

RESIDENT

Groundwater - Hazard

Reasonable Maximum Exposure - 95% UCL

Groundwater Operable Unit Remedial Investigation

Middlesex Sampling Plant

Middlesex, New Jersey

CONTAMINANT	Concentration		Non-carcinogenic Dose: Drinking Water (mg/kg/day)	Non-carcinogenic Dose: Dermal (Shower) (mg/kg/day)	Non-carcinogenic Dose: Inhalation (Shower) (mg/kg/day)	Hazard Index: Drinking Water	Hazard Index: Dermal (Shower)	Hazard Index: Inhalation (Shower)	Hazard Index: TOTAL
METALs									
Manganese	6,610.0	ug/L	1.8E-01	4.1E-04		7.5E+00	4.2E-01		8.0E+00
Uranium	74.4	ug/L	2.0E-03	4.6E-06		6.8E-01	1.5E-03		6.8E-01
TOTAL						8.2E+00	4.3E-01		8.7E+00

TABLE 7 - 30

WELL URSMW2S - CHEMICAL CONCENTRATIONS

RESIDENT CHILD
Groundwater - Hazard
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Non-carcinogenic Dose: Drinking Water (mg/kg/day)	Non-carcinogenic Dose: Dermal (Shower) (mg/kg/day)	Non-carcinogenic Dose: Inhalation (Shower) (mg/kg/day)	Hazard Index: Drinking Water	Hazard Index: Dermal (Shower)	Hazard Index: Inhalation (Shower)	Hazard Index: TOTAL
METALs									
Manganese	6,610.0	ug/L	5.5E-01	7.0E-04		2.3E+01	7.3E-01		2.4E+01
Uranium	74.4	ug/L	6.2E-03	7.8E-06		2.1E+00	2.6E-03		2.1E+00
TOTAL						2.5E+01	7.3E-01		2.6E+01

TABLE 7 - 31

SITE WIDE CHEMICAL CONCENTRATIONS

RECREATIONAL USER
Surface Water & Sediment - Risk
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Carcinogenic Dose								Carcinogenic Risk				
CONTAMINANT	Surface Water Concentration		Incidental Ingestion Surf Water (mg/kg/day)	Dermal Surf Water (mg/kg/day)	Sediment Concentration		Incidental Ingestion Sediment (mg/kg/day)	Dermal Sediment (mg/kg/day)	Incidental Ingestion Surf Water	Dermal Surf Water	Incidental Ingestion Sediment	Dermal Sediment	TOTAL
METALs													
Arsenic		ug/L			7.5	mg/kg	8.6E-07	1.9E-06			1.3E-06	2.9E-06	4.1E-06
SVOC													
Benzo(a)anthracene	0.7	ug/L	8.5E-09	2.6E-07		mg/kg			6.2E-09	1.9E-07			1.9E-07
Benzo(b)fluoranthene	2.0	ug/L	2.3E-08	1.2E-06		mg/kg			1.7E-08	8.8E-07			8.9E-07
TOTAL									2.3E-08	1.1E-06		2.9E-06	5.2E-06

TABLE 7 - 32

SITE WIDE RADIOLOGICAL CONCENTRATIONS
RECREATIONAL USER
Surface Water & Sediment - Risk
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake - Total Exposure Period									Carcinogenic Risk					
	Surface Water Concentration		Incidental Ingestion Surf Water pCi	Dermal Surf Water pCi	Sediment Concentration		External Exposure (yr-pCi/g)	Incidental Ingestion Sediment pCi	Dermal Sediment pCi	Incidental Ingestion Surf Water	Dermal Surf Water	External Exposure Sediment	Incidental Ingestion Sediment	Dermal Sediment	TOTAL
ACTINIUM-228	-	pCi/L			1.4	pCi/g	1.2E-01	1.0E+02	7.5E+00			5.2E-07	2.0E-10	1.5E-11	5.2E-07
BISMUTH-212	53.6	pCi/L	3.8E+02	1.7E+02	1.4	pCi/g	1.2E-01	1.0E+02	7.5E+00	2.7E-10	3.0E-10	1.0E-07	7.2E-11	5.3E-12	1.0E-07
BISMUTH-214	-	pCi/L			7.1	pCi/g	5.7E-01	5.0E+02	3.7E+01			4.3E-06	9.6E-11	7.1E-12	4.3E-06
CESIUM-137	-	pCi/L			0.0	pCi/g	1.4E-03	1.3E+00	9.3E-02			3.7E-09	3.8E-11	2.8E-12	3.7E-09
LEAD-212	16.8	pCi/L	1.2E+02	5.3E+01	1.6	pCi/g	1.3E-01	1.1E+02	8.5E+00	2.9E-09	3.5E-09	6.6E-08	2.9E-09	2.1E-10	7.6E-08
LEAD-214	18.8	pCi/L	1.3E+02	6.0E+01	6.8	pCi/g	5.5E-01	4.8E+02	3.6E+01	4.5E-11	5.1E-11	5.4E-07	1.6E-10	1.2E-11	5.4E-07
PROTACTINIUM-234M	-	pCi/L			20.7	pCi/g	1.7E+00	1.5E+03	1.1E+02			1.1E-07			1.1E-07
RADIUM-226	1.2	pCi/L	8.1E+00	3.7E+00	3.4	pCi/g	2.8E-01	2.4E+02	1.8E+01	3.1E-09	2.7E-09	2.3E-06	9.3E-08	6.9E-09	2.4E-06
RADIUM-228	-	pCi/L			1.3	pCi/g	1.0E-01	9.0E+01	6.7E+00			4.6E-07	9.4E-08	6.9E-09	5.7E-07
THALLIUM-208	-	pCi/L			1.3	pCi/g	1.0E-01	9.1E+01	6.7E+00			1.8E-06			1.8E-06
THORIUM-228	-	pCi/L			1.5	pCi/g	1.2E-01	1.1E+02	7.9E+00			9.4E-07	3.2E-08	2.4E-09	9.7E-07
THORIUM-230	-	pCi/L			4.2	pCi/g	3.3E-01	2.9E+02	2.2E+01			2.7E-10	2.7E-08	2.0E-09	2.9E-08
THORIUM-232	-	pCi/L			1.1	pCi/g	8.5E-02	7.5E+01	5.5E+00			2.9E-11	7.5E-09	5.6E-10	8.1E-09
THORIUM-234	-	pCi/L			20.6	pCi/g	1.6E+00	1.4E+03	1.1E+02			2.7E-08	3.3E-08	2.5E-09	6.3E-08
URANIUM-234	16.8	pCi/L	1.2E+02	5.3E+01	22.2	pCi/g	1.8E+00	1.6E+03	1.2E+02	8.3E-09	8.4E-09	4.5E-10	1.1E-07	8.2E-09	1.4E-07
URANIUM-235	0.9	pCi/L	6.0E+00	2.7E+00	1.5	pCi/g	1.2E-01	1.1E+02	7.9E+00	4.3E-10	4.4E-10	6.6E-08	7.7E-09	5.7E-10	7.5E-08
URANIUM-238	17.0	pCi/L	1.2E+02	5.4E+01	22.3	pCi/g	1.8E+00	1.6E+03	1.2E+02	1.0E-08	1.1E-08	2.0E-07	1.4E-07	1.0E-08	3.7E-07
TOTAL										2.6E-08	2.7E-08	1.1E-05	5.4E-07	4.0E-08	1.2E-05

TABLE 7 - 33

BACKGROUND RADIOLOGICAL CONCENTRATIONS

RECREATIONAL USER
Surface Water & Sediment - Risk
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake - Total Exposure Period									Carcinogenic Risk					
	Surface Water Concentration		Incidental Ingestion Surf Water pCi	Dermal Surf Water pCi	Sediment Concentration		External Exposure (yr-pCi/g)	Incidental Ingestion Sediment pCi	Dermal Sediment pCi	Incidental Ingestion Surf Water	Dermal Surf Water	External Exposure Sediment	Incidental Ingestion Sediment	Dermal Sediment	TOTAL
ACTINIUM-228	-	pCi/L			1.3	pCi/g	1.0E-01	8.9E+01	6.6E+00			4.6E-07	1.8E-10	1.3E-11	4.6E-07
BISMUTH-212	-	pCi/L			0.9	pCi/g	6.9E-02	6.0E+01	4.5E+00			6.1E-08	4.3E-11	3.2E-12	6.1E-08
BISMUTH-214	-	pCi/L			1.0	pCi/g	7.6E-02	6.7E+01	5.0E+00			5.7E-07	1.3E-11	9.5E-13	5.7E-07
CESIUM-137	-	pCi/L			0.1	pCi/g	7.6E-03	6.7E+00	5.0E-01			1.9E-08	2.0E-10	1.5E-11	2.0E-08
LEAD-212	-	pCi/L			1.3	pCi/g	1.1E-01	9.3E+01	6.9E+00			5.4E-08	2.3E-09	1.7E-10	5.6E-08
LEAD-214	-	pCi/L			0.9	pCi/g	7.1E-02	6.2E+01	4.6E+00			7.0E-08	2.1E-11	1.6E-12	7.0E-08
PROTACTINIUM-234M	-	pCi/L			5.8	pCi/g	4.6E-01	4.1E+02	3.0E+01			3.2E-08			3.2E-08
RADIUM-226	1.4	pCi/L	9.8E+00	4.4E+00	1.2	pCi/g	9.9E-02	8.7E+01	6.5E+00	3.8E-09	3.2E-09	8.4E-07	3.4E-08	2.5E-09	8.9E-07
RADIUM-228	-	pCi/L			1.6	pCi/g	1.3E-01	1.1E+02	8.5E+00			5.9E-07	1.2E-07	8.8E-09	7.2E-07
THALLIUM-208	-	pCi/L			1.2	pCi/g	9.6E-02	8.4E+01	6.3E+00			1.7E-06			1.7E-06
THORIUM-228	0.4	pCi/L	3.0E+00	1.3E+00	1.6	pCi/g	1.3E-01	1.1E+02	8.1E+00	8.9E-10	1.1E-09	9.7E-07	3.3E-08	2.4E-09	1.0E-06
THORIUM-230	-	pCi/L			2.0	pCi/g	1.6E-01	1.4E+02	1.1E+01			1.3E-10	1.3E-08	9.7E-10	1.4E-08
THORIUM-232	-	pCi/L			1.4	pCi/g	1.1E-01	9.8E+01	7.3E+00			3.8E-11	9.9E-09	7.3E-10	1.1E-08
THORIUM-234	-	pCi/L			4.4	pCi/g	3.5E-01	3.1E+02	2.3E+01			5.7E-09	7.1E-09	5.2E-10	1.3E-08
URANIUM-234	0.9	pCi/L	6.6E+00	3.0E+00	2.3	pCi/g	1.8E-01	1.6E+02	1.2E+01	4.7E-10	4.7E-10	4.6E-11	1.1E-08	8.4E-10	1.3E-08
URANIUM-235	0.2	pCi/L	1.2E+00	5.5E-01	0.5	pCi/g	3.7E-02	3.3E+01	2.4E+00	8.8E-11	8.9E-11	2.0E-08	2.3E-09	1.7E-10	2.3E-08
URANIUM-238	1.0	pCi/L	7.3E+00	3.3E+00	2.3	pCi/g	1.9E-01	1.6E+02	1.2E+01	6.4E-10	6.9E-10	2.1E-08	1.4E-08	1.1E-09	3.8E-08
TOTAL										5.9E-09	5.6E-09	5.4E-06	2.5E-07	1.8E-08	5.7E-06

