Final Report

VOLUME I

Fort Edward Remedial Investigation Report

General Electric Company
Transmission Systems
Fort Edward, New York

January 20, 1997

O'BRIEN & GERE
ENGINEERS, INC.

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Background

The General Electric Company Fort Edward facility is located approximately 800 feet east of the Hudson River between the Villages of Hudson Falls to the north, and Fort Edward to the south. The facility is approximately 32 acres and bounded on the east by Broadway, on the south by Park Avenue and by the Delaware & Hudson Railroad/Allen Street on the west. An approximately 200 foot wide parcel located between Allen Street and the Hudson River is also owned by GE and is part of the Fort Edward Plant site.

The main manufacturing building, the largest building at the Fort Edward facility, is comprised of several joined structures which were constructed over a span of 25 years. The main building is divided into four sections; Buildings 23, 25, 25 and 27. The original manufacturing building (Bldg. 23) was constructed in 1942 by the U.S. government as an aircraft turret plant. Between 1942 and 1946, the building was leased by GE from the U.S. government and used for the manufacture of Selsyn motors. Production turned to the manufacture of small component capacitors after World War II.

Originally, above ground process tanks associated with the storage, refining, and distribution of capacitor fluids were located outside the boiler room in a gravel-covered area. Off-loading of these dielectric fluids from rail cars took place along the north side of the building where a Delaware & Hudson rail spur terminated.

The aluminum rolling mill or Foil Mill building (Bldg. 40) occupies the northwest portion of the site. The approximately 94,100 square ft building was constructed in phases over a 15 year period beginning in 1960. Prior to 1960, the land was owned by Washington County and was used as a county fairgrounds. The Foil Mill has been expanded several times since its original construction.

The original section of the Foil Mill housed the aluminum rolling mills, a motor room, and filter room. Beneath the rolling mills, cut into the concrete slab, a series of trenches were constructed to convey lubricating fluids (kerosene, mineral oil, Norpar) between the mills and the filter rooms. Recently, the rolling mills and associated system of trenches were decommissioned. The trenches and subgrade tanks used for water and lubricant storage were cleaned and filled with concrete.

Prior to 1976, untreated industrial wastewater and stormwater were discharged through a 30 inch outfall pipe to the Hudson River. As part of the 1976 PCB Abatement Project, industrial wastewater was redirected to a new wastewater treatment plant. The industrial wastewater treatment plant (IWWTP) at the Fort Edward facility treats effluent from the on-site sanitary waste water treatment plant and other waste waters (*i.e.*, ground water, industrial waste water, stormwater) generated at the facility. Effluent from the treatment plant is currently discharged to the Hudson River through a SPDES permitted outfall (Outfall 004). Treatment provided by the IWWTP consists of equalization, coagulation and filtration, and granular activated carbon adsorption. Since 1992, several upgrades to the IWWTP have been implemented to reduce effluent loadings to the Hudson River, including an in-line coagulation system utilizing existing multimedia pressure filters, an effluent recycling system, and a solids handling train.

This remedial investigation (RI) was conducted pursuant to Order on Consent #A5-0316-94-06 between the State of New York Department of Environmental Conservation (NYSDEC) and GE. The RI was conducted in accordance with the Remedial Investigation/Feasibility Study (RI/FS) Work Plan (Work Plan) prepared by O'Brien & Gere and dated April 1995 and attached to the Order on Consent. A supplemental RI technical scope of work was prepared and submitted to NYSDEC in March of 1996. The objectives of the RI are to evaluate impacts, if any, of chemical substances that may have previously migrated off-site, on human health and the environment; determining if contamination continues to migrate off-site; implementing interim remedial measures (IRMs) as necessary; gathering engineering data required to perform a feasibility study; and to satisfy any corrective action obligations pursuant to the Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act and the Hazardous and Solid Waste Amendments and the New York ECL Article 27, Title 9.

Prior to initiation of the field investigation program, a detailed sampling and analysis plan (SAP) was submitted to NYSDEC for review and approval prior to implementation. The SAP included a Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) submitted on August 9, 1995 and approved on August 14, 1995

RI activities

To fulfill the objectives of the RI, a field investigation program consisting of sampling and analysis of surface and near-surface soils, ground water, surface water and sewers from selected locations at or near the GE Fort Edward facility. All sampling and analysis procedures were performed in accordance with the NYSDEC-approved RI/FS Work Plan.

An evaluation of deep bedrock ground water conditions was performed to better define both the deep bedrock stratigraphy and ground water quality. The field activities associated with investigation of the deep bedrock consist of an integrity assessment of the well seals in former production wells PW-1 and PW-2; geophysical logging of PW-1; and video inspection of former production wells PW-1 and PW-2; installation of one monitoring well (OBG-26BD) within that borehole; ground water sampling of OBG-26BD from seven discreet screened zones via packer testing.

Field activities associated with the shallow bedrock investigation included a fracture trace analysis; recompletion of monitoring well GM-40D to a shallower depth; packer testing of recovery well GM-11D; and the drilling associated with the installation of 20 bedrock monitoring wells. Each newly installed well was developed and slug-tested according to the procedures presented in the NYSDEC-approved RI/FS Work Plan and RI FSP.

Two hydraulic monitoring programs were also performed to assess the hydraulic effects of pumping bedrock recovery wells GM-11D and GM-8DR on surrounding bedrock and unconsolidated hydrogeological units. A florescent dye test was performed to assess if overburden ground water and abandoned storm sewers near GM-8DR are sources of recharge to recovery wells GM-8DR and GM-11D.

A soil gas survey was performed in the vicinity of Building 40 to identify and define areas of VOC contamination. Field screening of samples collected from 119 locations with a gas chromatograph (GC) was performed in accordance with standard operating procedures (SOP) provided in the NYSDEC-approved RI FSP.

Near-surface soil grab samples were collected from seven locations north of Building 40 and analyzed for VOCs by USEPA SW-846 Method 8240, and PCBs by USEPA SW-846 Method 8080.

Forty-one soil borings were completed to better define the site unconsolidated stratigraphy and to evaluate the potential for the presence of non-aqueous phase liquids (NAPLs). Soil samples were collected and analyzed in accordance with the NYSDEC-approved RI FSP and QAPP. Soil samples were analyzed for VOCs by USEPA SW-846 Method 8240, and PCBs by USEPA SW-846 Method 8080. Selected soil samples were also analyzed for kerosene by USEPA SW-846 Method 8015-modified, and polynuclear aromatic hydrocarbons (PAHs) by USEPA SW-846 Method 8270.

The investigation of the shallow unconsolidated unit included the installation of 29 monitoring wells, the majority of which were installed in and around Building 40. Each newly installed well was developed and slug-tested in accordance with the procedures presented in the NYSDEC-approved RI/FS Work Plan and RI SAP.

Sixty-three soil borings were completed in the southern parking lot and inside and around the perimeter of the main manufacturing building to further delineate both the vertical and horizontal extent of dense non-aqueous phase liquids (DNAPLs) at the facility, and to better define the stratigraphy of the unconsolidated materials in the vicinity of the DNAPL.

Eleven soil borings were completed within the glacial till in the southern area of the facility to evaluate the potential for DNAPL within the glacial till unit in the central and south central portions of the facility. An addition borehole was completed and a monitoring well installed within to evaluate the potential for dissolved phase DNAPL within the glacial till at the southern boundary of the facility.

To address concerns that PCBs were migrating within the transitional sequence between the low permeability silty clay deposit and the overlying sand deposit, eleven monitoring wells were installed and one additional boring completed within the transition zone.

Characterization of bedrock and overburden ground water chemistry, and surface water chemistry was completed by the sampling and analysis performed in accordance with the NYSDEC-approved RI FSP. Ground water samples were collected from 92 new and pre-existing monitoring wells, residential wells and springs on October 31 through November 7, 1995, and from 129 new and pre-existing monitoring wells, residential wells and springs on June 17 through June 26, 1996. Additional sampling was performed on January 17,1996 and October 4, 1996.

Aqueous samples were analyzed for VOCs by USEPA Method 624, modified to include additional VOCs from USEPA SW-846 Method 8021. Aqueous samples were analyzed for PCBs by USEPA Method 608, modified to achieve lower practical quantitation limits (PQLs). Selected ground water samples were also analyzed for semi-volatile organic compounds (SVOCs) by USEPA Method 625.

An industrial sewer system assessment was performed to identify and evaluate the condition of select sewer pipes, manholes, and catch basins at the GE facility and assess the degree to which these sewer components may be serving as conduits for ground water migration or as reservoirs of contaminants that could potentially be released to the environment. In addition, the inspection satisfied the Corrective Action Provisions of the Part 373 permit regarding the performance of an integrity assessment of active industrial sewer lines which are suspected of having the potential to release hazardous constituents to environmental media.

Twelve aqueous samples were collected from manholes and analyzed in accordance with the NYSDEC-approved RI FSP and QAPP. Aqueous samples were analyzed for VOCs by USEPA Method 624, modified to include additional volatile organic compounds from USEPA SW-846 Method 8021. Water samples were also analyzed for PCBs by USEPA Method 608-modified, and for (SVOCs) by USEPA Method 625.

A video inspection of a total of 977 feet of sewer pipe was also performed to assess pipe integrity.

A risk assessment (RA) of potential impact to public health was conducted to facilitate the evaluation of possible future remedial action at the site. The following United States Environmental Protection Agency (USEPA) documents were used as principal guidance in the preparation of the RA:

- *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A) interim Final,* EPA/540/1089/002.
- *Guidelines for Exposure Assessment* (57 FR 104, May 29, 1992).

- *Guidance on Risk Characterization for Risk Managers and Risk Assessors*, February 26, 1992, USEPA Memorandum from Henry Habicht, Deputy Administrator, to Assistant Administrators and Regional Administrators.

RI results

The RI was successful in fulfilling its primary objectives of evaluating impacts, if any, of chemicals that may have previously migrated off-site on human health and the environment; determining if contamination continues to migrate off-site; implementing interim remedial measures (IRMs) as necessary; gathering engineering data required to perform a feasibility study; and to satisfy any corrective action obligations pursuant to the Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act and the Hazardous and Solid Waste Amendments and the New York ECL Article 27, Title 9. A summary of the RI results is presented in this section.

Geology

With the exception of fill, unconsolidated deposits of glacial origin unconformably overlie the bedrock at the GE facility in Fort Edward, New York. Five types of unconsolidated sediments have been identified at the site. These include glacial till, glacio-lacustrine silt and clay, a transitional zone, glacio-deltaic sand and gravel and artificial fill. The unconsolidated deposits are underlain by the Snake Hill Formation.

Glacial till is observed directly overlying bedrock at the site and is composed of a poorly sorted mixture of sand, gravel, and sometimes cobbles in a matrix of fine sand and silt with occasional clay seams. The glacial till unit is absent in the area around the equalization basin, located in the southwestern portion of the site, where it appears to have been removed during the excavation activities associated with the construction of the basin. The glacio-lacustrine silt and clay unit can best be described as dark grey silt and clay, with frequent clayey silt seams and occasional fine sand partings.

Glacio-lacustrine silt and clay deposits are generally observed overlying the glacial till unit. The glacio-lacustrine silt and clay unit ranges in thickness from 44.9 feet in the northeast corner of the site adjacent to Upper

Broadway and thins out to zero feet in the vicinity of the Foil Mill, the area of the former leachfield and the equalization basin.

Overlying the glacio-lacustrine silt and clay unit in the eastern and southeastern portions of the site is a sequence of light gray sand and silt interbedded with frequent seams and partings of clay and silt which become more frequent with depth. This zone has been designated the transition zone and represents a change in depositional environment from a deep water , low energy glacial lake environment to a higher energy, near shore environment.

The uppermost unconsolidated unit at the Fort Edward plant is a glacio-deltaic sand and gravel unit and is ubiquitous throughout the site and is best described as brown coarse to fine sand with a little fine gravel. The glacio-deltaic sand and gravel unit is thinnest in the western portion of the site in the vicinity of the Foil Mill. This unit thickens considerably to the east and is observed at a thickness of 28.4 feet along the eastern property boundary of the site.

The bedrock immediately underlying the unconsolidated deposits in the vicinity of the Fort Edward plant are the shales of the Middle Ordovician Snake Hill Formation. The Snake Hill Formation is the highest and youngest formation encountered in the study area. The Snake Hill Formation has been differentiated into three distinct units, these are the Upper, Middle and Lower Snake Hill Shale. The Upper Snake Hill Formation consists of approximately 200 feet of dark grey to black, fine grained, massive to moderately jointed shale.

Hydrogeology

A conceptualization of the hydrogeologic system at the Fort Edward facility includes four hydrogeologic units: the shallow unconsolidated unit, the transition zone unit, the low permeability confining unit and the shallow bedrock unit.

The shallow unconsolidated unit is composed of glacio-deltaic sand. The water table generally occurs in this unit under unconfined conditions and is free to rise and fall in response to ground water recharge and discharge. The transition zone hydrogeologic unit lies stratigraphically between the shallow unconsolidated unit and the shallow bedrock unit. The transition zone is limited in its extent across the site and is only found in the eastern portion of the site. This unit is less permeable than the overlying unconsolidated hydrogeologic unit.

The shallow unconsolidated unit and the transition zone is generally hydraulically separated from the shallow bedrock unit by a low permeability till and clay-rich aquitard which extend across the site.

The shallow bedrock hydrogeologic unit is composed of black, dense shale of the Snake Hill Formation. Ground water flow within the shallow bedrock hydrogeologic unit occurs principally through secondary porosity features such as fractures, joints and bedding planes. At the Fort Edward facility, the ground water in the shallow bedrock hydrogeologic unit is generally observed under confined conditions, with the exception of monitoring well OBG-46BS.

Ground water flow within the shallow unconsolidated unit at the facility is controlled by a ground water table divide which trends northeast to southwest between monitoring well location OBG-54 and GM-5. Ground water flow in the northwestern, western and southwestern portion of the facility is generally to the west towards the Hudson River. Flow in the central and southeastern portion of the facility is generally to the southeast toward Park Avenue.

As a result of pumping, ground water flow in the shallow unconsolidated unit has been altered in the southeastern portion of the facility. A trough of depression, has been formed in the vicinity of the shallow ground water recovery system. Water levels have been drawn down in the area between recovery well RW-3 and monitoring well GM-29 and indicate that ground water immediately south of Park Avenue is being pulled back (i.e., north) toward the shallow ground water recovery system. Ground water flow within the shallow unconsolidated unit in the area south of Park Avenue is generally to the south. Ground water flow in the central portion of the off-site ground water plume (i.e., areas west of Putnam Avenue and Ethan Allen) is generally to the south and shifts toward the southwest in the area west of Broadway, south of well OBG-60.

Ground water flow within the transition zone is principally horizontal through the fine sand and silt layers and seams within this unit. Based on ground water levels measured during pumping of the shallow unconsolidated unit ground water recovery system, ground water flow in the transition zone is from northeast to southwest toward the ground water recovery wells.

Ground water flow in the shallow bedrock is controlled by a hydrogeologic divide which trends north-northwest to the south-southeast in the vicinity of Lower Allen Street. Ground water flow in the area west of Lower Allen Street is generally to the west towards the Hudson River. In the area east of Lower Allen Street ground water in the shallow bedrock flows from west to east across the facility. Similarly, the intermediate bedrock ground water in the west portion of the facility flows west to east across the facility. Ground water flow directions and hydraulic gradients do not appear to change appreciably from high to low recharge conditions within the shallow bedrock unit.

The effect of ground water pumping from bedrock recovery wells GM-8DR and GM-11D is observed in the southwestern portion of the facility. Water levels have been drawn down in the immediate vicinity of these two wells and indicates that ground water immediately east of pumping well GM-11D is being pulled back (i.e., west) toward the pumping well.

Ground water flow within the deep bedrock is controlled by a hydrogeologic divide which trends north to south between well OBG-15BD through the area of the Foil Mill towards well location OBG-26. Ground water flow in the western portion of the facility and west of Lower Allen Street is generally to the west towards the Hudson River. Ground water in the central and eastern portion of the facility flows west to east across the facility towards Upper Broadway. Ground water flow directions and hydraulic gradients do not change appreciably from high to low recharge conditions within the deep bedrock unit.

Soil gas results

Three areas of elevated concentrations of kerosene constituents in soil gas were observed; the southeastern portion of building 40, the area near well GM-2 and the area between the northern portion of building 40 and well cluster OBG-43. Additionally, three areas of elevated chlorinated VOCs were observed; the northwest and southeast corners of Building 40 and the area immediately south of the Building 40 near the rail line.

Constituents in soil

PCBs were detected in soil samples collected from two relatively recent soil piles (i.e., SS-1 and SS-2) and two piles created in the past (i.e., SS-3 and SS-5). The highest concentrations of total PCBs were detected at 2.17 mg/kg in soil boring SS-1 and 2.56 mg/kg in soil boring SS-2, both located in the soil piles created more recently.

The results of 30 environmental soil samples collected from 17 soil borings installed around Building 40 indicate that VOCs were detected in 13 soil samples collected from 11 of the 17 soil borings. Kerosene was detected in 14 soil samples collected from 11 of the 17 soil borings. The highest concentrations (i.e., greater than 10 mg/kg) of total VOCs characteristic of kerosene were detected between 14.1 and 66.0 mg/kg in the following four soil boring locations and depth intervals; SB-37S-1 (3 to 5 feet), SB-43 S-4 (5 to 6 feet), OBG-50 S-3 (4 to 6 feet), and the field duplicate of OBG-55 S-3 (4 to 6 feet). These soil borings are located off the northwestern and southwestern corners of Building 40.

In general, the highest concentrations of kerosene and kerosene-related VOCs were detected between 14.1 and 66.0 mg/kg, at 4 to 6 feet below ground surface, within the upper few feet of the ground water surface. These soil borings are located off the northwestern and southwestern corners of Building 40. Similarly, kerosene and characteristic kerosene VOCs were absent or detected at lower concentrations in the soil samples collected above the ground water table and/or 7 to 10 feet below the ground surface.

Aroclor-1242 was identified in eight of the soil samples, the highest concentration reported is at 36.0 mg/kg in the soil sample collected from 8 to 9.4 feet below ground surface from soil boring location SB-49, located between Buildings 27 and 40.

A comparison of analytical results from soil samples collected in the vicinity of Building 40 indicates that the results for each VOC and Aroclor detected, were below USEPA's industrial risk-based concentrations.

Three soil samples were collected from approximately 2 to 3 feet below ground surface in three soil borings (OBG-69, OBG-70, and OBG-71) and analyzed for PAHs. No PAHs were detected in the three soil samples.

Twenty-one (21) soil samples were collected from the 12 soil borings under Building 40, from depths ranging from 0.5 to 15 feet below ground surface. In general, the highest concentrations of VOCs were detected in soil samples collected from 5 to 9 feet below ground surface, which coincides with the upper 1 to 3 feet of the ground water surface in the majority of the wells.

The comparison of analytical results from soil samples collected under Building 40 indicates that all results for each VOC detected, and the total

PCB concentrations for each sample, were below USEPA's available industrial risk-based concentrations.

No VOCs were detected in any of the four soil samples collected in the former leachfield area, south of Building 40. Concentrations of Aroclor-1242 and/or Aroclor-1254 were detected in three of the four soil samples collected from the former leachfield area at locations LF-1, LF-3, and LF-4. The soil sample collected from 6 to 7.9 feet below ground surface in soil boring LF-1 contained the highest PCB concentrations; Aroclor-1242 at 63 mg/kg and Aroclor-1254 at 140 mg/kg. The total PCB concentrations detected in the three remaining soil samples collected were well below USEPA's industrial risk-based concentration of 41 mg/kg for Aroclor-1254.

Consitituents in ground water

Foil Mill

Concentrations of one or more VOCs characteristic of kerosene were detected above the NYSDEC Class GA ground water standards or guidance values in monitoring wells GM-5, OBG-50, OBG-52, OBG-55, and OBG-68 and ranged in total concentrations from 11 to 1,250 μg/L.

Concentrations of chlorinated VOCs, 1,1-dichloroethane and/or 1,1,1-trichloroethane, were detected at or above NYSDEC Class GA ground water standards (5 μg/L each) in monitoring wells OBG-55 and OBG-68 and ranged in total concentrations from 5 to an estimated 1,310 μg/L.

Concentrations of Aroclor-1242 and/or Aroclor-1254 were detected above NYSDEC Class GA ground water standard of 0.10 μg/L in monitoring wells F-2, F-3, GM-2, GM-5, OBG-44S (destroyed), OBG-48S (destroyed), OBG-50, OBG-51, OBG-52, OBG-53, OBG-1A(replaced GM-1), OBG-54 and OBG-68 and ranged in total concentrations of 0.12 to 60 μg/L.

Concentrations of one or more VOCs characteristic of kerosene were detected above NYSDEC Class GA ground water standards or guidance values in monitoring wells FM-1, FM-5, FM-7, FM-9, FM-10, FM-11, and FM-12 and ranged in total concentration from 63 to 251 μg/L.

Concentrations of chloroethane, 1,1-dichloroethane, cis-1,2-dichloroethene, and 1,1,1-trichloroethane were detected above NYSDEC Class GA ground water standards in monitoring wells FM-9 and FM-11 and ranged in total concentration from 216 to 1,521 μg/L.

Concentrations of Aroclor-1242 and/or Aroclor-1254 were detected above the NYSDEC Class GA ground water standard of 0.10 μg/L in each of the 10 wells in Building 40, and ranged in total concentration of 0.264 to 310 μg/L. Additionally, Aroclor-1242 was detected at concentrations of 4.4 and 220 mg/L in the LNAPL samples collected from monitoring wells FM-5 and FM-12, respectively.

Leachfield

One shallow unconsolidated unit monitoring well, OBG-83, was installed in the leachfield area as part of the Supplemental RI scope of work. VOCs were not detected in the ground water sample collected from this well during the supplemental RI sampling event. Aroclor-1242 was detected at an estimated concentration of 0.059 μg/L, below the Class GA ground water standard of 0.10 μg/L.

Eastern property boundary

No VOCs or PCBs were detected in monitoring well OBG-42S, located on the northeastern property boundary.

Transition zone

Trichloroethene was the most frequently detected VOC in the transition zone wells. The next most frequently detected VOCs included cis-1,2-dichloroethene, benzene, and chloroform. Concentrations of trichloroethene and/or cis-1,2-dichloroethene were detected above NYSDEC Class GA ground water standards (5 μg/L each) in on-site transition zone wells OBG-63, OBG-64, and OBG-82 and ranged in total concentrations from 8 to 4,300 μg/L. Trichloroethene was detected above the NYSDEC Class GA ground water standard of 5 μg/L at concentrations of 29 and 30 μg/L in one off-site transition zone well, OBG-76, located in the area of the off-site overburden plume south of the facility.

Aroclor-1242 and/or Aroclor-1254 were detected above the NYSDEC Class GA ground water standard of 0.10 μg/L in one off-site well, OBG-76, at 0.39μg/L and five on-site wells, OBG-63, OBG-64, OBG-65, OBG-66, and OBG-82, and ranged in total concentration from 2.0 to 28.1 μg/L. Aroclor-1242 was detected in off-site well OBG-79 at an estimated concentration of 0.055 μg/L, well below the ground water standard of 0.10 μg/L.

Southern portion of the facility

Twenty-five (25) shallow unconsolidated unit monitoring wells are located within the southern portion of the facility.

Trichloroethene and cis-1,2-dichloroethene were the most frequently detected VOCs in the shallow unconsolidated unit ground water collected from the southern portion of the facility. The other less frequently detected VOCs include tetrachloroethene, vinyl chloride, 1,1,1-trichloroethane, 1,1-dichloroethane, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, chloroform, and methylene chloride.

Concentrations of one or more chlorinated VOCs were detected at or above NYSDEC Class GA ground water standards in shallow unconsolidated unit monitoring wells GM-8A, GM-12A, GM-12B, GM-12C, GM-21, GM-22, GM-23, GM-24, GM-25, GM-30, GM-32, GM-33, and GM-35 and ranged in total concentrations of 5 to 10,000 μg/L.

Concentrations of several chlorobenzenes including; chlorobenzene; 1,2-dichlorobenzene; 1,4-dichlorobenzene; 1,3-dichlorobenzene; 1,2,4-trichlorobenzene; and, 1,3,5-trichlorobenzene were reported above NYSDEC Class GA ground water standards in shallow unconsolidated unit monitoring wells GM-8A, OBG-8B (formerly GM-8A), and GM-25 and ranged in total concentrations of 139 to 723 μg/L.

PCBs were detected in 19 of the 25 shallow unconsolidated unit monitoring wells located in the southern portion of the facility. Concentrations of Aroclor-1242 and/or Aroclor-1254 were detected at or above the NYSDEC Class GA ground water standard of 0.10 μg/L in GM-8A, OBG-8B (GM-8A replacement), GM-12A, GM-12B, GM-12C, GM-21, GM-22, GM-24, GM-25, GM-28, GM-30, GM-32, GM-33, GM-35, OBG-26T(till zone), and OBG-56 and ranged in concentration from 0.10 to 77 μg/L. It should be noted that PCBs were not confirmed in OBG-56 in January or June 1996.

Concentrations of Aroclor-1242 and/or Aroclor-1254 were reported below the NYSDEC Class GA ground water standard in GM-11, GM-16, GM-29, and GM-31, ranging from an estimated 0.055 to 0.093 μg/L.

Off-site

Shallow unconsolidated unit ground water monitoring wells and springs located off-site include 18 wells and springs.

Trichloroethene and cis-1,2-dichloroethene were the most frequently detected VOCs in shallow unconsolidated unit ground water samples collected off-site. The other VOCs detected include chloroform and bromodichloromethane. Concentrations of trichloroethene and/or cis-1,2-dichloroethene were detected above NYSDEC Class GA ground water standards (5 μg/L each) in off-site monitoring locations SW-3, SW-4, SW-5, GFNB, Dobroski, Griffin Avenue spring, Hillview Avenue spring, OBG-59, and OBG-61 and ranged in total concentrations from 8 to 3,920 μg/L.

Chloroform was detected at estimated concentrations of 25 and 14 μg/L in the samples collected from off-site well OBG-59 in the October/November 1995 and June 1996, respectively. These concentrations of chloroform are above the NYSDEC Class GA ground water standard of 7 μg/L.

Aroclor-1242 and/or Aroclor-1254 were reported above NYSDEC Class GA ground water standard of 0.10 μg/L in monitoring wells SW-3, SW-4, GFNB, OBG-57, and Rencor #2, ranging from total concentrations of 0.14 to 1.9 μg/L. However, concentrations of PCBs in OBG-57 located on the Rencor property have shown a decrease since January 1995 and PCBs were not detected in Rencor #2 in June 1996.

Bedrock ground water

With the exception of ground water recovery wells GM-11D and GM-8DR, and monitoring well GM-9D, no bedrock wells exhibited confirmed detections of VOC or PCBs levels above NYSDEC Class GA ground water standards.

Sewer sample results

Sewer sample analytical results indicate that PCBs were detected in every sample of industrial wastewater collected; concentrations ranged from 1.3 μg/L to 1200 μg/L.

VOCs were detected in wastewater samples collected from manholes MH-5, MH-7, MH-8, MH-9, and MH-23. Total VOC concentrations in these samples ranged from 3 to 94 μg/L. Compounds detected in manholes

MH-5, MH-7, MH-8, and MH-9 included bromodichloromethane, chlorobenzene, chloroform, and dichlorobenzene.

Risk assessment

A risk assessment (RA) of potential impacts to public health and the environment related to the presence of chemical substances at the General Electric Company (GE) Transmission Systems facility located in Fort Edward, New York was performed. The RA focuses on chemical substances detected in soil and ground water at the facility and site related chemical substances detected hydraulically downgradient of the facility.

For the purposes of the risk assessment, the site was organized according to the following areas. Risk estimates were developed for each area individually.

Area A - Area A represents the undeveloped area located north of the Building 40. This area was used for disposal of soil excavated during construction activities at the facility. Seven near-surface soil samples were collected from Area A and analyzed for PCBs and VOCs. Low concentrations of PCBs (< 2 ppm) were detected in soil in Area A. The detected concentrations of PCBs in Area A are less than published health based screening values for industrial soils. As such, no chemicals of potential concern (COPCs) were identified in this area, and it was concluded that there is no significant risk to human health associated with chemical substances detected in Area A.

Area B - Area B represents the areas located in the vicinity of Building 40. Kerosene was stored in above ground storage tanks located to the west of Building 40. Historical releases of kerosene during plant operations have resulted in elevated kerosene levels in soils in the vicinity of Building 40, and sub-surface kerosene free product at certain locations around Building 40. Chemical substances detected in soils and shallow ground water at Area B include PCBs, chlorobenzenes, alkyl substituted benzenes, and chlorinated aliphatics. Concentrations of chemical substances detected in soils at Area B did not exceed health based screening values for industrial soils. As such, no COPCs were identified in soils in Area B. PCBs, chlorinated VOCs, and benzene were identified as COPCs in shallow ground water. On-site workers engaged in soil excavation activities at Area B may be exposed to COPCs in ground water. The calculated RME HI for the on-site worker is 0.019, and the calculated RME cancer risk is 2.0E-06. Since the RME HI is less than 1, and the cancer risk is within the USEPA's acceptable range of 1.0E-04 to 1.0E-06 set forth in the National

Contingency Plan, it is concluded that chemical substances detected in Area B do not represent a significant chronic health risk to workers at the site.

Area C - Area C represents shallow and transition zone ground water in the southern portion of the site. Historical releases of PCB oil and chlorinated solvents in the southern portion of the plant have resulted in dissolved chlorinated VOCs and PCBs in ground water which have migrated to off-site locations to the south of the site. In addition, chlorinated VOCs have been detected in the down gradient surface springs to which the shallow ground water discharges, as well as in certain residential wells located downgradient of the site.

On site workers engaged in soil excavation activities at Area C may contact COPCs. The calculated RME HI for the on-site soil excavation worker is 2.8 and the calculated RME cancer risk is 4.2E-06. Since the calculated HI for Area C exceeds 1, risk management strategies to minimize worker exposures at source Area C may be appropriate. Such strategies may include utilization of personal protective equipment and a health and safety plan if soil excavation workers may contact shallow ground water at source Area C in the future.

Homes at which COPCs have been detected in downgradient residential supply well water have been connected to municipal water. However, some homes may use ground water for non-potable purposes such as car washing or lawn watering. The calculated RME HI for off-site resident exposed to ground water via non-potable uses is 0.85 and the calculated RME cancer risk is 3.0E-06. It is important to note, however, that exposures to off-site residents were derived based on the maximum detected COPC concentrations in off-site wells (well SW-3). The concentrations of chemical substances detected in former residential wells are significantly lower than the levels detected in SW-3. Therefore, while the calculated cancer risks suggest that remedial strategies may be appropriate for off-site ground water, there is no significant health risk to residents based on current ground water usage patterns.

The calculated RME HI for the adolescent exposed to off-site spring water is 0.03, and the calculated RME cancer risk is 3.0E-07. Since the RME HI is less than 1, and the cancer risk is less than 1E-06, it is concluded that chemical substances detected in off-site springs do not represent a significant chronic health risk to recreators who may be active in the vicinity of the springs.

Area D - Area D represents a DNAPL layer located in the southern portion of the facility. Historical releases of PCB oil in the plant have resulted in a PCB and chlorinated VOC DNAPL located approximately 25 ft. below land surface.. It is highly unlikely that workers would excavate soils to 25 ft. bls. Therefore, the direct contact with DNAPL exposure pathway is incomplete. DNAPL acts as a source of dissolved chemical substances to ground water. The potential health risks associated with dissolved chemical substances were quantified as part of the Area C evaluation.

Area E - Area E represents shallow bedrock ground water at the southern portion of the site. Chlorinated VOC's and PCBs were detected in shallow bedrock ground water at Area E. Workers are not expected to contact ground water in the shallow bedrock unit. Therefore, the direct contact with shallow bedrock ground water exposure pathway is incomplete. COPCs in Area E may migrate to off-site locations via ground water transport. The detected COPCs in ground water at off-site areas were evaluated as part of the Area C evaluation.

Area F - Area F represents the leach field located in the southwestern portion of the site. Waste water from the facility was discharged to the leachfield prior to construction of the plant site wastewater treatment facility in 1976. PCBs were identified as COPCs sub-surface soil at the Area F. Workers engaged in soil excavation activities in this area may contact COPCs in sub-surface soils. The calculated RME cancer risk for the on-site worker is 6.0E-06. Since the cancer risk is within the USEPA's acceptable range of 1.0E-04 to 1.0E-06 set forth in the National Contingency Plan, it is concluded that chemical substances detected at source Area F do not represent a significant chronic health risk to workers at the site.

Area G - Area G represents the active and inactive storm sewers at the facility. COPCs were detected in water collected from the inactive sewers. The water in the inactive sewers results from infiltration of shallow ground water to the sewer. Chemical residues in the sewers may dissolve in the water which may periodically leak to ground water depending on the ground water elevation. As such, the inactive sewers may act as a source of COPCs to ground water. Therefore, the COPCs detected in the inactive sewers are considered to be representative of shallow ground water at the site, and the direct contact with ground water pathway for Area G is classified as complete. The calculated RME HI for the on-site worker is 0.006, and the cancer risk for the on-site worker is 8.9E-05. Since the HI is less than 1 and the cancer risk is within the USEPA's acceptable range of 1.0E-04 to 1.0E-06 set forth in the National Contingency Plan, it is concluded that chemical substances detected at source Area G do not represent significant chronic health risk to workers at the site.