TABLE 7 - 34

BACKGROUND CHEMICAL CONCENTRATIONS
RECREATIONAL USER
Surface Water & Sediment - Risk
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Carcinogenic Dose								Carcinogenic Risk				
CONTAMINANT	Surface Water Concentration		Incidental Ingestion Surf Water (mg/kg/day)	Dermal Surf Water (mg/kg/day)	Sediment Concentration		Incidental Ingestion Sediment (mg/kg/day)	Dermal Sediment (mg/kg/day)	Incidental Ingestion Surf Water	Dermal Surf Water	Incidental Ingestion Sediment	Dermal Sediment	TOTAL
METALs													
Arsenic		ug/L			4.5	mg/kg	5.1E-07	1.1E-06			7.7E-07	1.7E-06	2.5E-06
TOTAL												1.7E-06	2.5E-06

TABLE 7 - 35

BACKGROUND CHEMICAL CONCENTRATIONS

RECREATIONAL USER
Surface Water & Sediment - Hazard
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Non-carcinogenic Dose								Hazard Index				
CONTAMINANT	Surface Water Concentration		Incidental Ingestion Surf Water (mg/kg/day)	Dermal Surf Water (mg/kg/day)	Sediment Concentration		Incidental Ingestion Sediment (mg/kg/day)	Dermal Sediment (mg/kg/day)	Incidental Ingestion Surf Water	Dermal Surf Water	Incidental Ingestion Sediment	Dermal Sediment	TOTAL
METALs													
Aluminum	-	ug/L			20506.9	mg/kg	1.8E-02				1.8E-02		1.8E-02
Antimony	-	ug/L			1.5	mg/kg	1.3E-06				3.4E-03		3.4E-03
Arsenic	-	ug/L			4.5	mg/kg	4.0E-06	8.9E-06			1.3E-02	3.0E-02	4.3E-02
Barium	-	ug/L			136.3	mg/kg	1.2E-04				1.7E-03		1.7E-03
Cadmium	-	ug/L			0.4	mg/kg	3.9E-07	2.9E-08			7.8E-04	2.3E-03	3.1E-03
Chromium (III)	21.7	ug/L	1.9E-06	8.7E-07	34.6	mg/kg	3.1E-05		1.3E-06	4.5E-05	2.1E-05		6.6E-05
Cobalt	-	ug/L			12.5	mg/kg	1.1E-05				5.6E-04		5.6E-04
Copper	-	ug/L			45.6	mg/kg	4.1E-05				1.0E-03		1.0E-03
Manganese	-	ug/L			384.9	mg/kg	3.4E-04				1.4E-02		1.4E-02
Nickel	23.4	ug/L	2.1E-06	1.9E-07	32.5	mg/kg	2.9E-05		1.0E-04	2.3E-04	1.4E-03		1.8E-03
Selenium	-	ug/L				mg/kg							
Silver	-	ug/L				mg/kg							
Uranium	2.3	ug/L	2.0E-07	9.1E-08	7.1	mg/kg	6.3E-06		6.8E-05	3.0E-05	2.1E-03		2.2E-03
Vanadium	-	ug/L			50.1	mg/kg	4.5E-05				6.4E-03		6.4E-03
Zinc	72.9	ug/L	6.5E-06	1.8E-06	125.7	mg/kg	1.1E-04		2.2E-05	5.8E-06	3.7E-04		4.0E-04
TOTAL									1.9E-04	3.2E-04		3.2E-02	9.6E-02

TABLE 7 - 36

BACKGROUND RADIOLOGICAL CONCENTRATIONS

RESIDENT
Groundwater - Risk
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake				Radiological Cancer Risk		
	Concentration		Drinking Water (pCi)	Dermal (Shower) (pCi)	Drinking Water	Dermal (Shower)	TOTAL
RADIUM-226	1.1	pCi/L	4.9E+03	2.6E-02	1.9E-06	1.0E-11	1.9E-06
RADIUM-228	1.2	pCi/L	5.4E+03	2.9E-02	5.6E-06	3.0E-11	5.6E-06
THORIUM-228	0.6	pCi/L	2.5E+03	1.3E-02	7.4E-07	3.9E-12	7.4E-07
URANIUM-234	1.0	pCi/L	4.5E+03	2.4E-02	3.2E-07	1.7E-12	3.2E-07
URANIUM-235	1.5	pCi/L	6.5E+03	3.5E-02	4.7E-07	2.5E-12	4.7E-07
URANIUM-238	0.3	pCi/L	1.4E+03	7.4E-03	1.2E-07	6.4E-13	1.2E-07
TOTAL					9.2E-06	4.9E-11	9.2E-06

TABLE 7 - 37

BACKGROUND CHEMICAL CONCENTRATIONS

RESIDENT
Groundwater - Hazard
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Non-carcinogenic Dose: Drinking Water (mg/kg/day)	Non-carcinogenic Dose: Dermal (Shower) (mg/kg/day)	Non-carcinogenic Dose: Inhalation (Shower) (mg/kg/day)	Hazard Index: Drinking Water	Hazard Index: Dermal (Shower)	Hazard Index: Inhalation (Shower)	Hazard Index: TOTAL
METALs									
Aluminum	137.0	ug/L	3.8E-03	8.4E-06		3.8E-03	8.4E-05		3.8E-03
Copper	2.1	ug/L	5.8E-05	1.3E-07		1.4E-03	3.2E-06		1.4E-03
Manganese	1,530.0	ug/L	4.2E-02	9.4E-05		1.7E+00	9.8E-02		1.8E+00
Nickel	3.7	ug/L	1.0E-04	4.6E-08		5.1E-03	5.7E-05		5.1E-03
Uranium	1.0	ug/L	2.6E-05	5.9E-08		8.8E-03	2.0E-05		8.8E-03
Vanadium	0.7	ug/L	1.9E-05	4.3E-08		2.7E-03	2.4E-04		3.0E-03
Zinc	16.0	ug/L	4.4E-04	5.9E-07		1.5E-03	2.0E-06		1.5E-03
		ug/L							
TOTAL						1.8E+00	9.9E-02		1.9E+00

TABLE 7 - 38

SITE WIDE RADIOLOGICAL CONCENTRATIONS
RESIDENT
Groundwater - Risk
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake				Radiological Cancer Risk		
	Concentration		Drinking Water (pCi)	Dermal (Shower) (pCi)	Drinking Water	Dermal (Shower)	TOTAL
RADIUM-226	1.2	pCi/L	5.3E+03	2.8E-02	2.1E-06	1.1E-11	2.1E-06
RADIUM-228	0.4	pCi/L	1.8E+03	9.4E-03	1.8E-06	9.7E-12	1.8E-06
THORIUM-234	20.9	pCi/L	9.2E+04	4.9E-01	2.1E-06	1.1E-11	2.1E-06
URANIUM-234	21.0	pCi/L	9.3E+04	4.9E-01	6.5E-06	3.5E-11	6.5E-06
URANIUM-235	1.0	pCi/L	4.5E+03	2.4E-02	3.2E-07	1.7E-12	3.2E-07
URANIUM-238	20.9	pCi/L	9.2E+04	4.9E-01	8.0E-06	4.3E-11	8.0E-06
TOTAL					2.1E-05	1.1E-10	2.1E-05

TABLE 7 - 39

SITE WIDE CHEMICAL CONCENTRATIONS

RESIDENT
Groundwater - Risk
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Carcinogenic Dose Drinking Water (mg/kg/day)	Carcinogenic Dose Dermal (Shower) (mg/kg/day)	Carcinogenic Dose Inhalation (Shower) (mg/kg/day)	Carcinogenic Risk Drinking Water	Carcinogenic Risk Dermal (Shower)	Carcinogenic Risk Inhalation (Shower)	Carcinogenic Risk TOTAL
SVOC									
Dichlorobenzene, 1,4-	0.8	ug/L	4.5E-06	1.8E-06		1.1E-07	4.4E-08		1.5E-07
VOCs									
Carbon Tetrachloride	3.8	ug/L	2.1E-05	2.2E-06	2.5E-05	2.8E-06	2.8E-07	1.3E-06	4.4E-06
Chloroform	3.0	ug/L	1.7E-05	5.7E-07	2.0E-05			1.6E-06	1.6E-06
Chloromethane	2.7	ug/L	1.5E-05	1.6E-07	1.8E-05	2.0E-07	2.1E-09	1.1E-07	3.2E-07
Dichloroethane, 1,2-	1.3	ug/L	7.5E-06	1.4E-07	8.8E-06	6.8E-07	1.3E-08	8.0E-07	1.5E-06
Trichloroethylene	3.1	ug/L	1.7E-05	1.1E-06	2.0E-05	1.9E-07	1.2E-08	2.2E-07	4.3E-07
TOTAL						4.0E-06	3.5E-07	4.1E-06	8.4E-06

TABLE 7 - 40

SITE WIDE CHEMICAL CONCENTRATIONS
RESIDENT
Groundwater - Hazard
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Non-carcinogenic Dose: Drinking Water (mg/kg/day)	Non-carcinogenic Dose: Dermal (Shower) (mg/kg/day)	Non-carcinogenic Dose: Inhalation (Shower) (mg/kg/day)	Hazard Index: Drinking Water	Hazard Index: Dermal (Shower)	Hazard Index: Inhalation (Shower)	Hazard Index: TOTAL
METALs									
Aluminum	272.3	ug/L	5.2E-03	1.7E-05		5.2E-03	1.7E-04		5.4E-03
Chromium (III)	77.7	ug/L	1.5E-03	4.8E-06		9.9E-04	2.5E-04		1.2E-03
Cobalt	7.5	ug/L	1.4E-04	1.9E-07		7.2E-03	9.3E-06		7.2E-03
Copper	20.0	ug/L	3.8E-04	1.2E-06		9.6E-03	3.1E-05		9.6E-03
Manganese	2,990.0	ug/L	5.7E-02	1.8E-04		2.4E+00	1.9E-01		2.6E+00
Nickel	36.1	ug/L	6.9E-04	4.5E-07		3.5E-02	5.6E-04		3.5E-02
Selenium	15.3	ug/L	2.9E-04	9.4E-07		5.9E-02	6.3E-04		5.9E-02
Silver	3.7	ug/L	7.1E-05	1.4E-07		1.4E-02	6.8E-04		1.5E-02
Uranium	59.7	ug/L	1.1E-03	3.7E-06		3.8E-01	1.2E-03		3.8E-01
Vanadium	5.7	ug/L	1.1E-04	3.5E-07		1.6E-02	1.9E-03		1.8E-02
Zinc	35.3	ug/L	6.8E-04	1.3E-06		2.3E-03	4.4E-06		2.3E-03
SVOC									
Phenol	5.1	ug/L	9.8E-05	4.5E-06		3.3E-04	1.5E-05		3.4E-04
Dichlorobenzene, 1,4-	0.8	ug/L	1.5E-05	9.6E-06		5.1E-04	3.2E-04		8.3E-04
VOCs									
Carbon Disulfide	2.5	ug/L	4.7E-05	4.9E-06	6.2E-05	4.7E-04	4.9E-05	3.1E-04	8.3E-04
Carbon Tetrachloride	3.8	ug/L	7.3E-05	1.1E-05	9.5E-05	1.0E-01	1.6E-02		1.2E-01
Chloroform	3.0	ug/L	5.7E-05	3.0E-06	7.4E-05	5.7E-03	3.0E-04	5.3E-03	1.1E-02
Chloromethane	2.7	ug/L	5.2E-05	8.6E-07	6.8E-05			7.9E-04	7.9E-04
Dichloroethane, 1,2-	1.3	ug/L	2.6E-05	7.3E-07	3.3E-05	8.5E-04	2.4E-05	2.4E-02	2.5E-02
Trichloroethylene	3.1	ug/L	5.9E-05	6.0E-06	7.7E-05				
TOTAL						3.0E+00	2.1E-01	3.0E-02	3.3E+00

TABLE 7 - 41

SITE WIDE CHEMICAL CONCENTRATIONS

RESIDENT CHILD
Groundwater - Hazard
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Non-carcinogenic Dose: Drinking Water (mg/kg/day)	Non-carcinogenic Dose: Dermal (Shower) (mg/kg/day)	Non-carcinogenic Dose: Inhalation (Shower) (mg/kg/day)	Hazard Index: Drinking Water	Hazard Index: Dermal (Shower)	Hazard Index: Inhalation (Shower)	Hazard Index: TOTAL
METALs									
Aluminum	272.3	ug/L	1.5E-02	2.9E-05		1.5E-02	2.9E-04		1.6E-02
Chromium (III)	77.7	ug/L	4.4E-03	8.2E-06		2.9E-03	4.2E-04		3.3E-03
Cobalt	7.5	ug/L	4.2E-04	3.2E-07		2.1E-02	1.6E-05		2.1E-02
Copper	20.0	ug/L	1.1E-03	2.1E-06		2.8E-02	5.3E-05		2.8E-02
Manganese	2,990.0	ug/L	1.7E-01	3.2E-04		7.0E+00	3.3E-01		7.3E+00
Nickel	36.1	ug/L	2.0E-03	7.6E-07		1.0E-01	9.5E-04		1.0E-01
Selenium	15.3	ug/L	8.6E-04	1.6E-06		1.7E-01	1.1E-03		1.7E-01
Silver	3.7	ug/L	2.1E-04	2.3E-07		4.2E-02	1.2E-03		4.3E-02
Uranium	59.7	ug/L	3.4E-03	6.3E-06		1.1E+00	2.1E-03		1.1E+00
Vanadium	5.7	ug/L	3.2E-04	6.0E-07		4.6E-02	3.3E-03		4.9E-02
Zinc	35.3	ug/L	2.0E-03	2.2E-06		6.6E-03	7.4E-06		6.6E-03
SVOC									
Phenol	5.1	ug/L	2.9E-04	7.7E-06		9.6E-04	2.6E-05		9.8E-04
Dichlorobenzene, 1,4-	0.8	ug/L	4.5E-05	1.7E-05		1.5E-03	5.5E-04		2.1E-03
VOCs									
Carbon Disulfide	2.5	ug/L	1.4E-04	8.4E-06	1.6E-04	1.4E-03	8.4E-05	8.0E-04	2.3E-03
Carbon Tetrachloride	3.8	ug/L	2.1E-04	2.0E-05	2.5E-04	3.1E-01	2.8E-02		3.3E-01
Chloroform	3.0	ug/L	1.7E-04	5.2E-06	1.9E-04	1.7E-02	5.2E-04	1.4E-02	3.1E-02
Chloromethane	2.7	ug/L	1.5E-04	1.5E-06	1.8E-04			2.1E-03	2.1E-03
Dichloroethane, 1,2-	1.3	ug/L	7.5E-05	1.3E-06	8.6E-05	2.5E-03	4.2E-05	6.2E-02	6.4E-02
Trichloroethylene	3.1	ug/L	1.7E-04	1.0E-05	2.0E-04				
TOTAL						8.9E+00	3.7E-01	7.8E-02	9.3E+00

TABLE 7 - 42

WELL B18W24S - RADIOLOGICAL CONCENTRATIONS

RESIDENT
Groundwater - Risk
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake				Radiological Cancer Risk		
	Concentration		Drinking Water (pCi)	Dermal (Shower) (pCi)	Drinking Water	Dermal (Shower)	TOTAL
RADIUM-226	0.4	pCi/L	1.6E+03	8.7E-03	6.3E-07	3.3E-12	6.3E-07
URANIUM-234	168.5	pCi/L	7.4E+05	3.9E+00	5.3E-05	2.8E-10	5.3E-05
URANIUM-235	10.9	pCi/L	4.8E+04	2.5E-01	3.4E-06	1.8E-11	3.4E-06
URANIUM-238	166.8	pCi/L	7.4E+05	3.9E+00	6.4E-05	3.4E-10	6.4E-05
TOTAL					1.2E-04	6.4E-10	1.2E-04

TABLE 7 - 43

WELL B18W24S - CHEMICAL CONCENTRATIONS
RESIDENT
Groundwater - Hazard
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Non-carcinogenic Dose: Drinking Water (mg/kg/day)	Non-carcinogenic Dose: Dermal (Shower) (mg/kg/day)	Non-carcinogenic Dose: Inhalation (Shower) (mg/kg/day)	Hazard Index: Drinking Water	Hazard Index: Dermal (Shower)	Hazard Index: Inhalation (Shower)	Hazard Index: TOTAL
METALs									
Aluminum	618.5	ug/L	1.2E-02	3.8E-05		1.2E-02	3.8E-04		1.2E-02
Cobalt	1.0	ug/L	1.9E-05	2.5E-08		9.6E-04	1.2E-06		9.6E-04
Copper	4.1	ug/L	7.9E-05	2.5E-07		2.0E-03	6.3E-06		2.0E-03
Manganese	22.2	ug/L	4.3E-04	1.4E-06		1.8E-02	1.4E-03		1.9E-02
Nickel	3.0	ug/L	5.8E-05	3.7E-08		2.9E-03	4.7E-05		2.9E-03
Selenium	19.7	ug/L	3.8E-04	1.2E-06		7.6E-02	8.1E-04		7.7E-02
Silver	1.5	ug/L	2.9E-05	5.5E-08		5.8E-03	2.8E-04		6.0E-03
Uranium	504.3	ug/L	9.7E-03	3.1E-05		3.2E+00	1.0E-02		3.2E+00
Vanadium	3.0	ug/L	5.8E-05	1.8E-07		8.2E-03	1.0E-03		9.2E-03
Zinc	9.5	ug/L	1.8E-04	3.5E-07		6.1E-04	1.2E-06		6.1E-04
VOCs									
Carbon Disulfide	2.1	ug/L	4.0E-05	4.2E-06	5.3E-05	4.0E-04	4.2E-05	2.6E-04	7.1E-04
TOTAL						3.3E+00	1.4E-02	2.6E-04	3.4E+00