1. Introduction

1.1. General

This remedial investigation (RI) report has been developed by O'Brien & Gere Engineers, Inc. (O'Brien & Gere) on behalf of the General Electric Company (GE). The RI was conducted pursuant to Order on Consent #A5-0316-94-06 between the State of New York Department of Environmental Conservation (NYSDEC) and GE. The RI was conducted in accordance with the Remedial Investigation/Feasibility Study Work Plan (Work Plan) prepared by O'Brien & Gere and dated April 1995 and attached to the Order on Consent.

The project study area is the GE Fort Edward Plant located approximately 800 feet east of the Hudson River between the Villages of Hudson Falls to the north, and Fort Edward to the south. The facility is approximately 32 acres and bounded on the east by Broadway, on the south by Park Avenue and by the Delaware & Hudson Railroad/Allen Street on the west as shown on Figure 1-1. As shown on Figure 1-2, an approximately 200 foot wide parcel located between Allen Street and the Hudson River is also owned by GE and is part of the Fort Edward Plant site.

1.2. Project objectives

During the past two decades, GE, in consultation with the NYSDEC and the New York State Department of Health (NYSDOH), has sought to address environmental issues at the Fort Edward facility. The objective of this comprehensive RI report is to integrate the current and historical investigation results into a comprehensive report. Specifically, the objectives of the RI are to evaluate impacts, if any, of chemical substances that may have previously migrated off-site, on human health and the environment; determining if contamination continues to migrate off-site; implementing interim remedial measures (IRMs) as necessary; gathering engineering data required to perform a feasibility study; and to satisfy any corrective action obligations pursuant to the Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act and the Hazardous and Solid Waste Amendments and the New York ECL Article 27, Title 9.

1.3. Project scope

The scope of work at the site was based on the remedial investigation objectives and understanding of site conditions. The RI scope of work was detailed in the RI/FS Work Plan dated April 1995 (O'Brien & Gere 1995). A supplemental RI scope of work was prepared and submitted to the NYSDEC on March 19, 1996 and approved on April 9, 1996.

Prior to initiation of the field investigation program, a detailed sampling and analysis plan (SAP) was submitted to NYSDEC for review and approval prior to implementation. The SAP included a Field Sampling Plan (FSP) submitted on August 9, 1995 and approved on August 14, 1995, and Quality Assurance Project Plan (QAPP) submitted on August 9, 1995 and approved on August 14, 1995. A site-specific Field Health and Safety Plan (FHSP) was also prepared in October 1994, to address issues relating to worker health and safety during implementation of the RI.

1.3.1. Initial scope

The original scope of the RI was detailed in the NYSDEC approved RI/FS Work Plan. The original scope of work included the following items outlined below. A complete description of the field investigation methodology is included as Section 3.

- Compilation of historical site environmental information; including information on buildings, underground tank, utilities, known past and present solid or hazardous waste treatment or disposal areas.

- Implementation of the residential well sampling program consisting of the following:

  - identification of residential and commercial wells within the study area that were used as a drinking water source;

  - collection and analysis of samples from identified wells; and

  - connection, at GE's expense, of residences and businesses sampled to the available public water supply at GE's expense, which the state and local health officials believe is the best, most reliable long-term source of drinking water.

- Deep bedrock evaluation consisting of the following:
  - integrity assessment of former production wells (PW-1 and PW-2) well seals;
  - geophysical logging of PW-1;
  - decommissioning PW-1 and PW-2;
  - drilling new deep bedrock corehole;
  - packer testing, ground water sampling and analysis; and
  - installation of deep bedrock monitoring well.
- Shallow bedrock investigation including bedrock fracture trace analysis, bedrock drilling and monitoring well installation, well development and water level measurements, monitoring well sampling and analysis.
- Expanded shallow unconsolidated aquifer study consisting of the following:
  - soil gas sampling and analysis;
  - ground water level measurements;
  - inspection and sampling of site sewers;
  - soil borings and soil sampling;
  - installation of new monitoring wells; and,
  - monitoring well sampling and analysis.
- A Dense Non-Aqueous Phase Liquid (DNAPL) investigation completely characterizing the extent of subsurface DNAPL at the Fort Edward facility. The DNAPL investigation included the drilling and subsurface sampling of 70 soil borings and two DNAPL observation wells.

1.3.2. Supplemental RI scope

A supplemental RI technical scope of work was prepared and submitted to NYSDEC in March of 1996. The objective of the supplementary scope of work was to complete the collection of engineering data necessary to perform the feasibility study of remedial alternatives. The scope of work for the supplemental RI included the following activities.

- Collecting four ground water samples from well GM-11D from the following intervals 13.8-20 feet, 28.8-45 feet, 43.8 to 60 feet and 58.8-70 feet. Samples from each interval were analyzed for VOCs and PCBs.

- Drilling and installation of ten additional bedrock monitoring wells. The new wells included four bedrock well pairs consisting of shallow and intermediate bedrock wells. One new deep bedrock well drilled at the location of OBG-42BS and one intermediate well installed at well pair OBG-46 near the equalization basin.

- Available public records were reviewed to determine if new potable water sources have been activated within this study area. New sources of potable water were sampled for PCBs and VOCs along with the residences that have not been connected to the public water supply. Additionally, connection to the public water main were also offered to residents at no charge.

- The shallow unconsolidated aquifer study was expanded to include the drilling and installation of seven wells in the transition zone between the glacio-lacustrine clay and the overlying glacio-deltaic sand deposit. Following installation and development, the wells were sampled and analyzed for VOCs and PCBs.

- In-situ hydraulic conductivity tests were performed on each new monitoring well to determine the hydraulic conductivity of the screened interval. These tests involve observing the recovery of water levels toward an equilibrium level after an initial perturbation. Detailed procedures are outlined in Section 3.

- Following installation of the new bedrock, shallow unconsolidated unit and transition zone monitoring wells, the new and pre-existing wells were sampled. The samples were analyzed for volatile organic compounds by USEPA Test Method 624 and PCBs by USEPA Test Method 608. All wells were sampled in accordance with the procedures outlined in Section 3 of this report and were analyzed in accordance with the procedures outlined in the NYSDEC-approved Quality Assurance Project Plan developed for this project.

A detailed hydraulic monitoring program was conducted to assess the hydraulic effects of pumping bedrock recovery wells GM-8DR and GM-11D on the surrounding bedrock and unconsolidated hydrogeologic units. The detailed hydraulic monitoring program included the collection of manual water levels in the two recovery wells and 14 monitoring wells for a 15 day period. In addition, continuous water level monitoring was performed during the same period in 13 wells.

A dye tracer test was performed to assist in determining if overburden ground water and a previously abandoned sewer are sources of recharge to the shallow and intermediate bedrock. The dye tracer study was performed by injecting a fluorescent dye into an abandoned sewer at manhole #27 and monitoring the discharge from bedrock recovery wells GM-8DR and GM-11D for indications of dye twice daily for one week and then daily for an additional one week.

1.4. Report organization

Section 1 outlines the initiation, objectives and scope of the project. Section 2 discusses the facility background, including a summary of previous investigations and compilation of historical data.

Field methodologies associated with monitoring well installation, surveying, water level monitoring, ground water sampling, hydraulic conductivity testing, soil borings, and Non-Aqueous Phase Liquid (NAPL) field screening procedures and dye testing are described in Section 3.

Section 4 presents regional and site-specific geologic information and provides the framework for Section 5 which details hydrogeologic conditions. Section 6 discusses the nature and extent of contamination at the site. Section 7 presents the methodology and results of the risk assessment. Sections 8 and 9 present the remedial investigation conclusions and recommendations.

2. Background

2.1. General

Present facilities at the Fort Edward plant consist of seven permanent buildings, including the main manufacturing building and former aluminum foil rolling mill, an industrial wastewater collection and treatment facility, aboveground bulk storage tanks, and several parking areas. Other structures on the site include a pump house, a maintenance building, a 6 NYCRR Part 373 permitted hazardous waste storage area and a chemical storage building.

The main manufacturing building, the largest building at the Fort Edward facility, is comprised of several joined structures which were constructed over a span of 25 years. For purposes of this report, the main building is divided into four sections as follows:

- original manufacturing building (Bldg. 23),
- addition to manufacturing building (Bldg. 25),
- warehouse (Bldg. 26), and
- capacitor plant expansion (Bldg. 27)

The original manufacturing building was constructed in 1942 by the U.S. government as an aircraft turret plant. Between 1942 and 1946, the building was leased by GE from the U.S. government and used for the manufacture of Selsyn motors. Production turned to the manufacture of small component capacitors after World War II.

Originally, above ground process tanks associated with the storage, refining, and distribution of capacitor fluids were located outside the boiler room in a gravel-covered area. Off-loading of these dielectric fluids from rail cars took place along the north side of the building where a Delaware & Hudson rail spur terminated. Two metal-sided Butler buildings were erected on-site to the west of the main building in the 1950s. In 1959, the original building was expanded to the west. The expansion included erection of a 18,520 square ft steel-frame building and modifications to the storage tank area. The tank farm area was enclosed and the tanks elevated and placed on a concrete slab floor.

Two significant building additions were completed in 1966. To the north, a 97,500 square ft addition (Bldg. 27) was constructed to house GE's film manufacturing operations, which were being relocated from the GE Hudson Falls plant. The tank car off-load area was relocated to the west and the original rail spur shortened. The building was constructed of metal with a concrete slab foundation. In addition, a warehouse (Bldg. 26) was added to the west side of Building 25 in 1966, replacing the two Butler buildings. (The Butler buildings were disassembled and resurrected at the GE Hudson Falls plant site.) Building 26 is similar to Building 27 in construction, and is 18,900 square feet in size. Building 26 itself was subsequently expanded in 1973 to include a loading dock (Bldg. 29) and waste storage building (Bldg. 31).

The aluminum rolling mill or Foil Mill building (Bldg. 40) occupies the northwest portion of the site. The approximately 94,100 square ft building was constructed in phases over a 15 year period beginning in 1960. Prior to 1960, the land was owned by Washington County and was used as a county fairgrounds. The Foil Mill has been expanded several times since its original construction.

The original section of the Foil Mill housed the aluminum rolling mills, a motor room, and filter room. In 1963, the Foil Mill was expanded to the east and in 1967, a warehouse area was constructed to the south of the original structure. The most recent additions to the Foil Mill were completed in 1973 with the addition of a large melt furnace/slug mill operation to the north and a building housing a sixth rolling mill and motor room to the west. Beneath the rolling mills, cut into the concrete slab, a series of trenches were constructed to convey lubricating fluids (kerosene, mineral oil, Norpar) between the mills and the filter rooms. In December 1993, these trenches and associated process tanks were inspected to assess their integrity (O'Brien & Gere March 1994a). Except for some minor spalling of the concrete and external corrosion of one of the process tanks, no major problems were observed. Recently, the rolling mills and associated system of trenches were decommissioned. The trenches and subgrade tanks used for water and lubricant storage were cleaned and filled with concrete.

Prior to 1976, untreated industrial wastewater and stormwater were discharged through a 30 inch outfall pipe to the Hudson River. As part of the 1976 PCB Abatement Project, industrial wastewater was redirected to a new wastewater treatment plant. The original treatment system included a concrete equalization basin and a Calgon activated carbon treatment plant. In 1978, the system was upgraded by the replacement of the Calgon unit with a carbon system manufactured by Westvaco.

The industrial wastewater treatment plant (IWWTP) at the Fort Edward facility treats effluent from the on-site sanitary waste water treatment plant and other waste waters (*i.e.*, ground water, industrial waste water, stormwater) generated at the facility. Effluent from the treatment plant is currently discharged to the Hudson River through a SPDES permitted outfall (Outfall 004). The industrial waste water treatment plant facilitates removal of PCBs and other chemical substances from influent streams prior to discharging to the Hudson River.

Treatment provided by the IWWTP consists of equalization, coagulation and filtration, and granular activated carbon adsorption. The 1.73 million gallon, concrete, in-ground, equalization basin receives combined waste water flows from the facility. Multi-media filters and a pulsed-bed carbon column are located within the treatment plant building. A NYSDEC-approved polymer is injected at the beginning of the feed line to the multi-media filters, with mixing provided by an in-line static mixer. A 40,000 pound, pulsed-bed, granular activated carbon column receives effluent from the filters.

Since 1992, several upgrades to the IWWTP have been implemented to reduce effluent loadings to the Hudson River. In August 1992, an in-line coagulation system utilizing existing multimedia pressure filters was installed in the liquid treatment train at the IWWTP. To further reduce mass loadings to the Hudson River, an effluent recycling system was installed to provide water for backwash of the multimedia filters in lieu of the municipal water supply system.

Between March 1993 and March 1994, a solids handling train was designed, constructed and initiated. The purpose of this system is to capture filtered solids and to remove accumulated solids from the equalization basin and process them for disposal.

2.2. Summary of previous investigation

Several subsurface hydrogeologic investigations have been performed in the vicinity of the Fort Edward plant site. Over the last twenty years, the following environmental consulting firms have performed worked at the site: Dames & Moore, Geraghty & Miller, Lawler, Matusky & Skelly Engineers, Dunn Geoscience, and O'Brien & Gere.

This section summarizes the results of previous hydrogeologic investigations. A more detailed summary of historical environmental data and previous remedial actions is contained in a separate report entitled "Historical Environmental Data Compilation for GE Fort Edward Plant" (O'Brien & Gere 1996). A copy of the report is included as Appendix A.

Dames & Moore (1976) Initial investigations of ground water conditions at the GE Fort Edward plant were conducted in 1976. An investigation of geohydrologic conditions related to the planned construction of the impounding basin at the Fort Edward plant was undertaken by Dames & Moore (Dames & Moore 1976a). Two principal water bearing units - consolidated bedrock and unconsolidated sand, gravel, silt and clay deposits - were identified. The shallow aquifer at the site was identified as a "sand zone varying in thickness from about five feet to about 33 ft, that is underlain by impermeable varved clay, and/or till" (Dames & Moore 1976b).

A ground water divide was identified near Building 40 with a small portion of ground water flow to the west and the majority merging to the east and southeast leaving the plant in the vicinity of Park Avenue. The deep aquifer at the plant was reported to consist of consolidated bedrock consisting of shale and limestone. During drilling of test borings, bedrock was encountered at depths of 10 to 25 feet with static ground water levels in piezometers installed about the same as water levels observed in the overlying shallow sand aquifer.

PCBs were found in ground water from both the shallow aquifer and at deep bedrock. Concentrations of PCBs in the deep bedrock were reported at approximately 3 to 26 μg/L with concentrations in shallow wells generally less than 5 to 10 μg/L.

Geraghty & Miller (1982-83) In 1982, Geraghty & Miller was retained to conduct a hydrogeologic evaluation following the discovery of kerosene in a sewer manhole at the Fort Edward plant. As part of the investigation, 24 monitoring wells were installed in the shallow sand aquifer to define ground water flow and quality. Additionally, well GM-12D was drilled into the shallow bedrock to obtain ground water quality and water levels in the upper zone of the bedrock aquifer.

The evaluation confirmed the presence of kerosene in an isolated area near the Foil Mill. In addition, the study identified a narrow plume of dissolved organic chemicals in the southern portion of the plant. The results of the

Geraghty & Miller study are presented in a report entitled "Hydrogeology of the General Electric Company Capacitor Plant" (Geraghty & Miller 1983).

Lawler, Matusky and Skelly (1985) Pursuant to Administrative Order on Consent #T032785 between NYSDEC and GE, a revised RI report was prepared by LMS (LMS 1985) and submitted to the NYSDEC. As described in the report, several remedial actions had been implemented at the site to remove known sources of kerosene. With respect to PCBs, the report indicated that PCB concentrations in water in the shallow aquifer on the western portion of the plant site were generally below detection limits.

As reported in the 1985 RI report (LMS 1985), two former on-site production wells (PW-1 and PW-2) were sampled and analyzed for PCBs and VOCs. Concentrations of PCBs as high as 33,000 μg/L and total VOCs of 4,000 μg/L were detected in PW-1. Based on the available data, it was concluded that PCBs and VOCs detected in the wells were the results of leakage in the immediate vicinity of the wells. The two on-site production wells were each sealed with a wood/rubber packer and bentonite to prevent contaminants from entering the deep aquifer.