TABLE 7 - 44

WELL B18W24S - CHEMICAL CONCENTRATIONS

RESIDENT CHILD
Groundwater - Hazard
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Non-carcinogenic Dose: Drinking Water (mg/kg/day)	Non-carcinogenic Dose: Dermal (Shower) (mg/kg/day)	Non-carcinogenic Dose: Inhalation (Shower) (mg/kg/day)	Hazard Index: Drinking Water	Hazard Index: Dermal (Shower)	Hazard Index: Inhalation (Shower)	Hazard Index: TOTAL
METALs									
Aluminum	618.5	ug/L	3.5E-02	6.5E-05		3.5E-02	6.5E-04		3.5E-02
Cobalt	1.0	ug/L	5.6E-05	4.2E-08		2.8E-03	2.1E-06		2.8E-03
Copper	4.1	ug/L	2.3E-04	4.3E-07		5.8E-03	1.1E-05		5.8E-03
Manganese	22.2	ug/L	1.2E-03	2.3E-06		5.2E-02	2.4E-03		5.4E-02
Nickel	3.0	ug/L	1.7E-04	6.4E-08		8.5E-03	8.0E-05		8.6E-03
Selenium	19.7	ug/L	1.1E-03	2.1E-06		2.2E-01	1.4E-03		2.2E-01
Silver	1.5	ug/L	8.4E-05	9.5E-08		1.7E-02	4.7E-04		1.7E-02
Uranium	504.3	ug/L	2.8E-02	5.3E-05		9.5E+00	1.8E-02		9.5E+00
Vanadium	3.0	ug/L	1.7E-04	3.2E-07		2.4E-02	1.7E-03		2.6E-02
Zinc	9.5	ug/L	5.3E-04	6.0E-07		1.8E-03	2.0E-06		1.8E-03
VOCs									
Carbon Disulfide	2.1	ug/L	1.2E-04	7.1E-06	1.4E-04	1.2E-03	7.1E-05	6.8E-04	1.9E-03
TOTAL						9.8E+00	2.5E-02	6.8E-04	9.9E+00

TABLE 7 - 45

WELL URSMW2D - CHEMICAL CONCENTRATIONS

RESIDENT

Groundwater - Risk

Central Tendency Analysis - EPC =95% UCL

Groundwater Operable Unit Remedial Investigation

Middlesex Sampling Plant

Middlesex, New Jersey

CONTAMINANT	Concentration		Carcinogenic Dose Drinking Water (mg/kg/day)	Carcinogenic Dose Dermal (Shower) (mg/kg/day)	Carcinogenic Dose Inhalation (Shower) (mg/kg/day)	Carcinogenic Risk Drinking Water	Carcinogenic Risk Dermal (Shower)	Carcinogenic Risk Inhalation (Shower)	Carcinogenic Risk TOTAL
VOCs									
Carbon Tetrachloride	46.2	ug/L	2.6E-04	2.6E-05	3.1E-04	3.4E-05	3.4E-06	1.6E-05	5.4E-05
Chloroform	22.4	ug/L	1.3E-04	4.3E-06	1.5E-04			1.2E-05	1.2E-05
Dichloroethane, 1,2-	1.3	ug/L	7.5E-06	1.4E-07	8.8E-06	6.8E-07	1.3E-08	8.0E-07	1.5E-06
Trichloroethylene	35.7	ug/L	2.0E-04	1.3E-05	2.4E-04	2.2E-06	1.4E-07	2.6E-06	5.0E-06
TOTAL						3.7E-05	3.6E-06	3.2E-05	7.2E-05

TABLE 7 - 46

WELL URSMW2D - RADIOLOGICAL CONCENTRATIONS

RESIDENT

Groundwater - Risk

Central Tendency Analysis - EPC =95% UCL

Groundwater Operable Unit Remedial Investigation

Middlesex Sampling Plant

Middlesex, New Jersey

	Radiological Uptake				Radiological Cancer Risk		
	Concentration		Drinking Water (pCi)	Dermal (Shower) (pCi)	Drinking Water	Dermal (Shower)	TOTAL
RADIUM-226	4.9	pCi/L	2.1E+04	1.1E-01	8.3E-06	4.4E-11	8.3E-06
URANIUM-234	1.1	pCi/L	4.8E+03	2.6E-02	3.4E-07	1.8E-12	3.4E-07
URANIUM-235	0.2	pCi/L	6.7E+02	3.5E-03	4.8E-08	2.5E-13	4.8E-08
URANIUM-238	0.3	pCi/L	1.3E+03	6.6E-03	1.1E-07	5.8E-13	1.1E-07
TOTAL					8.8E-06	4.7E-11	8.8E-06

TABLE 7 - 47

WELL URSMW2D - CHEMICAL CONCENTRATIONS
RESIDENT
Groundwater - Hazard
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Non-carcinogenic Dose: Drinking Water (mg/kg/day)	Non-carcinogenic Dose: Dermal (Shower) (mg/kg/day)	Non-carcinogenic Dose: Inhalation (Shower) (mg/kg/day)	Hazard Index: Drinking Water	Hazard Index: Dermal (Shower)	Hazard Index: Inhalation (Shower)	Hazard Index: TOTAL
METALs									
Manganese	65.2	ug/L	1.3E-03	4.0E-06		5.2E-02	4.2E-03		5.6E-02
Uranium	0.9	ug/L	1.8E-05	5.6E-08		5.8E-03	1.9E-05		5.9E-03
VOCs									
Carbon Tetrachloride	46.2	ug/L	8.9E-04	1.4E-04	1.2E-03	1.3E+00	2.0E-01		1.5E+00
Chloroform	22.4	ug/L	4.3E-04	2.3E-05	5.6E-04	4.3E-02	2.3E-03	4.0E-02	8.5E-02
Dichloroethane, 1,2-	1.3	ug/L	2.6E-05	7.3E-07	3.3E-05	8.5E-04	2.4E-05	2.4E-02	2.5E-02
Trichloroethylene	35.7	ug/L	6.8E-04	6.9E-05	8.9E-04				
TOTAL						1.4E+00	2.1E-01	6.4E-02	1.6E+00

TABLE 7 - 48

WELL URSMW2D - CHEMICAL CONCENTRATIONS

RESIDENT CHILD
Groundwater - Hazard
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

			Non-carcinogenic Dose			Hazard Index			
CONTAMINANT	Concentration		Drinking Water (mg/kg/day)	Dermal (Shower) (mg/kg/day)	Inhalation (Shower) (mg/kg/day)	Drinking Water	Dermal (Shower)	Inhalation (Shower)	TOTAL
METALs									
Manganese	65.2	ug/L	3.7E-03	6.9E-06		1.5E-01	7.2E-03		1.6E-01
Uranium	0.9	ug/L	5.1E-05	9.7E-08		1.7E-02	3.2E-05		1.7E-02
VOCs									
Carbon Tetrachloride	46.2	ug/L	2.6E-03	2.4E-04	3.0E-03	3.7E+00	3.4E-01		4.1E+00
Chloroform	22.4	ug/L	1.3E-03	3.9E-05	1.5E-03	1.3E-01	3.9E-03	1.0E-01	2.3E-01
Dichloroethane, 1,2-	1.3	ug/L	7.5E-05	1.3E-06	8.6E-05	2.5E-03	4.2E-05	6.2E-02	6.4E-02
Trichloroethylene	35.7	ug/L	2.0E-03	1.2E-04	2.3E-03				
TOTAL						4.0E+00	3.5E-01	1.7E-01	4.5E+00

TABLE 7 - 49

WELL URSMW2S - RADIOLOGICAL CONCENTRATIONS

RESIDENT
Groundwater - Risk
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake				Radiological Cancer Risk		
	Concentration		Drinking Water (pCi)	Dermal (Shower) (pCi)	Drinking Water	Dermal (Shower)	TOTAL
RADIUM-226	0.4	pCi/L	1.6E+03	8.7E-03	6.3E-07	3.3E-12	6.3E-07
RADIUM-228	-	pCi/L					
URANIUM-234	168.5	pCi/L	7.4E+05	3.9E+00	5.3E-05	2.8E-10	5.3E-05
URANIUM-235	10.9	pCi/L	4.8E+04	2.5E-01	3.4E-06	1.8E-11	3.4E-06
URANIUM-238	166.8	pCi/L	7.4E+05	3.9E+00	6.4E-05	3.4E-10	6.4E-05
TOTAL					1.2E-04	6.4E-10	1.2E-04

TABLE 7 - 50

WELL URSMW2S - CHEMICAL CONCENTRATIONS

RESIDENT
Groundwater - Hazard
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Non-carcinogenic Dose					Hazard Index			
CONTAMINANT	Concentration		Drinking Water (mg/kg/day)	Dermal (Shower) (mg/kg/day)	Inhalation (Shower) (mg/kg/day)	Drinking Water	Dermal (Shower)	Inhalation (Shower)	TOTAL
METALs									
Manganese	6,610.0	ug/L	1.3E-01	4.1E-04		5.3E+00	4.2E-01		5.7E+00
Uranium	74.4	ug/L	1.4E-03	4.6E-06		4.8E-01	1.5E-03		4.8E-01
TOTAL						5.8E+00	4.3E-01		6.2E+00

TABLE 7 - 51

WELL URSMW2S - CHEMICAL CONCENTRATIONS

RESIDENT CHILD
Groundwater - Hazard
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

CONTAMINANT	Concentration		Non-carcinogenic Dose: Drinking Water (mg/kg/day)	Non-carcinogenic Dose: Dermal (Shower) (mg/kg/day)	Non-carcinogenic Dose: Inhalation (Shower) (mg/kg/day)	Hazard Index: Drinking Water	Hazard Index: Dermal (Shower)	Hazard Index: Inhalation (Shower)	Hazard Index: TOTAL
METALs									
Manganese	6,610.0	ug/L	3.7E-01	7.0E-04		1.5E+01	7.3E-01		1.6E+01
Uranium	74.4	ug/L	4.2E-03	7.8E-06		1.4E+00	2.6E-03		1.4E+00
TOTAL						1.7E+01	7.3E-01		1.8E+01

TABLE 7 - 52

SITE RADIOLOGICAL CONCENTRATIONS

RESIDENT
Groundwater - Dose
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake - Annual				Annnual Radiological Dose		
	Concentration		Drinking Water (pCi/yr)	Dermal (Shower) (pCi/yr)	Drinking Water (mrem/yr)	Dermal (Shower) (mrem/yr)	TOTAL (mrem/yr)
ACTINIUM-228	1.6	pCi/L	1.1E+03	6.2E-03	2.4E-03	1.3E-08	2.4E-03
RADIUM-226	1.2	pCi/L	8.5E+02	4.8E-03	1.1E+00	6.3E-06	1.1E+00
RADIUM-228	0.4	pCi/L	2.8E+02	1.6E-03	4.0E-01	2.3E-06	4.0E-01
THORIUM-234	20.9	pCi/L	1.5E+04	8.2E-02	2.0E-01	1.1E-06	2.0E-01
URANIUM-234	21.0	pCi/L	1.5E+04	8.3E-02	4.2E+00	2.4E-05	4.2E+00
URANIUM-235	1.0	pCi/L	7.2E+02	4.0E-03	1.9E-01	1.1E-06	1.9E-01
URANIUM-238	20.9	pCi/L	1.5E+04	8.2E-02	3.7E+00	2.1E-05	3.7E+00
TOTAL					9.9E+00	5.6E-05	9.9E+00

TABLE 7 - 53

BACKGROUND RADIOLOGICAL CONCENTRATIONS

RESIDENT
Groundwater - Dose
Central Tendency Analysis - EPC =95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake - Annual				Annnual Radiological Dose		
	Concentration		Drinking Water (pCi/yr)	Dermal (Shower) (pCi/yr)	Drinking Water (mrem/yr)	Dermal (Shower) (mrem/yr)	TOTAL (mrem/yr)
RADIUM-226	1.1	pCi/L	5.5E+02	2.9E-03	7.3E-01	3.9E-06	7.3E-01
RADIUM-228	1.2	pCi/L	6.0E+02	3.2E-03	8.6E-01	4.6E-06	8.6E-01
THORIUM-228	0.6	pCi/L	2.8E+02	1.5E-03	1.1E-01	5.8E-07	1.1E-01
URANIUM-234	1.0	pCi/L	5.0E+02	2.6E-03	1.4E-01	7.6E-07	1.4E-01
URANIUM-235	1.5	pCi/L	7.2E+02	3.8E-03	1.9E-01	1.0E-06	1.9E-01
URANIUM-238	0.3	pCi/L	1.5E+02	8.2E-04	3.9E-02	2.1E-07	3.9E-02
TOTAL					2.1E+00	1.1E-05	2.1E+00

TABLE 7 - 54

WELL B18W24S - RADIOLOGICAL CONCENTRATIONS

RESIDENT
Groundwater - Dose
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake - Annual				Annnual Radiological Dose		
	Concentration		Drinking Water (pCi/yr)	Dermal (Shower) (pCi/yr)	Drinking Water (mrem/yr)	Dermal (Shower) (mrem/yr)	TOTAL (mrem/yr)
RADIUM-226	0.4	pCi/L	2.6E+02	1.5E-03	3.4E-01	1.9E-06	3.4E-01
URANIUM-234	168.5	pCi/L	1.2E+05	6.6E-01	3.4E+01	1.9E-04	3.4E+01
URANIUM-235	10.9	pCi/L	7.6E+03	4.3E-02	2.0E+00	1.1E-05	2.0E+00
URANIUM-238	166.8	pCi/L	1.2E+05	6.6E-01	3.0E+01	1.7E-04	3.0E+01
TOTAL					6.6E+01	3.7E-04	6.6E+01

TABLE 7 - 55

WELL B18W24S - RADIOLOGICAL CONCENTRATIONS

RESIDENT
Groundwater - Dose
Central Tendency Analysis - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake - Annual				Annnual Radiological Dose		
	Concentration		Drinking Water (pCi/yr)	Dermal (Shower) (pCi/yr)	Drinking Water (mrem/yr)	Dermal (Shower) (mrem/yr)	TOTAL (mrem/yr)
RADIUM-226	0.4	pCi/L	1.8E+02	9.6E-04	2.4E-01	1.3E-06	2.4E-01
URANIUM-234	168.5	pCi/L	8.3E+04	4.4E-01	2.4E+01	1.3E-04	2.4E+01
URANIUM-235	10.9	pCi/L	5.3E+03	2.8E-02	1.4E+00	7.5E-06	1.4E+00
URANIUM-238	166.8	pCi/L	8.2E+04	4.3E-01	2.1E+01	1.1E-04	2.1E+01
TOTAL					4.6E+01	2.5E-04	4.6E+01

TABLE 7 - 56

SITE WIDE RADIOLOGICAL CONCENTRATIONS

RECREATIONAL USER
Surface Water & Sediment - Dose
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake - Annual						
	Surface Water Concentration	Incidental Ingestion Surf Water (pCi/yr)	Dermal Surf Water (pCi/yr)	Sediment Concentration	External Exposure (yr-pCi/g)	Incidental Ingestion Sediment (pCi/yr)	Dermal Sediment (pCi/yr)
ACTINIUM-228	- pCi/L			1.4 pCi/g	1.3E-02	1.1E+01	8.3E-01
BISMUTH-212	53.6 pCi/L	4.2E+01	1.9E+01	1.4 pCi/g	1.3E-02	1.1E+01	8.3E-01
BISMUTH-214	- pCi/L			7.1 pCi/g	6.3E-02	5.5E+01	4.1E+00
CESIUM-137	- pCi/L			0.0 pCi/g	1.6E-04	1.4E-01	1.0E-02
LEAD-212	16.8 pCi/L	1.3E+01	5.9E+00	1.6 pCi/g	1.5E-02	1.3E+01	9.4E-01
LEAD-214	18.8 pCi/L	1.5E+01	6.6E+00	6.8 pCi/g	6.1E-02	5.3E+01	4.0E+00
PROTACTINIUM-234M	- pCi/L			20.7 pCi/g	1.8E-01	1.6E+02	1.2E+01
RADIUM-226	1.2 pCi/L	9.0E-01	4.1E-01	3.4 pCi/g	3.1E-02	2.7E+01	2.0E+00
RADIUM-228	- pCi/L			1.3 pCi/g	1.1E-02	1.0E+01	7.4E-01
THALLIUM-208	- pCi/L			1.3 pCi/g	1.1E-02	1.0E+01	7.5E-01
THORIUM-228	- pCi/L			1.5 pCi/g	1.3E-02	1.2E+01	8.7E-01
THORIUM-230	- pCi/L			4.2 pCi/g	3.7E-02	3.3E+01	2.4E+00
THORIUM-232	- pCi/L			1.1 pCi/g	9.5E-03	8.3E+00	6.2E-01
THORIUM-234	- pCi/L			20.6 pCi/g	1.8E-01	1.6E+02	1.2E+01
URANIUM-234	16.8 pCi/L	1.3E+01	5.9E+00	22.2 pCi/g	2.0E-01	1.7E+02	1.3E+01
URANIUM-235	0.9 pCi/L	6.7E-01	3.0E-01	1.5 pCi/g	1.4E-02	1.2E+01	8.8E-01
URANIUM-238	17.0 pCi/L	1.3E+01	6.0E+00	22.3 pCi/g	2.0E-01	1.7E+02	1.3E+01
TOTAL							

	Radiological Dose					
	Incidental Ingestion Surf Water (mrem/yr)	Dermal Surf Water (mrem/yr)	External Exposure (mrem/yr)	Incidental Ingestion Sediment (mrem/yr)	Dermal Sediment (mrem/yr)	TOTAL (mrem/yr)
ACTINIUM-228			7.7E-02	2.4E-05	1.8E-06	7.7E-02
BISMUTH-212	4.4E-05	2.0E-05	1.5E-02	1.2E-05	8.9E-07	1.5E-02
BISMUTH-214			6.2E-01	1.6E-05	1.2E-06	6.2E-01
CESIUM-137			5.7E-04	7.0E-06	5.2E-07	5.8E-04
LEAD-212	5.9E-04	2.7E-04	1.0E-02	5.8E-04	4.3E-05	1.2E-02
LEAD-214	9.2E-06	4.1E-06	8.2E-02	3.3E-05	2.5E-06	8.2E-02
PROTACTINIUM-234M			1.6E-02			1.6E-02
RADIUM-226	1.2E-03	5.4E-04	9.7E-04	3.5E-02	2.6E-03	4.1E-02
RADIUM-228				1.4E-02	1.1E-03	1.5E-02
THALLIUM-208			2.6E-01			2.6E-01
THORIUM-228			1.1E-04	4.7E-03	3.5E-04	5.1E-03
THORIUM-230			4.5E-05	1.8E-02	1.3E-03	1.9E-02
THORIUM-232			4.9E-06	2.3E-02	1.7E-03	2.4E-02
THORIUM-234			4.4E-03	2.2E-03	1.6E-04	6.8E-03
URANIUM-234	3.8E-03	1.7E-03	7.9E-05	5.0E-02	3.7E-03	5.9E-02
URANIUM-235	1.8E-04	8.0E-05	9.8E-03	3.2E-03	2.3E-04	1.3E-02
URANIUM-238	3.4E-03	1.5E-03	2.1E-05	4.4E-02	3.3E-03	5.3E-02
TOTAL	9.2E-03	4.1E-03	1.1E+00	2.0E-01	1.5E-02	1.3E+00