As part of the RI, concentrations of VOCs and PCBs in the shallow aquifer were identified in the southwestern portion of the site. South of the plant site, a ground water plume that discharges at a series of springs southwest of the site was identified. Based primarily on residential well sampling and samples collected from six off-site monitoring wells installed by the NYSDEC, the horizontal extent of VOCs and PCBs in the shallow ground water was defined. Following documentation of on-site and off-site ground water conditions at and in the vicinity of the GE Fort Edward plant, on-site and off-site feasibility studies of remedial alternatives were undertaken. (The revised off-site feasibility study report was completed in January 1988 [LMS 1988a]; the on-site feasibility study report was completed in May 1989 [LMS 1989]).

Lawler, Matusky and Skelly (1987-88) In May 1987, Geraghty & Miller collected soil samples for PCB analysis from soil borings drilled near the former PCB unloading area (located in the area immediately north of Building 26) and from soil borings in the former leach field. Based on the subsequent analytical results, LMS was retained by GE to perform supplemental investigations to further delineate the extent of PCB contaminated soils in both the former PCB unloading area and the former leach field.

The results of soil sampling performed in the vicinity of the former PCB unloading area indicated that PCB contamination was confined to the corner of Buildings 25, 26 and 27. The results of soil sampling in the former leach field indicated that PCB contamination appeared to be limited to a few of the seepage boxes themselves or to seepage areas around the boxes (LMS 1988).

In addition, three test pits were dug adjacent to abandoned sewer lines that may have carried PCB-contaminated wastes. Samples collected from these test pits revealed no PCB contamination. However, at one test pit location (along the south side of the Foil Mill), LMS indicated that ground water encountered had an oily sheen and emitted a strong kerosene odor.

Geraghty & Miller (1987-88) Geraghty & Miller was retained in 1987 to conduct a hydrogeologic investigation to re-evaluate ground water flow and quality in the upper zone of the bedrock aquifer. Geraghty & Miller conducted a three-phased investigation comprised of deepening two existing bedrock wells, installing a new bedrock well, and collecting ground water samples from the six bedrock wells.

Historically, well GM-8D(R) has exhibited the highest concentration of PCBs of the six shale bedrock monitoring wells. Concentrations of PCBs and VOCs in bedrock have historically been detected primarily in wells GM-8D(R) and GM-11D. Based on the water quality, wells GM-8D(R) and GM-11D were converted to shallow bedrock ground water recovery wells in 1988.

Dunn Geoscience (1990) In March 1990, an evaluation of on-site hydrogeologic conditions and the efficiency of existing recovery well RW-1A was conducted. The results of the study indicated that pumping of RW-1A had not effectively dewatered the shallow sand deposits at the site (Dunn 1990a). In addition, it was concluded that the limited saturated thickness, limited drawdown, overpumpage and well construction materials resulted in biofouling problems with RW-1A, ultimately compromising the efficiency and effectiveness of the recovery system. A multiple recovery well system was recommended to maximize contaminant plume capture and to limit well drawdowns to a maximum of approximately four feet.

In April 1990, Dunn installed a monitoring well (DGC-41) between recovery well RW-1A and existing well GM-16 in support of remedial design efforts. DNAPL (later identified as PCB oil) was observed in purge water during well development activities. During June 1990, a supplemental hydrogeologic investigation was conducted which included installation of 24 test borings in the southern portion of the plant. The purpose of the supplemental investigation was to assess the extent of subsurface DNAPL in the parking lot area. Results of the test boring program indicated that subsurface DNAPL were present in relatively small areas in and around monitoring wells GM-27 and DGC-41. Two DNAPL recovery wells (ORW-1 and ORW-2) were subsequently constructed adjacent to these wells.

Dames & Moore (1993-94) In November 1993, NYSDEC and GE collected soil and water samples from several locations near the plant outfall (Outfall 004) for PCB analysis and petroleum identification. PCB concentrations in soil near the outfall ranged from 148 to 5,571 mg/kg. In June 1994, under Consent Order #A5-0313-93-12, Dames & Moore collected an additional 49 soil samples along the river bank for PCBs and selected sample analysis for TPH, petroleum identification and congener-specific PCBs. As reported in their "Outfall 004 Investigation Report" (Dames & Moore 1994b), concentrations of PCBs in the soil samples ranged from 0.5 mg/kg to 44,800 mg/kg .

O'Brien & Gere (1995) An additional subsurface investigation was performed by O'Brien & Gere in the vicinity of the former Outfall 004 pipeline to collect information regarding hydrogeologic conditions and the distribution of PCBs in the unimproved parcel owned by GE between Lower Allen Street and the top of the Hudson River bank.

The 004 subsurface investigation involved the installation of 25 soil borings and nine monitoring wells in the vicinity of the former Outfall 004 pipeline and the sampling and analysis of soil and ground water for PCBs. The results of soil sampling indicated PCB concentrations as high as 20,000 mg/kg. The highest PCB concentrations were measured in samples of pipe bedding material and undisturbed soil beneath the 30-inch pipeline while the fill material above the top of the pipe was generally clean. PCBs were also detected in samples of till obtained 10 to 14 ft north and south of MH-2. Soil samples collected approximately 40 ft north and south of manhole MH-2 did not contain significant concentrations of PCB.

Results of ground water sampling indicated concentrations of PCBs between 0.553 and 110 μg/L in ground water within the former Outfall 004 pipeline trench; ground water outside the trench was relatively unimpacted. This was consistent with results of previous seep sampling and analysis conducted in 1994 by Dames & Moore and indicates that the most probable source of PCB contamination in the seeps observed at the top of the bank was contaminated bedding materials and soils associated with the former Outfall 004 pipeline.

Shallow bedrock well OBG-48BS and deep bedrock well OBG-44BD (both outside the estimated trench boundary) also contained low levels of PCB (3.6 and 0.097 μg/L, respectively) indicating that a pathway may exist for PCBs migration to the bedrock from upper zones and that contaminated bedding materials are a likely source of PCBs detected in bedrock ground water.

The extent of impacted soils and ground water appeared to be limited to a narrow conduit formed by the former Outfall 004 pipeline trench. As part of the comprehensive remedial investigation at the site, additional ground water monitoring well installation and sampling is being conducted by O'Brien & Gere. Results of the RI are presented in subsequent sections of this RI summary report.

2.3. Compilation of historical data

As mentioned, a report summarizing historic environmental information and data for the GE Fort Edward Plant (O'Brien & Gere 1996) is included as Appendix A. The report summarizes information on buildings, underground storage tanks, industrial sewer system and other underground utilities, and known past and present solid or hazardous waste treatment or disposal areas. Information on the nature and extent of subsurface contaminants at the plant is assembled along with available geological and hydrogeological information for the site. Remedial measures undertaken at and in the vicinity of the plant are also documented.

3. Field investigation methodology

3.1. General

This section describes in detail the procedures employed for performing the tasks associated with the RI scope of work presented in the RI/FS Work Plan and the supplemental RI scope of work. All field activities were performed in accordance with the procedures provided in the NYSDEC-approved Remedial Investigation Field Sampling Plan (O'Brien & Gere, August 9, 1995, as revised).

3.2. Deep bedrock ground water evaluation

Evaluation of deep bedrock ground water conditions was performed to address concerns that former production wells PW-1 and PW-2 may have facilitated the downward migration of PCBs from the overburden into the deep bedrock at the site. The initial evaluation was performed in accordance with O'Brien & Gere's technical proposal dated October 5, 1994 and approved by NYSDEC in a letter dated October 12, 1994. The objective of the initial evaluation was to assess the integrity of the "temporary" well seals installed in the upper portion of the two boreholes in June 1983 and identification of potential deep bedrock ground water discharge zones. This initial evaluation was expanded to include geophysical logging of the former production well PW-1 borehole.

Based on the results of the geophysical logging of PW-1 and indications of accumulated sediment in the bottom of the borehole, another expansion of the deep bedrock ground water evaluation was proposed. The details of this work scope was presented in the NYSDEC-approved Deep Bedrock Ground Water Evaluation Work Plan. This work plan was submitted to NYSDEC and approved on March 10, 1995. The objective of this work scope was to visually inspect the PW-1 and PW-2 boreholes, to permanently decommission former production wells PW-1 and PW-2 and to test deep bedrock ground water quality at the Fort Edward Plant.

3.2.1. Former production well evaluation

3.2.1.1. Integrity assessment of former production well seals

During the period from October 13 to 18, 1994, an integrity assessment of the temporary well seals consisting of the following was performed:

- A visual inspection of the upper portion of the bedrock borehole and seals using borehole televising techniques.
- Hydraulic testing of the seals.

The visual inspection focused on determining whether or not visible contamination was entering the borehole and possibly collecting at the top of the seals. In addition, the top of the seal was visually inspected to identify cracks, if present, or other conduits in the seals. No visible contamination or significant cracks were identified.

The hydraulic testing of the seals was performed by adding approximately 5-feet of potable water to the PW-1 and PW-2 boreholes above the seals and monitoring the water levels for 24-hours. Following an initial period of hydration, water level measurements indicated that the seals were intact with no measurable leakage through the seals.

3.2.1.2. Geophysical logging of deep production well PW-1

To assist in determining the nature of bedrock at the site, geophysical logging of the former production well PW-1 was performed between February 6 and 8, 1995. In addition, geophysical logging of monitoring wells GM-40D and OBG-44BD was performed. The borehole geophysical logging was performed by Mid-Hudson Geosciences of New Paltz, New York.

The following borehole geophysical methods were utilized to determine the nature of the bedrock at the site:

- Natural gamma logging;
- EM-39 conductivity logging;
- Single point resistivity log;

- Fluid resistivity log;
- Temperature log;
- Spontaneous potential log; and
- Caliper log.

Monitoring well GM-40D was logged from the top of the 8-inch inside diameter (ID) steel casing (i.e., measuring point) to the bottom of its borehole at a depth of approximately 180 feet. All log depths were recorded relative to the measuring point. The fluid resistivity and ground water temperature logs for well GM-40D are valid below the water table which was recorded at approximately 82 feet below the measuring point. The caliper, spontaneous potential, resistivity and conductivity logs for well GM-40D are valid below the steel casing which reportedly extends to a depth of 109 feet below grade. The natural gamma and single point resistivity logs are valid from the bottom of the borehole to ground surface.

Monitoring well OBG-44BD was logged from the top of the 2-inch ID (i.e., measuring point) PVC riser pipe to the bottom of the well screen at a depth of approximately 139 feet below the measuring point. All log depths were recorded relative to the measuring point. The resistivity and conductivity logs for well OBG-44BD are valid below the steel casing which reportedly extends to a depth of 87 feet below grade. The natural gamma log is valid from the bottom of the well screen to ground surface.

Former production well PW-1 was logged from the top of the 2.25-inch ID steel support pipe for the temporary well seal, to the bottom of its borehole at a depth of approximately 585 feet below the top of the steel pipe. All log depths were recorded relative to the top of the steel support pipe. The fluid resistivity and ground water temperature logs for well PW-1 are valid below the water table which was recorded at approximately 91 feet below the top of the steel pipe. The caliper, spontaneous potential, resistivity and conductivity logs for well PW-1 are valid below the bottom of the steel support pipe starting at approximately 34 feet. The natural gamma and single point resistivity logs are valid from the bottom of the borehole to ground surface. The induction tool (i.e., resistivity and conductivity) was flooded at 400 feet, therefore, no valid measurements were recorded below that depth.

Each well was logged at a speed of approximately 10 feet per minute. Fluid resistivity and ground water temperature were logged first before the standing water in the borehole was disturbed and all caliper logs were run from the bottom of the borehole to the top.

The results of the geophysical logging, in particular, the nature of the bedrock at the site, will be discussed in Section 4. Detailed information is presented on the geophysical logs in Appendix B.

3.2.1.3. Video inspection of former production wells PW-1 and PW-2

To assist in determining the nature of the bedrock and former production wells PW-1 and PW-2 boreholes, video logging was performed by O'Brien & Gere during the period from April 12 to 14, 1995. Access to the borehole in order to perform the video logging was performed through the 2.25-inch ID steel support pipe.

The borehole video logging was performed using a GeoVision Micro^{TM} Model #GVMICROM1 video system manufactured by Marks Products, Inc. The video system consists of a high resolution color camera mounted inside a 11/8-inch outside diameter (OD) x 13-inch stainless steel water proof housing equipped with a single bulb out-front light source. The video signal was viewed on a portable color television and recorded on VCR tape. In addition, the video system provides an optical encoded footage counter which displays depth to the nearest foot.

A brief discussion of the results of the video survey are as follows.

- Former production well PW-1 consists of open borehole from approximately 26 feet BG to approximately 568 feet BG. The interval from approximately 26 to 35 feet BG consists of open borehole within the glacio-lacustrine silt and clay unit. The interval from approximately 35 to 37 feet BG appears to consist of glacial till with an open bedrock borehole extending from 37 feet to 568 feet BG. In addition, the video logging indicates potential migration of contaminants into the borehole originating from the glacial till layer. At 568 feet the borehole is obstructed by what appears to be two pieces of U-shaped metallic bars which are lodged against the side of the borehole. Attempts to dislodge these bars were unsuccessful and the nature of the borehole below this depth is unknown. Additionally, several feet of bacteria growth has accumulated on the bottom of the borehole obscuring the view beyond the obstruction.

- Former production well PW-2 consists of open borehole from approximately 45 feet BG to approximately 572.5 feet BG. The borehole walls exhibit significant growth of iron bacteria, therefore, it was difficult to assess the nature of the bedrock. However, no significant voids or fractures were observed and the sides of the borehole appeared to be relatively smooth. In addition, several feet of bacteria growth has accumulated on the bottom of the borehole, although, total depth soundings of the borehole indicate that there does not appear to be a build-up of sediment in the bottom of the borehole.

3.2.1.4. Decommissioning of former production wells PW-1 and PW-2

Former production wells PW-1 and PW-2 were permanently decommissioned during the period from June 27 to July 6, 1995 by sealing the entire length of each borehole with a combination of cement-bentonite grout and bentonite chips. Well decommissioning activities were performed by Parratt-Wolff, Inc. of East Syracuse, New York. Well decommissioning activities were supervised by O'Brien & Gere personnel.

Decommissioning activities were performed by tremi-grouting from the bottom of the borehole, forcing borehole fluids upward. The grout was placed into the borehole through the inside of the 2.25-inch ID support pipe. At the conclusion of the borehole grouting program each of the temporary well seals were grouted in place within the upper portion of each of the boreholes.

Former production well PW-1 is a 10-inch diameter well open to a measured depth of 587 feet BG. A total of 2,190 gallons of grout was used to seal the entire length of the borehole. Due to the loss of grout to the formation and fractures intersecting the borehole, 65 bags of bentonite chips were added to the borehole in the interval from 547 to approximately 480 feet below grade in order to seal the borehole, thus reducing the loss of grout.

Former production well PW-2 is a 15-inch diameter well open to a measured depth of 573 feet BG. A total of 5,060 gallons of grout was used to seal the entire length of the borehole.

The ground water displaced from each of the boreholes during grouting activities was containerized in a temporary storage tank. This ground water was characterized and, after receiving approval by NYSDEC's Division of Water, was discharged to the on-site equalization basin for subsequent treatment at the Fort Edward Plant waste water treatment facility.

3.2.2. Deep bedrock monitoring well installation

3.2.2.1. Drilling program

Drilling equipment for the deep bedrock monitoring well installation was mobilized to the GE Fort Edward plant on May 1, 1995. Drilling and well installation activities were performed by Hydro Group, Inc. (Hydro Group) of Schoharie, New York. Drilling of the new deep bedrock borehole commenced on May 2, 1995 utilizing a Gus Pech 1000 rotary drilling rig.

Overburden drilling was performed utilizing mud rotary techniques. The boring was advanced through the overburden materials to the top bedrock using a 12¼-inch diameter tricone drill. Based on examinations of the drilling materials, the top of bedrock was estimated at 26.0 feet below grade. The boring was then advanced to 30.3 feet below grade, creating a 4.3 feet rock socket.

When the borehole was free of drill cuttings, the drill stem and bit were removed so that a permanent overburden casing could be installed. An 8-inch diameter steel casing was permanently installed and grouted in place to 29.5 feet below grade.

Rock coring

Following installation of the overburden casing, rock coring activities commenced . Rock coring was performed using conventional wireline coring methods incorporating an HQ core barrel equipped with a diamond impregnated core bit. Each rock core run was approximately ten feet in length and was timed from start to finish. A temporary re-circulation tank was used to contain the drilling fluids during the coring activities. Observations regarding the time for each core run to proceed as well as the circulation of the drilling fluid were recorded in the field notes. At the conclusion of each core run, the core barrel was retrieved and carefully opened. The rock core was immediately screened with an HNU photoionization detector (PID) and was checked for odors. Cores were carefully measured before being placed in wooden rock core storage boxes, and then the boxes were labeled with the following information: project name and number, boring designation, date, run number, depth of run, penetration rate, length of recovery, and Rock Quality Designation (RQD).