TABLE 7 - 57

BACKGROUND RADIOLOGICAL CONCENTRATIONS

RECREATIONAL USER
Surface Water & Sediment - Dose
Reasonable Maximum Exposure - 95% UCL
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Radiological Uptake - Annual								
	Surface Water Concentration		Incidental Ingestion Surf Water (pCi/yr)	Dermal Surf Water (pCi/yr)	Sediment Concentration		External Exposure (yr-pCi/g)	Incidental Ingestion Sediment (pCi/yr)	Dermal Sediment (pCi/yr)
ACTINIUM-228	-	pCi/L			1.3	pCi/g	1.1E-02	9.9E+00	7.4E-01
BISMUTH-212	-	pCi/L			0.9	pCi/g	7.7E-03	6.7E+00	5.0E-01
BISMUTH-214	-	pCi/L			1.0	pCi/g	8.5E-03	7.4E+00	5.5E-01
CESIUM-137	-	pCi/L			0.1	pCi/g	8.5E-04	7.4E-01	5.5E-02
LEAD-212	-	pCi/L			1.3	pCi/g	1.2E-02	1.0E+01	7.6E-01
LEAD-214	-	pCi/L			0.9	pCi/g	7.9E-03	6.9E+00	5.2E-01
PROTACTINIUM-234M	-	pCi/L			5.8	pCi/g	5.2E-02	4.5E+01	3.4E+00
RADIUM-226	1.4	pCi/L	1.1E+00	4.9E-01	1.2	pCi/g	1.1E-02	9.7E+00	7.2E-01
RADIUM-228	-	pCi/L			1.6	pCi/g	1.4E-02	1.3E+01	9.4E-01
THALLIUM-208	-	pCi/L			1.2	pCi/g	1.1E-02	9.4E+00	6.9E-01
THORIUM-228	0.4	pCi/L	3.3E-01	1.5E-01	1.6	pCi/g	1.4E-02	1.2E+01	9.0E-01
THORIUM-230	-	pCi/L			2.0	pCi/g	1.8E-02	1.6E+01	1.2E+00
THORIUM-232	-	pCi/L			1.4	pCi/g	1.2E-02	1.1E+01	8.1E-01
THORIUM-234	-	pCi/L			4.4	pCi/g	3.9E-02	3.4E+01	2.5E+00
URANIUM-234	0.9	pCi/L	7.3E-01	3.3E-01	2.3	pCi/g	2.0E-02	1.8E+01	1.3E+00
URANIUM-235	0.2	pCi/L	1.4E-01	6.1E-02	0.5	pCi/g	4.1E-03	3.6E+00	2.7E-01
URANIUM-238	1.0	pCi/L	8.1E-01	3.7E-01	2.3	pCi/g	2.1E-02	1.8E+01	1.4E+00

	Radiological Dose					
	Incidental Ingestion Surf Water (mrem/yr)	Dermal Surf Water (mrem/yr)	External Exposure (mrem/yr)	Incidental Ingestion Sediment (mrem/yr)	Dermal Sediment (mrem/yr)	TOTAL (mrem/yr)
ACTINIUM-228			6.8E-02	2.1E-05	1.6E-06	6.8E-02
BISMUTH-212			9.0E-03	7.1E-06	5.3E-07	9.0E-03
BISMUTH-214			8.3E-02	2.1E-06	1.6E-07	8.3E-02
CESIUM-137			3.1E-03	3.7E-05	2.8E-06	3.1E-03
LEAD-212			8.3E-03	4.7E-04	3.5E-05	8.8E-03
LEAD-214			1.1E-02	4.3E-06	3.2E-07	1.1E-02
PROTACTINIUM-234M			4.6E-03			4.6E-03
RADIUM-226	1.4E-03	6.5E-04	3.5E-04	1.3E-02	9.5E-04	1.6E-02
RADIUM-228				1.8E-02	1.4E-03	2.0E-02
THALLIUM-208			2.5E-01			2.5E-01
THORIUM-228	1.3E-04	5.9E-05	1.1E-04	4.8E-03	3.6E-04	5.5E-03
THORIUM-230			2.2E-05	8.7E-03	6.5E-04	9.4E-03
THORIUM-232			6.5E-06	3.0E-02	2.2E-03	3.2E-02
THORIUM-234			9.3E-04	4.6E-04	3.4E-05	1.4E-03
URANIUM-234	2.1E-04	9.5E-05	8.2E-06	5.1E-03	3.8E-04	5.8E-03
URANIUM-235	3.6E-05	1.6E-05	3.0E-03	9.6E-04	7.1E-05	4.1E-03
URANIUM-238	2.1E-04	9.3E-05	2.1E-06	4.6E-03	3.4E-04	5.3E-03
TOTAL	2.0E-03	9.1E-04	4.4E-01	8.6E-02	6.4E-03	5.3E-01

Table 8-1

Background and Maximum Concentration of Contaminants in the Vicinity of MSP
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Contaminants	Surface Water		Sediments	
	Background Concentration	Maximum Concentration	Background Concentration	Maximum Concentration
Metals	**(mg/L)**	**(mg/L)**	**(mg/kg dry weight)**	**(mg/kg dry weight)**
Aluminum	1.8E+01	5.5E+00	3.2E+04	3.6E+04
Antimony	--[a]	6.0E-03	2.8E+00	1.3E+01
Arsenic	7.4E-03	5.0E-03	7.8E+00	3.7E+01
Barium	1.3E-01	1.0E-01	1.6E+02[b]	2.2E+02
Beryllium	3.7E-01	1.0E-03	1.9E+00	1.7E+00
Cadmium	7.3E-04[b]	4.7E-04	8.1E-01	6.5E+00
Calcium	3.4E+01	3.8E+01	3.1E+03	1.5E+04
Chromium	4.4E-02	5.0E-02	5.6E+01	8.6E+01
Cobalt	1.7E-02	5.0E-03	1.7E+01	3.5E+01
Copper	4.8E-02	1.4E-02	8.0E+01	3.6E+02
Iron	2.2E+01	5.2E+00	5.8E+04	3.9E+04
Lead	1.6E-02[b]	1.1E-02	5.2E+01	4.8E+02
Magnesium	9.3E+00	1.1E+01	1.2E+04	1.1E+04
Manganese	1.2E+01	6.0E-01	6.9E+02	2.8E+03
Mercury (total)	--[a]	--[a]	2.9E-01	5.2E-01
Nickel	4.8E-02	1.7E-01	5.1E+01	6.6E+01
Potassium	5.1E+00	3.7E+00	4.3E+03	2.9E+03
Selenium	--[a]	--[a]	--[a]	5.2E+00
Silver	2.4E-01	3.0E-03	--[a]	3.3E+00
Sodium	3.2E+01	6.6E+01	7.9E+02	2.2E+03
Uranium	6.6E-03	1.4E-01	1.2E+01	3.3E+02
Vanadium	4.5E-02	1.1E-02	7.6E+01	1.4E+02
Zinc	1.4E-01	5.1E-01	2.0E+02	3.1E+03
Semi-Volatile Organics	**(mg/L)**	**(mg/L)**	**(mg/kg dry weight)**	**(mg/kg dry weight)**
Benzo(a)anthracene	--[a]	7.4E-04	--[a]	--[a]
Benzo(b)fluoranthene	--[a]	2.0E-03	--[a]	--[a]
Chrysene	--[a]	1.7E-03	--[a]	--[a]
Di-n-octyl phthalate	1.5E-03[b]	--[a]	--[a]	--[a]
Fluoranthene	--[a]	2.3E-03	--[a]	--[a]
Phenanthrene	--[a]	9.1E-04	--[a]	--[a]
Pyrene	--[a]	2.5E-03	--[a]	--[a]
Radionuclides	**(pCi/L)**	**(pCi/L)**	**(pCi/g dry weight)**	**(pCi/g dry weight)**
Actinium-228	--[a]	--[a]	1.3E+00[b]	1.4E+00
Bismuth-212	--[a]	5.4E+01	8.6E-01[b]	1.8E+00
Bismuth-214	--[a]	--[a]	9.5E-01[b]	7.1E+00

Table 8-1

Background and Maximum Concentration of Contaminants in the Vicinity of MSP
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Radionuclides (cont.)	**(pCi/L)**	**(pCi/L)**	**(pCi/g dry weight)**	**(pCi/g dry weight)**
Cesium-137	--[a]	--[a]	1.8E-01	2.0E-01
Lead-212	--[a]	1.7E+01	1.3E+00[b]	1.6E+00
Lead-214	--[a]	1.9E+01	8.9E-01[b]	6.8E+00
Protactinium-234m	--[a]	--[a]	5.8E+00[b]	2.1E+01
Radium-226	2.5E+00	3.8E+00	1.5E+00	1.3E+01
Radium-228	2.1E+00	1.2E+00	2.1E+00	3.3E+00
Thallium-208	--[a]	--[a]	1.2E+00[b]	1.3E+00
Thorium-228	7.5E-01	8.1E-01	2.1E+00	3.9E+00
Thorium-230	1.7E+00	1.5E+00	3.0E+00	1.9E+01
Thorium-232	2.5E+00	1.3E-01	1.9E+00	2.3E+00
Thorium-234	--[a]		4.4E+00	2.1E+01
Uranium-233/234	1.9E+00	4.7E+01	3.6E+00	1.1E+02
Uranium-235/236	6.6E-01	3.5E+00	1.9E+00	9.3E+00
Uranium-238	2.2E+00	4.5E+01	3.7E+00	1.1E+02

a. Indicates that either no analyses were conducted for the contaminant or the contaminant was not detected in the samples.
b. Indicates the maximum detected concentration was used as the basis for the background concentration.

Table 8-2

Surface Water and Sediment ESVs for the Chemical Contaminants Included in the MSP SERA[a]
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Contaminant	Surface Water ESV (mg/L)	Sediment ESV (mg/kg dry weight)
Metals		
Aluminum	8.7E-02	5.8E+04[b]
Antimony	3.0E-02[c]	2.0E+00[b]
Arsenic	1.5E-01	6.0E+00
Barium	4.0E-03[c]	--[d]
Beryllium	6.6E-04[c]	--[d]
Cadmium	1.3E-03[e]	6.0E-01
Calcium	1.2E+02[c]	--[d]
Chromium	--[d]	2.6E+01
Chromium III	4.2E-02[e]	--[d]
Chromium VI	1.1E-02	--[d]
Cobalt	2.3E-02[c]	--[d]
Copper	5.6E-03[f]	1.6E+01
Iron	1.0E+00	2.0E+04[b]
Lead	1.2E-03[e]	3.1E+01
Magnesium	8.2E+01[c]	--[d]
Manganese	1.2E-01[c]	4.6E+02[b]
Mercury (total)	7.7E-04	2.0E-01
Mercury (inorganic)	1.3E-03	--[d]
Mercury (methyl)	2.8E-06	--[d]
Nickel	2.9E-02[e]	1.6E+01
Potassium	5.3E+01[c]	--[d]
Selenium	5.0E-03	--[d]
Silver	3.6E-04[c]	1.0E+00
Sodium	6.8E+02[c]	--[d]
Uranium	2.6E-03[c]	--[d]
Vanadium	2.0E-02[c]	--[d]
Zinc	6.6E-02[e]	1.2E+02
Semi-Volatile Organics		
Benzo(a)anthracene	2.7E-05[c]	3.2E-01
Benzo(b)fluoranthene	--[d]	--[d]
Chrysene	--[d]	3.4E-01
Di-n-octyl phthalate	7.1E-01[c]	>1.0E+05[b]
Fluoranthene	6.2E-03[c]	7.5E-01
Phenanthrene	6.3E-03[c]	5.6E-01
Pyrene	--[d]	4.9E-01

a. The sources of the surface water and sediment ESVs are the U.S. EPA National Ambient Water Quality Criteria (EPA, 1999) and the NJDEP's *Guidance for Sediment Quality Evaluations* (NJDEP, 1998), respectively, unless otherwise noted.
b. Source: Jones et al. (1997).
c. Source: Suter and Tsao (1996).
d. No ESV was found for the contaminant.

Table 8-2

Surface Water and Sediment ESVs for the Chemical Contaminants Included in the MSP SERA[a]
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

e. The surface water ESV is a function of hardness (mg/L), a hardness of 50 mg/L is assumed for the SERA.
f. Source: NJ Surface Water Quality Standards (NJDEP, 2002).
g. 1,2-Benzenedicarboxylic acid and di-n-octyl phthalate are synonyms for the same contaminant, the ESVs listed for di-n-octyl phthalate are included here.

Table 8-3

Hazard Quotients for Metals and Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Contaminant	Surface Water			Sediments		
	ESV (mg/L)	Maximum Concentration (mg/L)	Hazard Quotient	ESV (mg/kg dry weight)	Maximum Concentration (mg/kg dry weight)	Hazard Quotient
Metals						
Aluminum	8.7E-02	5.5E+00	6.3E+01	5.8E+04	3.6E+04	6.1E-01
Antimony	3.0E-02	6.0E-03	2.0E-01	2.0E+00	1.3E+01	6.5E+00
Arsenic	1.5E-01	5.0E-03	3.3E-02	6.0E+00	3.7E+01	6.2E+00
Barium	4.0E-03	1.0E-01	2.5E+01	--[a]	2.2E+02	--[b]
Beryllium	6.6E-04	1.0E-03	1.5E+00	--[a]	1.7E+00	--[b]
Cadmium	1.3E-03	4.7E-04	3.5E-01	6.0E-01	6.5E+00	1.1E+01
Calcium	1.2E+02	3.8E+01	3.3E-01	--[a]	1.5E+04	--[b]
Chromium	--[a]	5.0E-02	--[b]	2.6E+01	8.6E+01	3.3E+00
Chromium III	4.2E-02	5.0E-02[c]	1.2E+00	--[a]	8.6E+01[c]	--[b]
Chromium VI	1.1E-02	5.0E-02[c]	4.5E+00	--[a]	8.6E+01[c]	--[b]
Cobalt	2.3E-02	5.0E-03	2.2E-01	--[a]	3.5E+01	--[b]
Copper	5.6E-03	1.4E-02	2.4E+00	1.6E+01	3.6E+02	2.3E+01
Iron	1.0E+00	5.2E+00	5.2E+00	2.0E+04	3.9E+04	1.9E+00
Lead	1.2E-03	1.1E-02	9.0E+00	3.1E+01	4.8E+02	1.6E+01
Magnesium	8.2E+01	1.1E+01	1.3E-01	--[a]	1.1E+04	--[b]
Manganese	1.2E-01	6.0E-01	5.0E+00	4.6E+02	2.8E+03	6.1E+00
Mercury (total)	7.7E-04	--[d]	--[b]	2.0E-01	5.2E-01	2.6E+00
Mercury (inorganic)	1.3E-03	--[d]	--[b]	--[a]	5.2E-01[c]	--[b]
Mercury (methyl)	2.8E-06	--[d]	--[b]	--[a]	5.2E-01[c]	--[b]
Nickel	2.9E-02	1.7E-01	5.8E+00	1.6E+01	6.6E+01	4.1E+00
Potassium	5.3E+01	3.7E+00	7.0E-02	--[a]	2.9E+03	--[b]
Selenium	5.0E-03	--[d]	--[b]	--[a]	5.2E+00	--[b]
Silver	3.6E-04	3.0E-03	8.3E+00	1.0E+00	3.3E+00	3.3E+00

Table 8-3

Hazard Quotients for Metals and Organic Compounds
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Metals (cont.)						
Sodium	6.8E+02	6.6E+01	9.7E-02	--[a]	2.2E+03	--[b]
Uranium	2.6E-03	1.4E-01	5.2E+01	--[a]	3.3E+02	--[b]
Vanadium	2.0E-02	1.1E-02	5.4E-01	--[a]	1.4E+02	--[b]
Zinc	6.6E-02	5.1E-01	7.8E+00	1.2E+02	3.1E+03	2.5E+01
Semi-Volatile Organics						
Benzo(a)anthracene	2.7E-05	7.4E-04	2.7E+01	3.2E-01	--[d]	--[b]
Benzo(b)fluoranthene	--[a]	2.0E-03	--[d]	--[a]	--[d]	--[b]
Chrysene	--[a]	1.7E-03	--[d]	3.4E-01	--[d]	--[b]
Di-n-octyl phthalate	7.1E-01	1.5E-03[e]	2.1E-03	--[a]	--[d]	--[b]
Fluoranthene	6.2E-03	2.3E-03	3.7E-01	7.5E-01	--[d]	--[b]
Phenanthrene	6.3E-03	9.1E-04	1.4E-01	5.6E-01	--[d]	--[b]
Pyrene	--[a]	2.5E-03	--[d]	4.9E-01	--[d]	--[b]

a. No ESV was found for the contaminant.
b. Hazard quotient could not be calculated because of the lack of an ESV or contaminant concentration.
c. Concentrations of chromium III and VI were set equal to the total chromium concentration; concentrations of inorganic and methyl mercury were set equal to the total mercury concentration.
d. Contaminant was not detected in the environmental medium or the medium was not evaluated for the contaminant.
e. The hazard quotient for this contaminant is based on a sample collected at the background location; the compound was not detected at any other location.

Table 8-4

Radionuclide-Specific Data Used in the MSP SERA
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	External Dose Conversion Factors (Sv/m^3 per Bq/s)[a]		Energy (MeV/dis)[a]			Gamma Absorption Factor, ? ?[b]	
Radionuclide[c]	**Water Immersion**	**Sediments**	**a**	**ß**	**?**	**Small Organisms**	**Large Organisms**
Cs-137	1.5E-20	3.9E-21	0.0E+00	1.9E-01	0.0E+00	0.0E+00	0.0E+00
Ba-137m	6.3E-17	1.7E-17	0.0E+00	6.5E-02	6.0E-01	1.2E-02	1.2E-01
Ra-226	7.0E-19	1.7E-19	4.8E+00	4.0E-03	7.0E-03	7.0E-01	9.4E-01
Rn-222	4.2E-20	2.5E-19	5.5E+00	0.0E+00	0.0E+00	1.0E+00	1.0E+00
Po-218	9.7E-22	2.6E-22	6.0E+00	0.0E+00	0.0E+00	1.0E+00	1.0E+00
Pb-214	2.6E-17	6.7E-18	0.0E+00	2.9E-01	2.5E-01	1.2E-02	9.0E-02
Bi-214	1.7E-16	4.4E-17	0.0E+00	6.6E-01	1.5E+00	1.0E-02	8.0E-02
Po-214	8.9E-21	2.4E-21	7.7E+00	0.0E+00	0.0E+00	1.0E+00	1.0E+00
Ra-228	0.0E+00	0.0E+00	0.0E+00	1.7E-02	0.0E+00	1.0E+00	1.0E+00
Ac-228	1.0E-16	2.8E-17	0.0E+00	4.8E-01	9.7E-01	1.2E-02	1.1E-01
Th-228	2.1E-19	4.2E-20	5.4E+00	2.1E-02	3.0E-03	7.0E-01	9.4E-01
Ra-224	1.0E-18	2.6E-19	5.7E+00	2.0E-03	1.0E-02	7.0E-01	9.4E-01
Rn-220	4.0E-20	1.1E-20	6.3E+00	0.0E+00	0.0E+00	1.0E+00	1.0E+00
Po-216	1.8E-21	4.9E-22	6.8E+00	0.0E+00	0.0E+00	1.0E+00	1.0E+00
Pb-212	1.5E-17	3.6E-18	0.0E+00	1.8E-01	1.5E-01	1.0E-02	1.0E-01
Bi-212	2.0E-17	5.4E-18	2.2E+00	4.7E-01	1.9E-01	1.0E-02	1.0E-01
Po-212	0.0E+00	0.0E+00	8.8E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tl-208	3.8E-16	9.7E-17	0.0E+00	6.0E-01	3.4E+00	8.5E-03	8.0E-02
Th-230	3.9E-20	6.4E-21	4.7E+00	1.5E-02	2.0E-03	7.0E-01	9.4E-01
Th-232	2.0E-20	2.8E-21	4.0E+00	1.2E-02	1.0E-03	7.0E-01	9.4E-01
U-234	1.8E-20	2.1E-21	4.8E+00	1.3E-02	2.0E-03	7.0E-01	9.4E-01
U-235	1.6E-17	3.8E-18	4.4E+00	4.9E-02	1.6E-01	1.0E-02	1.0E-01
Th-231	1.2E-18	1.9E-19	0.0E+00	1.7E-01	2.6E-02	8.0E-02	4.5E-01