Reaming

Rock coring activities continued to a depth of approximately 280 feet below grade. After concluding the packer testing activities in the upper 280 feet, the corehole was then reamed out to 7⅞-inch diameter using a tricone roller bit. The corehole was reamed out to approximately 280 ft bg to accommodate installing a 5-inch diameter steel casing. The casing was then grouted in place and the grout was allowed to cure before continuing with coring activities. The corehole was also reamed after coring to 430 ft bg and again when the base of the corehole was reached at 600 ft bg to accommodate the larger diameter packers which were used during the packer testing.

3.2.2.2. Packer testing program

In order to more fully define zones of groundwater movement, packer testing of discrete intervals was performed and hydraulic data collected. A total of seven discrete zones were packed off tested and sampled. The packer testing was performed by isolating each discrete interval with a double packer assembly. Two neoprene/rubber inflatable packers were separated by a perforated conductor pipe which permitted water to be pumped from the isolated zone between the two packers. A pneumatic bladder pump and a Grundfos Redi-Flo 2 submersible pump were utilized to pump water from the isolated zone. Packer testing was performed at two intervals within the lower portion of the Snake Hill Shale, at three intervals within the Glens Falls Limestone and at three intervals within the Beekmantown Group. Table 3-1 details the depth and designation of each packed off interval.

Table 3-1. *Deep bedrock installation of OBG-26BD.*

Date	Zone Designation	Zone Depth (ft bgs)	Rock Type	Ground Water Sample Collection
5/17/95	Zone A	221-271'	Upper and Middle Snake Hill Shale	PCBs, VOCs
5/17/95	Zone B	170-220'	Upper Snake Hill Shale	PCBs, VOCs
6/21/95	Zone C	375-420'	Lower Snake Hill Shale	PCBs, VOCs
6/21/95	Zone E	290-335'	Lower Snake Hill Shale	PCBs, VOCs
7/14/95	Zone F	545-595'	Isle LaMotte/ Beekmantown	PCBs, VOCs
7/14/95	Zone G	485-535'	Glens Falls/ Isle LaMotte	PCBs, VOCs
7/17/95	Zone H	425-475'	Glens Falls L.S.	PCBs, VOCs

* Zone D was omitted due to leaky packer assembly.
Source: O'Brien & Gere Engineers, Inc.

In the packer testing zones C, E, F, G, and H, pressure transducers were placed above and within the test zone to measure hydraulic head. In addition, hand measurements were collected periodically throughout the testing period with an electronic water level meter.

Ground water sampling

At the conclusion of the packer testing, each discrete interval was sampled after pumping a minimum of one volume from the test zone. Ground water samples were analyzed for VOCs by USEPA Method 8240, and total and filtered PCBs by USEPA Method 8080. In addition, samples from zones B, C, and G were collected and analyzed for the following inorganic parameters: Alkalinity (carbonate/bicarbonate), Ca, Mg, K, Na, Fe, Mn, Chlorides, Sulfates, Nitrites, and Total Dissolved Solids (TDS).

3.2.2.3. Monitoring well installation

Following the completion of packer testing/ground water sampling, borehole OBG-26BD was permanently converted into a monitoring well. Based on the results of the analytical sampling, the hydraulic data, and the inspection of the cores, the monitoring well was set to a total depth of 460 feet below grade. The monitoring well was constructed of 2-inch ID, flush-joint, Schedule 80 PVC riser pipe with a 30 foot section of 0.020-inch slot PVC well screen installed at the bottom of the monitoring well, resulting in a screened interval of 430 to 460 feet below grade. The original work plan specified installation of a 20 to 30 foot length of stainless-steel Channel Pack well screen, to be set at the appropriate depth (O'Brien & Gere 1995). A channel pack well screen consists of an inner and outer well screen prepacked with clean, uniform, silica well gravel sized such that 100% of the gravel pack is retained between the inner and outer screens.

On July 21, 1995, the first attempt at installing OBG-26BD began by setting the Channel Pack well screen and riser pipe to the total depth of 460 feet below grade. Two 5-inch outside-diameter (OD) rubber silt traps were installed on the PVC riser pipe approximately 2 and 3 feet above the top of the well screen to prevent cement grout from migrating into the screened interval. Approximately 2 feet of bentonite pellets and 10 feet of bentonite slurry were introduced into the annular space above the Channel Pack well screen. Approximately 100 gallons of a grout mixture was then prepared according to ASTM D5092-90 specifications and pumped into the annular space above the grout slurry via tremie pipe. When approximately 80 gallons of grout were in the borehole, water became displaced from the 2-inch PVC casing. Subsequently, a 1-inch disposable bailer was lowered into the 2-inch PVC casing to the bottom and when it returned, the bailer contained the cement grout. The monitoring well construction materials were subsequently removed from the borehole and the borehole was flushed with fresh water for approximately two hours to remove the 80 gallons of grout, the bentonite slurry and the bentonite pellets.

Hydro Group and O'Brien & Gere personnel returned to the site on Monday, July 24, 1995. The new total depth of the borehole measured 435.2 feet below grade, which was approximately 30 feet higher in depth than on July 21, 1996 prior to installing the well construction materials. This measurement was an indication that the grout had not been completely removed as was first thought on July 21, 1996 after two hours of flushing the borehole. The borehole was redrilled to a total depth of 467 feet utilizing a 4¾-inch tricone bit and utilizing rotary recirculation techniques.

Subsequent to redrilling, the borehole underwent a four-step acid treatment program. The acid treatment program involved injecting 30 gallons of muriatic acid at a strength of 20 degree Baume, allowing the acid to remain in the borehole overnight, pumping the residual acid solution out of the borehole, and flushing the borehole out with clean water to remove solids that precipitated from the acid solution. This four-step treatment program was performed twice on the borehole. The intention was to target the lowest 30 feet of the borehole to specifically remove grout that may have entered fractures which would prevent the fractures from yielding ground water.

After performing the acid treatments, the borehole underwent packer testing. Specifically, a rubber pneumatic packer was placed at 430 feet below grade to isolate and test the zone corresponding to the proposed screen setting for the monitoring well (430 to 460 ft). The results of the packer testing indicated that the zone had been neither permanently damaged nor incapable of yielding ground water. The borehole was then converted to a permanent monitoring well using a new PVC well screen and riser pipe.

Following a meeting with NYSDEC personnel, it was decided to reinstall a more conventional type of monitoring well (i.e., PVC well screen, sand pack, bentonite seal, etc.) rather than the stainless-steel Channel Pack well screen and silt traps.

When the packer testing of the screened interval was completed, the borehole was prepared for the monitoring well installation. The borehole was backfilled with #1 grade Morie Sand to approximately 460.5 feet. This depth allowed for the use of a 7-inch blank at the bottom of the well resulting in the bottom of the screened interval to be approximately 460 feet below grade.

When the 30 foot PVC well screen and associated riser pipe were lowered into the borehole, a sand pack consisting of #1 Morie sand was installed. The sand pack extended from 460 feet to 425 feet below grade, which corresponded to the sand pack extending five feet above the top of the well screen. A layer of #00 Morie sand was then added to 420 feet, extending the sand pack up to 10 feet above the top of the well screen. Bentonite pellets were then added to the borehole forming a bentonite pellet seal from 420 to 414.2 feet. Another layer of #00 Morie sand was added which extended from 414.2 to 405 feet below grade. The remainder of the annulus was backfilled from 405 to 1 feet below grade with cement/bentonite grout which was prepared according to ASTM D5092-90 standards.

3.3. Shallow bedrock investigation

3.3.1. Bedrock fracture analysis

To aid in the investigation of environmental conditions at the Fort Edward Plant site, a fracture trace analysis and field bedrock joint orientation analysis was performed. The objective of the analysis was to determine regional trend(s) of bedrock fracturing and/or jointing which may influence the general flow of ground water and to map site-specific photo linear features of geologic origin which may influence the transport of site-related compounds at the site.

Several sets of air photographs covering the site and surrounding area were examined to map site-specific photo linears of geologic control which may influence the transport of ground water at the Fort Edward Plant site. Additionally, aerial photographs were used to determine the regional trend(s) of bedrock fracturing or jointing, which may influence the general flow of ground water at the site.

Air photos used in the investigation were taken between 1940 and 1990 with the scales ranging from 1:20000 to 1:58000. Fracture orientations were collected for a distance of approximately 2000 ft along the edge of the Hudson River. Between 50 and 70 measurements were recorded at each site.

The results of the fracture trace analysis indicate that the primary fracture orientation of the study area is east to west between 260 to 280 degrees (N80W to N80E) dipping steeply approximately 75 to 85 degrees (N). The orientation of this fracture set rotates in a northwesterly direction from site 1 (south of the site) to site 3 (north of the site). There is a secondary orientation at site 1 ranging from approximately 360 to 30 degrees (NS to N30E) also steeply dipping between 60 and 80 degrees (E). At site 2 a secondary orientation ranges between 230 to 250 degrees (S50W to S70W). The fracture spacing at all three locations averaged between 230 to 250 degrees (S50W to S70W). The fracture spacing at all three locations averaged between 0.5 to 1 ft.

A regional lineament analysis using aerial photos was also completed. Several sets of aerial photos were examined. The photos were taken between 1940 and 1990 and the scales ranged between 1:20000 to 1:58000. Only regional lineaments were identified due to early and dense urbanization in the immediate vicinity of the site. Most of the lineaments identified had a north northeast (N20E to N40E) orientation. These are related to a major fault which is mapped at the surface to the east. A minor fault was observed in the river bed. This minor fault probably represents a splay off the major fault. A fracture set with this orientation may be present along the river outcrops but was probably not recorded due to its alignment with the orientation of the river cut itself.

3.3.2. Bedrock recovery well GM-11D packer testing

Bedrock packer testing began on March 11, 1996 and continued until March 15, 1996. Packer testing services were provided by SJB Services, Inc. of Cohoes, New York and were supervised by a qualified O'Brien & Gere geologist.

The scope of work performed for the investigation consisted of the following:

- Collection of ground water samples from discrete zones of the bedrock in well GM-11D.

- Analysis of samples for PCBs and volatile organic compounds (VOCs) by Adirondack Environmental Services (AES).

- Evaluation of data, which was then used to refine the locations and depths of additional bedrock wells installed during the supplemental field investigation.

- Bedrock ground water recovery well GM-11D was drilled in January 1987 and subsequently deepened in November of 1987 to a total depth of 70 feet. GM-11D was completed as an open 3⅞-inch diameter borehole open to the bedrock from 18.7 to 70 feet below ground. A 4-inch diameter steel casing is set from the ground surface approximately 6.2 feet into rock. In 1991, GM-11D was upgraded by the installation of a permanent submersible pump and discharge piping.

3.3.2.1. Ground water sampling

Four ground water samples were collected from GM-11D from the following intervals: 13.8 to 30 feet, 28.8 to 45 feet, 43.8 to 60 feet and 58.8 to 70 feet. Samples were collected using a combination of single and dual inflatable packer systems and inertial pumping techniques. Prior to setting the packer assembly, the well pump and well internals were removed. The packer assembly was then lowered to the bottom of the well and inflated, thereby sealing off a portion of the open bedrock borehole.

To ensure a proper seal of the inflatable packers, the packer pressure and the water levels, (both inside the well casing and outside the well casing, i.e., in the annulus) were monitored throughout the packer test.

Prior to collecting samples, ground water in the packed off interval was pumped to remove approximately three times its volume using inertial pumping techniques and a new length of polyethelene tubing. Dedicated Waterra polyethylene tubing and foot valves were used for pumping ground water. Purge water was pumped directly into the equalization basin. Samples were collected directly from the tubing in clean sample containers provided by the laboratory. The packer assembly was then raised to the new interval and the procedure was repeated until representative samples were collected from every interval. A qualified O'Brien & Gere geologist supervised the entire investigation and collected the samples.

3.3.2.2. Ground water analysis

Samples were collected on March 12, 13, and 14, 1996 for both VOCs (USEPA Test Method 624) and PCBs (USEPA Test Method 608-Modified). The analyses was performed by GE's contract laboratory, Adirondack Environmental Services (AES) of Albany, New York. One blind duplicate sample was also collected and analyzed.

3.3.3. Well drilling and installation program

Bedrock monitoring wells associated with the RI/FS were installed in two phases. During the first phase of RI/FS activities, 10 new bedrock monitoring wells were installed between August 25 and October 4, 1995. These 10 wells consisted of four bedrock well pairs and two individual bedrock wells and are identified in Table 3-2. Each pair consisted of a shallow (BS) and deep (BD) bedrock well.

Table 3-2. *Phase I RI/FS bedrock monitoring wells.*

OBG-43BS	OBG-42BD
OBG-43BD	
OBG-46BS	OBG-47BS
OBG-46BD	
OBG-49BS	OBG-15BS
OBG-49BD	OBG-15BD

As part of the Supplemental RI Scope, 10 additional bedrock monitoring wells were installed between May 6 and May 30, 1996. The supplemental bedrock wells consisted of four additional pairs and two individual wells identified in Table 3-3. The locations of all bedrock wells installed during the RI/FS activities are presented in Figure 1-2.

Table 3-3. *Supplemental RI bedrock monitoring wells.*

OBG-72BS	OBG-42BD
OBG-72BI	
OBG-73BS	OBG-46BI
OBG-73BI	
OBG-74BS	OBG-75BS
OBG-74BI	OBG-75BI

The bedrock well pairs installed as part of the Supplemental RI consisted of a shallow and an intermediate bedrock well.

3.3.3.1. Drilling

In accordance with the original NYSDEC-approved work plan and the Supplemental RI scope, 20 new bedrock monitoring wells were installed between August 25, 1995 and May 30, 1996. Drilling and well installation activities were performed by Parratt-Wolff, Inc. of East Syracuse, New York. Subsequent to obtaining access to the proposed drilling locations, subsurface drilling equipment was mobilized to the facility. Soil boring and monitoring well installation activities were supervised by qualified O'Brien & Gere geologists.

Soil borings were advanced in the unconsolidated deposits using hollow-stem auger techniques. Augers with a 4¼-inch, 6¼-inch, and 8¼-inch ID were advanced through overburden materials approximately 1-foot into bedrock. The top of the bedrock surface was determined by split-barrel sampler refusal and/or auger refusal. Prolonged grinding with augers at the top of rock made a competent bedrock surface available to seat the overburden casing. In addition, this shallow penetration created a rock socket, approximately 1-foot deep in most cases, to improve the grout seal for the casing at the overburden/bedrock interface.

Continuous split-barrel samples were collected at 2-foot intervals in accordance with American Society for Testing and Materials (ASTM) Method D-1586-84 at wells OBG-42BS, OBG-43BD, OBG-46BD, OBG-47BS, OBG-49BD, OBG-72BI, OBG-73BI, OBG-74BI and OBG-75BI in order to provide overburden data at each well or well pair location. Detailed information for these soil borings is presented on soil boring logs in Appendix C. The remaining borings were advanced through the overburden without collecting split-barrel samples.

Following advancement of the hollow-stem auger to the sampling depth, the split barrel sampler was lowered to the bottom of the boring and driven into the undisturbed soil using a 140-pound hammer with a 30-inch drop. A representative sample of the split-spoon was then transferred to a clear glass jar and capped for future examination. These jars were also capped with aluminum foil immediately following collection and allowed to equilibrate before screening the headspace with a PID for VOCs.

Soil samples were described in the field by the supervising geologist using the Modified Burmister and Unified Soil Classification Systems. In addition to logging the geologic descriptions, observations regarding moisture content, sample recovery, PID readings and any noticeable odors or stains were recorded by the attending geologist. PID values obtained from soil headspace readings were generally below 1 part per million (ppm).

After advancing through the unconsolidated deposits, a cement-bentonite grout was tremied into the augers which, when removed, left an approximately 8¼-inch OD annulus. An iron casing was lowered into the borehole to the top of bedrock and tapped into place with a 140-pound hammer. A 5-inch ID iron casing was used in shallow and intermediate bedrock wells OBG-15BS, OBG-42BS, OBG-43BS, OBG-46BS, OBG-46BI, OBG-47BS, OBG-49BS, OBG-72BS, OBG-72BI, OBG-73BS, OBG-73BI, OBG-74BS, OBG-74BI, OBG-75BS, and OBG-75BI. A 6-inch ID iron casing was used in the deeper boreholes to allow for telescoping casings (i.e., OBG-15BD, OBG-42BD, OBG-43BD, OBG-46BD, and OBG-49BD). The remainder of the annulus was grouted to the surface and some, but not all, of the grout inside the casing was pumped out. The remaining grout was allowed to cure for a minimum of 24 hours. This overburden casing became the protective casing for wells completed with an above ground stickup riser. For wells with flush-mounted roadway boxes, the steel casing was cut to approximately 0.5 feet below grade and secured with a locking expansion plug.

Shallow bedrock wells installed during Phase I activities were drilled by advancing through bedrock (i.e., OBG-43BS, OBG-46BS, OBG-49BS and OBG-15BS) using a 4½-inch diameter roller bit. Shallow and intermediate bedrock wells (i.e., OBG-46BI, OBG-72BS, OBG-73BS, OBG-74BS, and OBG-75BS) were drilled by advancing through bedrock using a 4¾-inch diameter roller bit.

Intermediate bedrock wells (i.e., OBG-72BI, OBG-73BI, OBG-74BI and OBG-75BI) shallow bedrock wells OBG-42BS and OBG-47BS, and deep bedrock wells OBG-15BD, OBG-42BD, OBG-43BD, OBG-46BD and OBG-49BD were drilled to total depth using a 4-inch OD (HX) diamond impregnated core bit. All rock core activities incorporated wireline coring techniques. Rock core was described by a qualified O'Brien & Gere geologist and recorded along with related depth, percent recovery and percent rock quality designation (RQD) information. A PID was used to check the core for VOCs immediately upon removal from the core barrel. Rock core recovered was placed in labeled core boxes for storage. Detailed information is presented on the core logs in Appendix C.

Deep bedrock wells OBG-15BD, OBG-42BD, OBG-43BD, OBG-46BD, and OBG-49BD were constructed by setting an inner (telescoping) casing below the top of bedrock to prevent potential cross contamination from the upper to the lower bedrock units. In order to set the telescoping casings, the borehole was reamed out to 5⅞ inches in diameter. As the grout was pumped into the borehole, the tremie pipe was kept within the grout as it was placed so that a continuous seal was achieved. A 4-inch ID iron casing was lowered into the borehole and tapped into place with a 140-pound hammer to seat the casing. Some, but not all, of the grout inside the casing was pumped out and the remaining grout was allowed to cure for a minimum of 24 hours.

Drill cuttings derived from the bedrock were placed in 55-gallon drums and subsequently managed for ultimate disposal in accordance with RCRA waste disposal regulations by GE's EHS staff. All cuttings were labeled with the borehole identification and the date which the cuttings were initially containerized.

3.3.3.2. Borehole development

During the first phase of shallow bedrock drilling, prior to the installation of the PVC well screen, riser pipe and sand pack, several of the open bedrock boreholes (i.e., OBG-15BD, OBG-42BS, OBG-43BD, OBG-46BD, and OBG-49BD) were developed for a period to remove residual fines from the borehole. This was performed by the drilling rig using drill rods, a surge block and clean potable water.

At the conclusion of rock coring activities during the first phase, the open bedrock coreholes were flushed with the drill rods. The surge block was then lowered into the corehole and the corehole was subsequently surged for approximately one hour. The surging action was limited to the bottom 20 feet of the borehole. The corehole was then flushed again with the clean potable water to remove drilling residue resulting from rock coring activities. A brief falling head test was conducted following surging activities to determine whether or not the borehole was capable of yielding ground water.

During the supplemental phase bedrock drilling activities, all 10 of the new open bedrock coreholes were developed prior to the installation of the PVC well screen riser pipe and sand pack. Each borehole was developed similarly to the method described above.

Following the monitoring well installation activities, each new borehole was subsequently developed in accordance with the NYSDEC-approved FSP.

3.3.3.3. Monitoring well installation

All bedrock monitoring wells were constructed of 2-inch ID, flush-joint, Schedule 40 PVC riser pipe with 0.020-inch slot well screen. For detailed information, refer to the well construction logs found in Appendix D.

Shallow bedrock well screens were installed such that the top of the screen was set at the depth corresponding to approximately four feet below the top of bedrock at that location. Intermediate bedrock well screens were installed such that a minimum of two feet separated the bottom of the shallow bedrock well screen from the top of the bentonite seal in the intermediate well in shallow bedrock-intermediate bedrock well pairs.

Each deep bedrock well location was cored to 140 ft bgs. Screen placement in the deep bedrock wells was based on examining the rock cores recovered from these wells. Deep bedrock monitoring wells OBG-15BD, OBG-42BD, and OBG-49BD were installed such that the base of the screen was 140 ft bgs. Monitoring well OBG-43BD was installed with the base of the screen set at 130 ft bgs. OBG-46BD was installed with the base of the screen set at 125 ft bgs.

The base of each well was equipped with a bottom plug and the top of each well was equipped with a non-threaded cap. A lock was placed on the cap for the flush-mounted wells. Wells with an above ground guard pipe were provided with a locking cover.

Following placement of the PVC well screen and riser, a sand pack was introduced gradually inside the boring, filling the annular space between the screen and the borehole adjacent to the screen. The sand pack extends from the bottom of the boring to approximately two feet above the top of the screen. The sand pack consists of a clean, graded, silica sand composed of a Morie Grade 1. A bentonite seal was placed above the sand pack to form a seal approximately 1 to 2 feet thick. A cement-bentonite grout was placed from the top of the bentonite pellet seal to the ground surface. The grout material consisted of Type I Portland cement mixed with a granular bentonite. The grout mixture was prepared in accordance with ASTM Method D-5092-90, such that approximately 3 to 5 pounds of bentonite was mixed with 6.5 to 7.0 gallons of water per 94-pound sack of cement. The grout was introduced via a tremie pipe lowered to just above the top of the bentonite pellet seal. A lockable cap was installed on top of the overburden casing grouted into place initially.

3.3.3.4. Decontamination procedure

Decontamination of drilling equipment during the shallow bedrock investigation was conducted in accordance with the procedures similar to that described in Section 3.5.3.

3.3.4. Monitoring well GM-40D recompletion

Monitoring well GM-40D, located in the southeast corner of the facility parking lot was completed in 1983 to a total depth of approximately 180 ft bgs. In order to allow comparison of potentiometric heads across the site, with a minimum of influence from vertical hydraulic head differences across the site, GM-40D was recompleted to a shallower depth corresponding to the new deep bedrock wells completed during the RI/FS (i.e., 140 ft bgs).

Grout pumping equipment was mobilized to GM-40D on August 23, 1995. An error in calculating the amount of grout needed to backfill GM-40D to the correct depth resulted in over-grouting the well up to 122 ft bgs. A drill rig was mobilized to the well on September 29, 1995 to drill out the 18 ft of excess grout. A 5⅞-inch diameter roller bit was used to drill out the grout. This was the original diameter of the open bedrock portion of this well. The grout was drilled out to 140 ft bgs. Subsequent to flushing out the well, a brief water level test was performed to determine if the well's natural fractures had been sealed off as a result of the excess grout. The results of the water level test indicated that GM-40D was not yielding appreciable amounts of ground water, probably resulting from natural fractures being sealed by the excess grout.

Field equipment was re-mobilized to GM-40D on October 16, 1995 to perform acid treatment. Fifteen (15) gallons of 31.5% hydrochloric acid (HCl) was added to GM-40D, creating an approximate 15% acid solution. This solution was allowed to remain in the well overnight. On October 17, 1995, the acid solution was pumped out in 50 gallon batches and neutralized. Over 600 gallons of ground water were removed from this well over a six hour period. Monitoring Well GM-40D maintained a flow rate of approximately five gpm. When well parameters stabilized over the course of pumping out the acid solution in GM-40D, it was determined that the well had reestablished equilibrium.

Based on an improved well yield resulting from the acid treatment enhancing the natural fractures in GM-40D, it was decided to have GM-40D remain an open bedrock well. The dedicated submersible pump could then still be utilized to collect ground water samples as in previous sampling rounds including GM-40D.

3.3.5. Hydraulic monitoring program

Detailed hydraulic monitoring programs (HMPs) were performed to assess the hydraulic effects of pumping of bedrock recovery wells GM-8DR and GM-11D on the surrounding bedrock and unconsolidated hydrogeologic units. The first HMP was performed from January 23 to February 1, 1996. A second, more extensive, HMP was performed between September 24 and

October 8, 1996, which included monitoring water levels in nine additional bedrock wells installed as part of the Supplemental RI. The hydraulic monitoring programs were performed in the west and southwest area of the facility. Bedrock recovery wells GM-8DR and GM-11D are located northeast and north of the equalization basin, respectively.

The first HMP consisted of continuous water level monitoring at four bedrock wells (GM-26D, OBG-46BS, OBG-46BD, and OBG-47BS) and hand measurements collected twice daily from 15 monitoring wells and the two bedrock recovery wells. The monitored wells include nine bedrock wells (OBG-15BS, OBG-15BD, OBG-43BS, OBG-43BD, OBG-44BS, OBG-44BD, OBG-49BS, OBG-49BD, and GM-9D) and six overburden wells (GM-7, GM-11, GM-14, GM-17, GM-22 and GM-24).

On January 23, 1996, an initial round of water levels was obtained from the bedrock recovery wells, all the wells included in the daily monitoring plan as listed above, (i.e., 19 monitoring wells), and additionally, all other bedrock wells (GM-12D, GM-40D, OBG-26BD, OBG-42BS, OBG-45BS, OBG-45BD, OBG-48BS, OBG-48BD). Background water levels were established over a period of two days. Water level monitoring on a daily or twice daily basis continued throughout the HMP until the end of the program on February 1, 1996. Water levels obtained during the first HMP are presented in Appendix E. The recovery wells were shut off at 1:30 p.m. on January 25, 1996 and restarted again on January 29, 1996 at 10:45 a.m. The recovery phase lasted four days and the drawdown phase went on for three days.

The detailed water level monitoring was performed using Telemetering Unattended Borehole Environment Recorder (TUBER) data loggers and associated pressure transducers manufactured by GeoGuard, Inc. The TUBER is a single channel data logger/pressure transducer which can be installed inside the riser pipe and/or well screen eliminating the need for additional equipment at the well head. The TUBER is capable of collecting and storing up to 38,400 data points for subsequent transfer to a portable computer. Using a 15-minute monitoring interval, approximately 400 days of data could be collected. A 15-minute monitoring interval was used for the continuous monitoring. This interval is sufficient to resolve cyclical fluctuations with periods greater than or equal to 30 minutes. A list of the wells where manual water level measurements were obtained along with the depth to water and water level elevation data are provided in Appendix E.

Monitoring was performed using 7 and 14 pounds per square inch (psi) transducers with full ranges of approximately 16 and 32 feet, respectively. The reported accuracy of the transducers is 0.1% full range at a constant temperature, or 0.016 and 0.032 feet for the 7 and 14 psi transducers, respectively. Transducer selection was based on the expected or potential range in water levels and availability.

TUBERs were installed as a dedicated installation, whereby the cable length for each unit was factory set to a length specified by O'Brien & Gere. The specified cable length was determined based on the measured depth to water at each well to be monitored, the expected range in water levels and the pressure rating of the pressure transducer employed at each well. Wherever possible the pressure transducer was set in the approximate center of its full range. Since all the components of the TUBER are installed within the borehole, wells with protective casings were able to be locked during the monitoring period. At locations with flush-mounted well covers, the wells were not able to be locked, but the flush-mount well covers were bolted in place to prevent unauthorized access.

At the beginning of the hydraulic monitoring program, water level measurements were obtained from each of the wells being monitored using the TUBERs and used to reference the instrumentation. Water level measurements were also obtained during the monitoring period in order to provide a check on the results and allow calibration, if necessary.

The second HMP included the collection of manual water level measurements twice a day from the two recovery wells (GM-8DR, GM-11D) and 14 monitoring wells (GM-7, GM-11, GM-14, GM-15, GM-22, GM-26D, OBG-83, OBG-26T, OBG-56, OBG-15BS, OBG-43BS, OBG-47BS, OBG-49BS, OBG-49BD) over a 15-day period. In addition, continuous water level monitoring was performed during the same period in 13 wells: OBG-8b, GM-9D, OBG-44BS, OBG-46BS, OBG-46BI, OBG-72, OBG-72BI, OBG-73BS, OBG-73BI, OBG-74BS, OBG-74BI, OBG-75BS and OBG-75BI.

Midway through the HMP, prior to turning the recovery wells back on, the TUBER in OBG-73BI was believed to be malfunctioning. Consequently, hand measurements of water levels were taken twice a day similar to the other hand measured wells. Examination of the pressure transducer cable in OBG-73BI at test completion, revealed that it was damaged. No data could be recovered from this unit due to water damage.

As part of the scheduled water level measurements, a full round of water levels was obtained from all of the wells on-site on September 23, 1996. Additionally, two full rounds of water levels were obtained from all of the bedrock wells associated with the site. These full rounds of water levels from bedrock recovery and monitoring wells were obtained on October 2, 1996 prior to turning the bedrock recovery wells back on, and on October 8, 1996 after the recovery wells were on for six days, to coincide with non-pumping and pumping conditions, respectively.

Continuous and manual water level monitoring was initiated two days prior to the shut down of the bedrock recovery wells and continued for six days after the restart of the system. The hydraulic monitoring program was initiated on September 24, 1996 and completed on October 8, 1996. The recovery wells GM-8DR and GM-11D were shut down September 26, 1996 at 4:30 p.m. and restarted on October 6, 1996 at 2:45 p.m. The water level elevation data are presented in Appendix E.

In addition to the ground water level data, climatic data regarding temperature, precipitation and barometric pressure were obtained for the monitoring period from the Glens Falls Airport which is located approximately six miles north-northwest of the facility. This data was obtained from the Northeast Regional Climate Center located in Ithaca, New York.

The results of the hydraulic monitoring program are discussed in Section 5.3 and 5.4.

3.3.5.1. Dye test

In addition to the continuous monitoring of the ground water level in manhole 27 during the hydraulic monitoring program, a dye tracer test was performed in order to assist in determining if overburden ground water and the abandoned storm sewers near GM-8DR are significant sources of recharge to the shallow and intermediate bedrock in the vicinity of bedrock recovery wells GM-8DR and GM-11D.

The dye tracer study was performed by injecting a fluorescent dye (rhodamine WT) into abandoned storm sewer sections P-37 and P-38 via manhole 27. The discharge from bedrock recovery wells GM-8DR and GM-11D was monitored for indications of the dye twice daily. The dye was injected into the abandoned storm sewer line in a way that provided adequate mixing of the dye with the existing ground water throughout the full length of pipes.

On October 9, 1996, manhole MH-27 was pumped down several feet to expose the invert of sewer line P-37 (from MH-27 to MH-4) and line P-28 (from MH-27 to MH-28). A plumbing consultant, Apex Sewer & Drain, used a high pressure water jetter to pump in the dye solution. The pressure jetter was first run up pipe segment, P-37, approximately 295 feet to the end of the line. Rhodamine WT dye was added to approximately 100 gallons of water in the tank and pumped into the pipe at a rate of approximately 15 gpm. The jetter was pulled back at a rate of approximately 50 feet/minute to distribute the dye equally through the full length of the pipe.

Similarly, the jetter was run up pipe segment P-38 a distance of 214 feet. Dye was then added to the jetter tank along with approximately 70 gallons of water. The jetter was retrieved at a rate of approximately 50 feet/minute while pumping approximately 15 gal/minute to fully and evenly distribute dye throughout the length of the pipe.

A sufficient amount of dye was mixed with the existing ground water within the storm sewers to provide an initial concentration of approximately 1 ppm.

Ground water samples were obtained from each of the two recovery wells twice daily for the first week and once daily for the second week, and were analyzed at the facility. Due to the light sensitive nature of the Rhadomine WT dye, analyses were performed as soon after collection as possible (i.e., within ½ hour), following the standard operating procedure provided by the manufacturer of the fluorometer. Upon collection, the ground water samples were placed into 250 milliliter glass bottles and stored in the dark until analysis. Each sample was labeled with the appropriate well identification and the date and time of sample collection. Starting on October 21, 1996, the ground water samples were immediately transferred into 40 mL amber vials and stored in a dark place until analysis on October 25, 1996. Dye analyses was performed using a Model 111 Fluorometer manufactured by G.K. Turner Associates of Palo Alto, California.

Results of the dye test are discussed in Section 5.4.3.2.

3.4. Shallow unconsolidated unit investigation

3.4.1. Soil gas survey

A soil gas survey was performed in the vicinity of the Building 40 to identify and define areas of VOC contamination and to assist in the placement of new shallow unconsolidated monitoring wells at the facility. The objectives of the soil gas survey are to investigate potential areas of trichloroethene (TCE), 1,1-dichloroethane (1,1-DCA), and kerosene contamination in the vicinity of Building 40 and to possibly identify the source(s) of the low level 1,1-DCA and chloroethane concentrations detected in monitoring well GM-10. The soil gas survey was performed between August 2 and 10, 1995.