Table 8-4

Radionuclide-Specific Data Used in the MSP SERA
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Radionuclide[c]							
U-238	8.0E-21	5.5E-22	4.2E+00	1.0E-02	1.0E-03	7.0E-01	9.4E-01
Th-234	7.6E-19	1.3E-19	0.0E+00	6.0E-02	9.0E-03	7.0E-01	9.4E-01
Pa-234m	1.5E-18	4.2E-19	0.0E+00	8.2E-01	1.2E-02	4.0E-01	8.8E-01
Pa-234	2.0E-16	1.3E-19	0.0E+00	4.9E-01	1.9E+00	1.0E-02	8.0E-02

a. Source: Eckerman and Ryman (1993).
b. Source: BJ, 1998.
c. Radioactive decay products, or daughters, are indented beneath their parents.

Table 8-5

Element-Specific Data Used in the MSP SERA[a]
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Radionuclide	Bioconcentration Factor (L/kg)[b]	Soil-to-Water Partition Coefficient (L/kg)[c]
Cesium	2.0E+03	1.0E+03
Radium	7.0E+01	4.5E+02
Thorium	1.0E+02	1.0E+05
Uranium	5.0E+01	4.5E+02

a. Data for short-lived daughters are not included in the table; bioconcentration factors and partition coefficients for these constituents were set equal to those of their long-lived parents.
b. Source: NRC, 1992.
c. Source: Baes et al., 1984.

Table 8-6

Radionuclide Doses Projected for the MSP SERA
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Surface Water / Aquatic Organisms			Sediments / Benthic Organisms	
		Estimated Dose (rad/d)			
Radionuclide	**Maximum Concentration (pCi/L)**	**Small Organism**	**Large Organism**	**Maximum Concentration (pCi/g)**	**Estimated Dose (rad/d)**
Cesium-137	--[a]	--[a]	--[a]	2.0E-01	7.1E-06
Radium-226	3.8E+00	3.4E-04	3.4E-04	1.3E+01	2.9E-03
Radium-228	1.2E+00	2.2E-06	2.6E-06	3.3E+00	5.1E-05
Thorium-228	8.1E-01	1.4E-04	1.4E-04	3.9E+00	7.0E-05
Thorium-230	1.5E+00	3.7E-05	3.7E-05	1.9E+01	4.6E-06
Thorium-232	1.3E-01	2.7E-06	2.7E-06	2.3E+00	4.8E-07
Uranium-234	4.7E+01	5.7E-04	5.7E-04	1.1E+02	3.1E-03
Uranium-235	5.3E+00	4.1E-05	4.1E-05	9.3E+00	2.6E-04
Uranium-238	4.5E+01	5.9E-04	5.9E-04	1.1E+02	3.2E-03
Total Dose		1.7E-03	1.7E-03		9.6E-03

a. Contaminant was not detected in the environmental medium.

Table 8-7

Summary of COPCs
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

	Surface Water		Sediments	
Contaminant	**Is Contaminant a COPEC?**	**Basis for Inclusion or Exclusion as COPEC**	**Is Contaminant a COPEC?**	**Basis for Inclusion or Exclusion as COPEC**
Metals				
Aluminum		Maximum concentration and ESV are less than background concentration		Maximum concentration is less than ESV
Antimony		Maximum concentration is less than ESV	**v**	Maximum concentration exceeds background and ESV
Arsenic		Maximum concentration is less than ESV	**v**	Maximum concentration exceeds background and ESV
Barium		Maximum concentration and ESV are less than background concentration	**v**	No available ESV
Beryllium		Maximum concentration and ESV are less than background concentration	**v**	No available ESV
Cadmium		Maximum concentration is less than ESV	**v**	Maximum concentration exceeds background and ESV
Calcium		Maximum concentration is less than ESV	**v**	No available ESV
Chromium	**v**	Maximum concentration exceeds background and ESV	**v**	Maximum concentration exceeds background and ESV
Cobalt		Maximum concentration is less than ESV	**v**	No available ESV
Copper		Maximum concentration and ESV are less than background concentration	**v**	Maximum concentration exceeds background and ESV

Table 8-7

Summary of COPCs
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Metals (cont.)				
Iron		Maximum concentration and ESV are less than background concentration		Maximum concentration and ESV are less than background concentration
Lead		Maximum concentration and ESV are less than background concentration	**v**	Maximum concentration exceeds background and ESV
Magnesium		Maximum concentration is less than ESV	**v**	No available ESV
Manganese		Maximum concentration and ESV are less than background concentration	**v**	Maximum concentration exceeds background and ESV
Mercury		Maximum concentration is less than ESV	**v**	Maximum concentration exceeds background and ESV
Nickel	**v**	Maximum concentration exceeds background and ESV	**v**	Maximum concentration exceeds background and ESV
Potassium		Maximum concentration is less than ESV	**v**	No available ESV
Selenium		Maximum concentration is less than ESV	**v**	No available ESV
Silver		Maximum concentration and ESV are less than background concentration	**v**	Maximum concentration exceeds background and ESV
Sodium		Maximum concentration is less than ESV	**v**	No available ESV
Uranium	**v**	Maximum concentration exceeds background and ESV	**v**	No available ESV

Table 8-7

Summary of COPCs
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Metals (cont.)				
Vanadium		Maximum concentration is less than ESV	**v**	No available ESV
Zinc	**v**	Maximum concentration exceeds background and ESV	**v**	Maximum concentration exceeds background and ESV
Semi-Volatile Organics				
Benzo(a)anthracene	**v**	Maximum concentration exceeds ESV		
Benzo(b)fluoranthene	**v**	No available ESV		
Chrysene	**v**	No available ESV		
Di-n-octyl phthalate		Maximum concentration is less than ESV		
Fluoranthene		Maximum concentration is less than ESV		
Phenanthrene		Maximum concentration is less than ESV		
Pyrene	**v**	No available ESV		

Table 8-8

Surface Water COPCs Ranked by Hazard Quotient
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Contaminant	ESV (mg/L)	Maximum Concentration (mg/L)	Hazard Quotient - Maximum Concentration	Mean Concentration[a] (mg/L)	Hazard Quotient – Mean Concentration
Metals					
Uranium	2.6E-03	1.4E-01	5.2E+01	5.1E-02	2.0E+01
Zinc	6.6E-02	5.1E-01	7.8E+00	1.3E-01	2.0E+00
Nickel	2.9E-02	1.7E-01	5.8E+00	2.7E-02	9.2E-01
Chromium	1.1E-02, 4.2E-02[b]	5.0E-02[c]	4.5E+00, 1.2E+00[b]	1.7E-02[c]	1.6E+00, 4.1E-01[b]
Semi-Volatile Organics					
Benzo(a)anthracene	2.7E-05	7.4E-04	2.7E+01	--[d]	--

a. The listed concentrations represent the 95th percent upper confidence limits of the means.
b. The listed information pertains to chromium VI and chromium III, respectively.
c. The total chromium concentration was assigned to chromium VI and III in order to conduct the SERA.
d. Indicates a 95th percentile UCL could not be calculated due to the lack of sufficient data.

Table 8-9

Sediment COPCs Ranked by Hazard Quotient
Groundwater Operable Unit Remedial Investigation
Middlesex Sampling Plant
Middlesex, New Jersey

Contaminant	**ESV (mg/L)**	**Maximum Concentration (mg/L)**	**Hazard Quotient - Maximum Concentration**	**Mean Concentration[a] (mg/L)**	**Hazard Quotient – Mean Concentration**
Zinc	1.2E+02	3.1E+03	2.5E+01	4.9E+02	4.1E+00
Copper	1.6E+01	3.6E+02	2.3E+01	1.0E+02	6.2E+00
Cadmium	6.0E-01	6.5E+00	1.1E+01	1.2E+00	2.0E+00
Lead	3.1E+01	4.8E+02	1.6E+01	1.2E+02	3.9E+00
Antimony	2.0E+00	1.3E+01	6.5E+00	2.6E+00	1.3E+00
Arsenic	6.0E+00	3.7E+01	6.2E+00	7.5E+00	1.2E+00
Manganese	4.6E+02	2.8E+03	6.1E+00	8.6E+02	1.9E+00
Nickel	1.6E+01	6.6E+01	4.1E+00	3.2E+01	2.0E+00
Chromium	2.6E+01	8.6E+01	3.3E+00	3.5E+01	1.3E+00
Silver	1.0E+00	3.3E+00	3.3E+00	2.3E+00	2.3E+00
Mercury	2.0E-01	5.2E-01	2.6E+00	1.6E-01	7.8E-01

a. The listed concentrations represent the 95th percent upper confidence limits of the means.