In indicating subsurface contamination, the effectiveness and representativeness of a soil-gas survey is highly dependent on site conditions, including hydrogeology, soils, and climate. Soil gas above a contaminated aquifer may not contain detectable levels of contaminants because of the dependence on the contaminant concentration, the density of the contaminant with respect to water, the depth of the water table, soil types and other factors. Soil-gas surveys are least effective where there are barriers to gaseous flow and diffusion, as in soils with low porosity (e.g., clayey soils) and in water-saturated soils. Conversely, impermeable surface layers such as pavement or concrete foundations can maximize soil-gas concentrations near the surface because paving minimizes both infiltration of spills and diffusion of soil gas into the atmosphere. Temperature, rainfall, barometric pressure can also affect concentrations of contaminants in the soil gas.

Conditions around Building 40 at the GE Fort Edward facility appeared to be well suited for a soil gas survey because the asphalt parking lot surrounding the building is expected to provide a capping effect to the soil gas. In addition, the climatic conditions were ideal during the soil gas survey. The warm temperatures and lack of precipitation should allow the organic constituents to volatilize into the interstitial (void) spaces between soil particles in the vadose (unsaturated) zone. In reference to recent soil borings completed in the area around Building 40, the soils between 2.5 and 4.0 feet generally consist of fine to course sand, which should also allow for unobstructed diffusion of the soil gas.

3.4.1.1. Sampling methodology

Prior to the initiation of the soil gas survey, a 50 foot grid was measured and marked. A few locations on the 50 foot grid were not accessible due to large equipment and trucks; therefore, the soil gas sampling location was moved slightly. The following areas were investigated:

- The area between Buildings 27 and 40;
- The area between Building 40 and Allen Street;
- The area immediately south of Building 40; and
- The area along the western property line.

In addition, a spoked grid was measured and marked from monitoring well GM-10, at 25 foot intervals to a maximum of 75 feet.

The majority of soil gas samples at the site were collected from a depth of 3.0 feet below ground surface. Samples from 2 to 4 feet below ground surface were appropriate in these investigation areas because the groundwater is relatively shallow (generally 4 to 8 feet below ground surface) and in paved areas. In a few cases, the samples were collected from depths of 4.5 to 6.0 feet below ground surface because the locations were on the soil berm surrounding the sanitary basin, located south of Building 40. The sample depths were greater to compensate for the elevated locations and to keep the comparative sampling depths consistent.

The sampling point was created by first drilling a hole through 2.5 to 4.0 feet of asphalt, concrete, and/or soil with either an electric hammer or a manual slide hammer. A disposable slotted aluminum shield point was connected to 3/16-inch Teflon® tubing and placed into the bottom of the hole. The annulus created around and above the slotted shield point and tubing was filled with clean sand. The column of sand was sealed by adding powdered bentonite and a small amount of distilled water. The soil gas sample location number and the corresponding date, time, and depth of installation were recorded in the soil vapor field log. The column of sand in the hole established a sampling annulus through which the surrounding soil gas vapors were extracted.

To allow the soil gas in the sampling annulus to reach equilibrium, a minimum of 30 minutes passed before the soil gas sample was collected. The soil gas sample was collected through the 3/16-inch Teflon® tubing, which extended approximately 1 foot above ground surface. A sample was collected into a new 1-liter Tedlar® bag inside a portable vacuum box. The Tedlar® bag was connected to the Teflon® tubing at a sampling point by a 2-inch length of Tygon® tubing that passed through a seal on the vacuum box. The 2-inch Tygon® tubing was replaced between each sampling location. As a result of evacuating the vacuum box, the soil gas sample flowed into the Tedlar® bag. Prior to collection of the sample, 1 liter of void volume was purged from the annulus and tubing. The sample was then collected into a new Tedlar® bag and transported, with minimal exposure to light, to the on-site laboratory for analysis. Each Tedlar® bag was identified with the grid location number and the date and time of collection was recorded in the soil vapor field log.

3.4.1.2. Analytical methodology

A portable Hewlett-Packard gas chromatograph (GC) equipped with an electron-capture detector (ECD) and a flame ionization detector (FID) was used to analyze the samples at the GE Fort Edward facility. The ECD was utilized because it is most sensitive to chlorinated volatile organic constituents and the FID to aromatic hydrocarbons. The instrument was controlled by a detachable, portable computer that records and integrates peaks, identifies peaks from calibration standards and libraries, and displays and records each trace, along with operating parameters and analysis results. With the exception of the calibration of kerosene detailed below, the soil gas samples were analyzed in accordance with the NYSDEC-approved RI FSP (O'Brien & Gere, August 1995, as revised).

The specific volatile compounds used as indicators of general volatile contamination included TCE, 1,1-DCA, and kerosene constituents, which have been detected in groundwater and soil in the area of the soil gas investigation. TCE, 1,1-DCA, naphthalene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, benzene, toluene, ethylbenzene, m-/p-xylene, and o-xylene standards were analyzed to calibrate the GC. A kerosene standard was also analyzed for calibration. Retention times, peak areas, and corresponding standard concentrations of observed peaks were entered into the library file. Compounds were tentatively identified and quantified on the basis of this library comparison. Compounds that were not identified in the library were designated unknowns.

Sample analysis was initiated by withdrawing a 100 microliter (μL) aliquot of soil gas sample from a Tedlar® bag using a gas tight syringe, and injecting the sample directly into the GC via the purged packed injection port. When increased sensitivity was desired, as in the case of the kerosene analyses, a 500-μL aliquot of soil gas sample was injected into the GC. After the sample was injected, it passed through the analytical column where volatile constituents were separated. The concentrations of TCE and 1,1-DCA were measured on the ECD, and the kerosene and associated constituents were measured on the FID. Upon completion of an analytical run, sample peaks were integrated using calibration information stored in the calibration library.

The GC calibration consisted of an initial calibration and continuing calibrations.

Initial Calibration: Prior to the beginning of the field activities, a four point calibration using TCE and 1,1-DCA standards was performed on August 1, 1995. In accordance with the field GC standard operating procedures (SOP) provided in the NYSDEC-approved RI FSP, three standards plus a method blank were used to generate calibration curves with correlation coefficients greater than 0.995. The low standard concentrations of the TCE and 1,1-DCA calibration curves, 0.23 and 1.8 parts per million volume of vapor (ppmv), respectively, were used as the practical quantitation limits. The initial calibration data was entered into the library software to provide quantitation of the matching peaks using the linear initial calibration curve.

Kerosene is a complex composition of volatile and semi-volatile constituents which include a mixture of aromatics, olefins (alkenes), cycloparaffins (alicyclic alkanes), and paraffins (alkanes). Due to the nature of the various constituents, numerous temperature programs were run to obtain the best resolution of aromatics and the heavier fractions. A temperature program which separated the major peaks in the lighter and heavier kerosene standard fractions was selected and used for an initial calibration. However, the sensitivity of the instrument began to fall by the third calibration standard, as evidenced by the decreased number of lighter fraction peaks and non-linearity of the peak areas. The decreased sensitivity was likely due to the heavier paraffins coating the injection port, column, and the FID. The temperatures of the GC were elevated after this analysis to remove the residual constituents and returned the instrument to the original sensitivity.

In order to meet the objectives of the soil gas survey by providing a cost effective screening tool, one-point standards of the lighter constituents of kerosene (i.e., naphthalene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, benzene, toluene, ethylbenzene, and xylenes) were analyzed daily for kerosene constituent identification. If the kerosene constituents were identified based on a retention time match, kerosene was qualitatively reported as present in the sample.

It should be noted that in addition to the GC analysis, a portable PID was utilized to screen each sample prior to GC analysis, as well as odor observations. Typically, the PID measurements are used to gauge the dilution factor required, if any, to obtain concentrations within the linear calibration of the GC. The highest concentration detected with the PID was 12 parts per million (ppm) on a sample with a very strong petroleum odor. This observation appears to support that the odor of low concentrations of petroleum constituents are easily detected and is often more sensitive (i.e., can be detected at lower concentrations) than analytical instruments. Therefore, odor observations were also taken into account to determine the presence or absence of kerosene in the soil gas samples.

Continuing Calibration: One-point calibration standards were performed for the indicator compounds at the beginning of each day and after every 10 samples to account for variations in instrument performance. In accordance with the field GC SOP, the continuing calibration TCE and 1,1-DCA standard recoveries were within 30% of the true concentration, with the exception of continuing calibration standards (CCS) analyzed on August 4 and 7, 1995. The CCS recoveries were biased high; however, 1,1-DCA was not detected in the associated samples; therefore, no action was required. The GC was recalibrated using 1,1-DCA on August 8, 1995.

The following paragraphs detail the quality control criteria required for this survey and the results.

GC Method Blanks: Method blanks (i.e., instrument runs without an injection) were analyzed at the beginning of each day to evaluate the baseline instrument response. No detectable concentrations of VOCs were detected in any of the GC blanks.

Syringe Blanks: A syringe blank was analyzed after each calibration run and after an environmental sample which contained elevated concentrations of VOCs. TCE and 1,1-DCA concentrations were not detected in any of the syringe blanks.

Kerosene constituents were often detected in syringe blanks due to the residual heavier constituents present in the injection port. (A known clean syringe was used for a syringe blank following the injection of a kerosene standard and carryover appeared). Syringe blanks were run until no or trace concentrations of kerosene constituents were present. Detectable trace concentrations of VOCs observed in the syringe blanks were subtracted from subsequent environmental samples.

Equipment Blanks: An equipment blank was collected daily by passing ambient air through the sample collection apparatus into a Tedlar bag. No detectable concentrations of VOCs were detected in any of the equipment blanks.

Field Duplicates: To assess the variability associated with the sampling and analysis of soil vapor samples, duplicate samples were collected and analyzed every twenty samples. The average relative percent deviation (RPD) between the original samples and their duplicates were less than 5.4%, when detected.

Record Keeping: All chromatograms and quantitation sheets were bound in three-ring binders and arranged by dates of analysis. A daily summary table of each sample analysis is also provided with each section. A methods summary which includes the instrument conditions and calibration information is also provided in the initial binder.

3.4.1.3. Decontamination of sampling equipment

The drill bits were decontaminated with Liquinox and distilled water between each sampling point.

3.4.2. Soil boring and sampling

3.4.2.1. Soil sampling approach

A total of 41 soil borings were drilled as part of the RI. Twenty soil borings were drilled as part of the RI in the overburden on-site beginning August 29 and ending September 15, 1995. Twelve borings are designated with the prefix "SB-" proceeded by the boring number (i.e., SB-004, SB-37, SB-38, SB-39, SB-40, SB-41, SB-42, SB-43, SB-47, SB-48, SB-49 and SB-50). The other eight are designated with the prefix "OBG-" proceeded by the boring number (i.e., OBG-50, OBG-51, OBG-52, OBG-53, OBG-54, OBG-55, OBG-56 and OBG-62). The borings designated as "OBG" were completed as monitoring wells.

The purpose of the on-site soil boring program was to better define the site unconsolidated stratigraphy and to evaluate the potential for the presence of non-aqueous phase liquid (NAPL). The drilling program was focused on the areas between building 27 and 40, south and west of building 40.

Seventeen borings are located around the perimeter of the Foil Mill (Building 40), refer to Figure 1-2. Borings SB-004 and OBG-62 are located approximately 150 ft west of the Foil Mill directly in between Lower Allen Street and the rail road tracks within the 004 former outfall area. Soil boring OBG-56 is located south of the equalization basin.

Eighteen soil borings were drilled as part of the Supplemental RI scope of work between May 4 and May 22, 1996 to further delineate the extent of VOC, PCB and kerosene contamination. Two of these borings, designated as OBG-67 and OBG-68, were drilled around the north and west sides of the Foil Mill. Boreholes OBG-67 and OBG-68 were completed as monitoring wells.

As part of the Supplemental RI scope of work, twelve borings were drilled within the interior of the Foil Mill. Ten of the borings were completed as monitoring wells (FM-1, FM-2, FM-5 through FM-12). Borings FM-3 and FM-4 were not converted to monitoring wells, and were grouted to the surface with a cement-bentonite mixture. Additionally, four borings were drilled as part of the Supplemental RI in the vicinity of the former leachfield in the western central portion of the site. They are designated with the prefix "LF-" and are labeled LF-1, LF-2 and LF-3. The fourth boring, LF-4 was completed as a monitoring well (OBG-83).

Three soil borings were drilled as part of the Supplemental RI scope of work on May 20, 1996 to determine the extent of Polynuclear Aromatic Hydrocarbons (PAHs). These borings, designated as OBG-69 through OBG-71, are located on the west side of the foil mill along the western property line. Borings OBG-69, OBG-70, and OBG-71 were completed as monitoring wells.

3.4.2.2. Drilling

In accordance with the NYSDEC-approved RI Work Plan and the scope of work for the Supplemental RI, a total of 41 soil borings were drilled between August 29, 1995 and May 22, 1996. Drilling and well installation activities during the two phases were performed by Parratt-Wolff, Inc. of East Syracuse, New York. Soil boring and monitoring well installation activities were supervised by a qualified O'Brien & Gere geologist.

Most soil borings were first hand augered with a 4-inch outer diameter (OD) hand auger when deemed necessary due to the proximity of soil boring location to utility lines. Hand augering depths varied from 2 to 10 ft depending on several factors: boring location, depth, geology, sampling depth, utilities or other obstructions. The depth of hand augering was recorded on the field test boring logs located in Appendix C.

Boreholes were drilled with a Mobile Drill Rig B-57 using 4¼-inch inner diameter (ID) hollow stem augers. A "B-type," 3-inch drive casing was also used in conjunction with or in lieu of the 4¼-inch hollow stem augers where conditions favored use of drive casing. The drive casing was used because of its smaller diameter, and would fit down a previously hand augered 4-inch diameter borehole, thus preventing possible encounters with utilities. It was also used because it produces fewer drill cuttings and helps to prevent vertical migration of contaminants in the borehole while drilling. Refer to Appendix C, test boring logs, for depths and intervals of split-barrel sampling.

The augers or casing were advanced to the top of the low-permeability unit (glacio-lacustrine silt and clay, glacial till, or bedrock, depending on site location), underlying the glacio-deltaic sand and gravel. The top of the lower permeability unit or bedrock surface was determined by split-barrel sampler inspection, blow counts, and refusal and/or auger refusal (for bedrock).

Following advancement of the hollow-stem auger/casing to the sampling depth, the split barrel sampler was lowered to the bottom of the boring and driven into the undisturbed soil using a 140-pound hammer with a 30-inch drop.

Soil samples were described in the field by the supervising geologist using the Modified Burmister Classification System. In addition to logging the geologic descriptions, observations regarding moisture content, sample recovery, PID readings and any noticeable odors or stains were recorded by the attending geologist. Soils were composed primarily of brown coarse to fine sand, and fine gravel, some silt, with minor amounts of clay.

All of the soil borings installed in Phase I were drilled until refusal in either the glacial till unit or in bedrock except for SB-004, OBG-50, OBG-51, and OBG-62. Borings SB-004 and OBG-62 were drilled to a desired sampling depth in the glacio-deltaic sand. Boring OBG-50 and OBG-51 were drilled until they reached the underlying low permeability unit. Borings in Phase 2 were drilled or driven until the low permeability unit was encountered/or until refusal, if the low permeability unit clay or till was thin (<2 feet). Drill cuttings were drummed and disposal of these drums was managed by the site EHS staff.

3.4.2.3. NAPL field screening procedures

The soil samples collected during the soil boring program were screened for the presence of NAPL. Split spoons and hand auger bucket piles were screened for health and safety purposes using an HNU PID or Photovac Microtip PID. Soil samples were also screened under an Ultraviolet light in a lightbox for flourescence. Samples were also visually inspected for evidence of NAPL. Samples were selected for laboratory analysis based on PID readings and the results of the UV fluorescence testing and visual inspection.

The field geologist, with consultation from the project hydrogeologist and chemist, made the final determination as to which samples were analyzed at the laboratory based on these field tests. Samples expected to exhibit the highest concentrations of contaminants were sent for laboratory analysis.

3.4.2.4. Sampling methodology

Test boring logs describing subsurface materials encountered in each boring were prepared on-site by a qualified geologist. The test boring logs in Appendix C contain descriptions of soil sample texture, composition color, consistency, and moisture content. A modified Burmister System was used as the soil classification system. Also recorded on the test boring logs were blow counts, penetration, percent recovery and field screening results. A representative sample of the split-spoon was then transferred to a clear glass jar and capped for future examination. These jars were also capped with aluminum foil immediately following collection and allowed to equilibrate before screening the headspace with a PID for VOCs.

3.4.2.5. Soil sample analysis

Based on the results of the field screening, one or more samples from selected borings were sent to the laboratory for PCB analysis by USEPA SW-846 Method 8080, VOC analysis by USEPA SW-846 Method 8240 modified to include 8021 constituents, kerosene by USEPA SW-846 Method 8015-modified, and/or PAHs by USEPA SW-846 Method 8270.

Soil sampling also included one boring, SB-41 in the area of the former mineral oil storage tank. Continuous split-barrel soil samples were collected from the ground surface down to the top of the low permeability glacial till unit. This soil sample was collected and analyzed by USEPA Methods 8240, 8270 and 8080 for VOCs, semi-volatile organic compounds and PCBs, respectively. A discussion of the analytical result is provided in Section 6.2.

3.4.3. Unconsolidated unit well drilling and installation program

3.4.3.1. General

The 29 unconsolidated unit monitoring wells installed as part of the RI were completed in two phases. During Phase I, eight monitoring wells were installed between August 31 and September 7, 1995. Monitoring wells identified as OBG-50 through OBG-55 are located around the perimeter of the Foil Mill in the western portion of the site. Monitoring well OBG-56 is located immediately south of the Equalization Basin, and monitoring well OBG-62 is located west of the facility and east of Lower Allen Street in the vicinity of the former 004 pipeline. Well locations are presented in Figure 1-2.

As part of the Supplemental RI, 21 additional monitoring wells were installed between May 4 and June 1, 1996. Five of the monitoring wells, identified as OBG-67 through OBG-71 were installed around the perimeter of the Foil Mill in the western portion of the site. Of these, two are located just north of the Foil Mill, and three are located west of the Foil Mill, along the western edge of the facility, just inside the fenceline. Monitoring well OBG-83 is located just east of the sanitary treatment system in the west central portion of the site. Monitoring well OBG-42S is located in the northeast section of the facility near the property boundary next to OBG-42BS and OBG-42BD. Ten monitoring wells are located inside Building 40 and are designated with the prefix “FM-”. The remaining two unconsolidated unit monitoring wells, installed as part of the Supplemental RI, OBG-84 and OBG-85, are located approximately 300 and 500 feet, respectively, south of the facility boundary along Sullivan Parkway.

In addition to the wells described above, two new wells were installed as replacements to those that were abandoned. Wells OBG-1a and OBG-8b were installed to replace monitoring wells GM-1 and GM-8a, respectively, which were both damaged during the previous year. Shallow unconsolidated unit monitoring wells installed as part of the Supplemental RI scope of work are identified in Table 3-4 and are shown on Figure 1-2.

Table 3-4. *Supplemental RI unconsolidated unit monitoring wells.*

On-Site Wells	Foil Mill Interior Wells	Off-Site Wells Sullivan Parkway
OBG-1a	FM-1	OBG-84
OBG-8b	FM-2	OBG-85
OBG-67	FM-5	
OBG-68	FM-6	
OBG-69	FM-7	
OBG-70	FM-8	
OBG-71	FM-9	
OBG-83	FM-10	
OBG-42S	FM-11	
	FM-12	

3.4.3.2. Drilling

In accordance with the original NYSDEC-approved work plan and the Supplemental RI scope of work, 29 monitoring wells were installed between August 31, 1995 and June 7, 1996. Drilling and well installation activities during the two phases were performed by Parratt-Wolff, Inc. of East Syracuse, New York. Soil boring and monitoring well installation activities were supervised by a qualified O'Brien & Gere geologist.

Soil borings were advanced in the unconsolidated deposits using hollow-stem auger techniques. 4¼-inch ID hollow stem augers were advanced to the top of the low-permeable unit (glacio-lacustrine silt and clay, glacial till, or bedrock, depending on site location), underlying the glacio-deltaic sand and gravel. The top of the lower permeable unit or bedrock surface was determined by split-barrel sampler inspection, blow counts, and refusal and/or auger refusal (for bedrock).

Continuous split-barrel samples were collected at 2-foot intervals in accordance with American Society for Testing and Materials (ASTM) Method D-1586-84 at all wells, in order to provide overburden data at each well location. Detailed information for these soil borings is presented on soil boring logs in Appendix C.

Following advancement of the hollow-stem auger to the sampling depth, the split barrel sampler was lowered to the bottom of the boring and driven into the undisturbed soil using a 140-pound hammer with a 30-inch drop.

A representative sample of the split-spoon was then transferred to a clear glass jar and capped for future examination. These jars were also capped with aluminum foil immediately following collection and allowed to equilibrate before screening the headspace with a PID for VOCs.

Soil samples were described in the field by the supervising geologist using the Modified Burmister and the Unified Classification Systems. In addition to logging the geologic descriptions, observations regarding moisture content, sample recovery, PID readings and any noticeable odors or stains were recorded by the attending geologist.

Drill cuttings generated during overburden drilling activities were placed into labeled 55-gallon drums and disposed of by the facility's EHS staff. See Section 3.10 for details on the disposition of drill cuttings.

3.4.3.3. Monitoring well installation

Monitoring wells were constructed of 2-inch ID, flush-joint, Schedule 40 PVC riser pipe with either 0.010-inch or 0.020-inch slot well screen. A summary of monitoring well construction and survey data including ground surface and measuring point elevations, screened intervals and sand pack intervals is included in Appendix D. For more detailed information, refer to the well construction logs also found in Appendix D.

Following placement of the PVC well screen and riser, a sand pack was introduced gradually inside the augers, filling the annular space between the screen and the borehole adjacent to the screen. The sand pack extends from the bottom of the boring to approximately one foot above the top of the screen. The sand pack consists of a clean, graded, silica sand composed of a Morie Grade 0 or Grade 1, depending on aquifer material grain size. In many of the wells , a bentonite seal was initially added to the bottom of the borehole, prior to addition of the gravel pack, to seal off the lower geologic unit minimizing vertical flow along the side of the casing. A bentonite seal was placed above the sand pack to form a seal approximately 1 to 2 feet thick. A cement-bentonite grout was placed from the top of the bentonite pellet seal to the ground surface (or, in the case of flush mounted wells, to within 1 ft of PVC casing. The grout material consisted of Type I Portland cement mixed with a granular bentonite. The grout mixture was prepared in accordance with ASTM Method D-5092-90, such that approximately 3 to 5 pounds of bentonite was mixed with 6.5 to 7.0 gallons of water per 94-pound sack of cement. The grout was introduced via a tremie pipe lowered to just above the top of the bentonite pellet seal. The grout was allowed to set for a minimum of 24 hours before wells were developed.

A four feet long, 4-inch ID steel riser pipe was used as the protective casing for wells completed above ground. Stickups for all wells are typically two feet above ground surface. For wells with flush-mounted roadway boxes, the PVC casing was cut to approximately 0.5 feet below grade.

The base of each well was equipped with a bottom plug and the top of each well was equipped with a non-threaded cap. Flush-mounted wells were secured with a locking expansion plug in lieu of a lockable cap on the protective casing. Wells with an aboveground protective casing were provided with a locking cover.

The cement seal or pad was sloped to channel water away from the well, and is deep enough to remain stable during freezing and thawing of the ground.

3.4.3.4. Monitoring well development

Each newly-constructed monitoring well was developed to:

- Remove fine-grained materials from the sand pack and formation;
- Reduce the turbidity of ground water samples;
- Increase the yield of the well to reduce the potential of the well yielding an insufficient volume of water during ground water sampling; and,
- Increase hydraulic conductivity immediately around the well.

The monitoring wells installed during Phase I were developed beginning September 27, 1995 and most were completed by October 12, 1995. Monitoring well OBG-26BD was developed between October 10, 1995 and November 9, 1995. The monitoring wells installed as part of the Supplemental RI were developed starting on May 9, 1996 to June 13, 1996. The only exceptions were OBG-78 and OBG-79, which were developed on September 26 to September 27, 1996, due to their delayed installation.

All ground water and solids resulting from the well development were managed as described in Section 3.10. Development water was drummed and pumped into the storm drain northeast of the drainage basin, discharging into the equalization basin. If NAPL was observed or analytical data of purge water showed high levels of VOCs or PCBs then the development water was containerized in 55-gallon drums and disposed of by EHS facility staff. The wells were developed using one of the following procedures:

- Bailing;
- Inertial pumping (i.e., waterra pump); and/or
- Powered suction-lift pumping in conjunction with manual inertial pumping.

All well development equipment was decontaminated, assembled and installed in the monitoring well. Care was taken not to introduce contaminants on the equipment during installation. All tubing used was new, pre-cleaned and dedicated to each monitoring well.

Well development proceeded by repeated removal of water from the well until the discharge water was relatively sediment free. Development effectiveness was monitored at regular intervals (after each well volume was removed) using a portable turbidity meter. In addition pH, temperature, and conductivity measurements were obtained during development and recorded. Well development was discontinued either when the turbidity of the discharged water reached the development goal of 50 Nephelometric Turbidity Units (NTUs) or when ground water chemical parameters stabilized. In either case a minimum of five well volumes were removed.

Most wells were developed by using dedicated HDPE tubing with one-way check valves and attached surge blocks. Water was evacuated from the well casings by rapidly raising or lowering the tubing and attached foot valves with a water pump or by hand. Addition of the surge block helped to loosen and remove fine grained material from within and around the well screen. All of the overburden wells used 5/8" OD high density polyethylene tubing if the waterra/inertial pump system was used.

Dedicated bailers were used for some of the wells due to the wells being screened in a low permeability material or if ground water had very high turbidity, both of which resulted in low flows through the foot valve and tubing. Bailers were also used if the height of the water column was very small (i.e., less than 1 foot). The bailers used were disposable, translucent, Teflon coated 36-inch long bailers; polyethylene 36-inch bailers were also used. One 5 feet long, 1.66-inch OD, transparent, PVC bailer was also used in well OBG-26BD. In all cases, dedicated nylon or polypropylene rope was attached to the bailers. Bailers were either left in the well or were decontaminated according to methods discussed in Section 3.4.1.3. and stored in plastic at the Fort Edward plant.

3.4.4. Soil disposal area (SWMU#16) grab sampling program

Grab soil samples were collected from seven locations in the soil disposal area (SWMU #16) located north of Building 40. Five samples were collected from the area of past soil disposal and two were collected from the area of recent soil disposal. The soil samples were collected from a depth of 18 to 24 inches below the existing soil piles using the procedures outlined in the NYSDEC-approved RI FSP.

3.4.4.1. Soil sample collection procedure

The seven sampling locations were identified, marked with stakes, and labelled with the location identification number. Ground plastic was placed next to the sample location and the surface material was removed. The soil boring was manually advanced to the sampling depth using a decontaminated stainless-steel bucket auger. The auger was used to collect the sample from a depth of 18 to 24 inches below the existing pile.

Sample containers were labeled with the sample location, date, time, and required analysis. New latex gloves were donned and the sample was withdrawn from the boring and transferred from the auger's bucket to the appropriate sample containers. Samples were collected with minimal agitation in order to reduce the loss of VOCs.

The sampling information was recorded on the chain-of-custody and the sample containers were immediately placed in a cooler containing wet ice. Descriptions of soil texture, composition, color, consistency, and moisture content were recorded on boring logs, located in Appendix C..

3.4.4.2. Analytical laboratory methods

In accordance with the NYSDEC-approved RI/FS QAPP, the soil samples were submitted to AES for VOC analysis by USEPA SW-846 Method 8240 and PCB analysis by USEPA SW-846 Method 8080. A discussion of the analytical results is provided in Section 6.2.

3.4.4.3. Decontamination procedure

Prior to collecting the first sample, between each sample and sample location, the stainless-steel bucket augers were decontaminated to prevent cross-contamination. The stainless-steel bucket augers were scrubbed with potable water and Liquinox and then rinsed with distilled or deionized water and allowed to air dry on a clean piece of plastic.

3.5. DNAPL investigation

3.5.1. Soil boring program

To better delineate both the horizontal extent and vertical distribution of DNAPLs at the facility, a total of 63 soil borings and 11 till zone borings were drilled at the site (Figure 1-2). Three phases of DNAPL soil borings were completed as part of the DNAPL investigation. Phase I included 22 borings (SB-1 through SB-22), and Phase II included 14 borings labeled SB-23 through SB-36.

In the third phase of DNAPL investigation, 23 soil borings and 11 till zone borings were completed between July 25 and September 11, 1995 by Parratt Wolff, Inc. Soil borings were labeled SB-53 through SB-75. Four additional borings were completed between May 22 and June 3, 1996. These borings labeled SB-76, SB-77, SB-78 and SB-79, were drilled in the center of the southeast parking lot.

3.5.1.1. Drilling methodology

Drilling of the DNAPL borings was conducted in a manner similar to drilling the on-site soil borings discussed in Section 3.4.2.2. DNAPL soil borings were advanced to the top of the low permeability glacio-lacustrine clay or till layer. In the event that DNAPL was encountered at the sand/clay interface, the boring was terminated in order to minimize the potential for DNAPL migration downward. If no DNAPL was encountered, borings were advanced to the glacial till/bedrock interface, and sampled continuously through the glacial till unit. Drill cuttings were drummed and disposed of by the Fort Edward GE facility EHS staff.

Continuous split-barrel soil samples were collected following ASTM standard D-1586 for the split-barrel sampling method. 24-inch (2-inch OD) split-barrel samples consisting of standard D-1586 for the split-barrel sampling method, a drive head, split-barrel and drive shoe, were used to collect the Split-barrel samples were subsurface samples. Following advancement of the hollow-stem auger to the top of the interval to be sampled, the split-barrel sampler was lowered to the bottom of the casing and driven into the undisturbed soil using 140-pound hammer with a 30-inch drop. The number of blows to achieve each 6 inches of penetration were recorded for each 2-foot interval sampled. All split-barrel samples were examined, classified and logged according to the Modified Burmister Classification and the Unified Soil Classification System by the O'Brien & Gere on-site hydrogeologist. Descriptions of soil sample texture, composition, color, consistency, moisture content, penetration, and percent recovery were recorded. Test boring logs describing the subsurface materials encountered in each boring were prepared by the on-site geologist.

Split-barrel samples were field screened using a PID and unaided visual inspections of the samples for the presence of DNAPL were performed. Additionally, examination of the fluorescence of the sample was performed in a dark area (e.g., a UV light box, back of a field vehicle, etc.) by scanning the sample with a UV light. The sample was left in the split-barrel sampler during the examination so that the sample interval of detected DNAPL, if any, could be determined.

Representative portions of the soil samples were retained in glass jars sealed with screw top lids. In compliance with ASTM methods, the sample jars were labeled with the following information: job designation, boring number, sample number, depth of sample, penetration record and length of recovery. Boring logs completed for each test boring are located in Appendix C.

If DNAPL was observed, a soil boring may have been converted into a 2-inch diameter PVC well to provide a mechanism for monitoring the thickness of DNAPL and the progress of DNAPL recovery operations. Soil borings which were not converted into monitoring wells were completely grouted to the surface using a cement/bentonite grout slurry.

3.5.1.2. Phase I test borings

The Phase I test boring program was initiated on November 15, 1994 and completed on December 20, 1994. A total of 22 test borings were installed as part of the RI. Two of the test borings were converted into permanent monitoring wells, designated OW-1 and OW-2. The test borings were advanced to the top of the low permeability glacio-lacustrine silt and clay unit. Six of the 22 test borings completed during Phase I were located approximately along the center line of Park Avenue, immediately to the south of the plant site. The remaining 16 test borings were located on the plant site. The locations of the test borings/monitoring wells are shown on Figure 1-2.

The test borings were advanced using hollow-stem auger drilling techniques. The only exception was the installation of test boring SB-11, where a hand auger was utilized to advance the boring the first 10.0 feet to clear utilities.

OP-Tech Environmental of Syracuse, New York drilled 19 of the 22 test borings in Phase I, including the installation of the two monitoring wells. Parratt-Wolff, Inc. of East Syracuse, New York performed the drilling of the remaining three Phase I test borings (i.e., SB-20, SB-21 and SB-22). A truck-mounted CME-75 drilling rig utilizing 4¼" ID hollow-stem augers was used to advance test borings SB-1 through SB-19. A truck mounted Ingersoll Rand A-200 drilling rig utilizing 3¼" ID hollow-stem augers was used to advance test borings SB-20-SB-22. All drilling activities associated with the Phase I program were supervised by an O'Brien & Gere geologist.

3.5.1.2.1. Monitoring well installation

Test boring SB-8 and SB-12 were converted into permanent monitoring wells based on substantial amounts of DNAPL that were observed while performing these test borings.

Monitoring well OW-1 (boring SB-8) was completed to a depth of 28.5 feet below grade. OW-1 is constructed of 2-inch, flush joint, schedule 40 PVC pipe with ten feet of 0.020 slot well screen set at approximately 18.5 to 28.5 feet below grade. With the well set at the correct depth, #1 Morie filter sand was gradually added to the annular space creating a sand pack extending from the bottom of the borehole to 2.0 feet above the screened portion of the well. A 1.0 foot thick bentonite pellet seal was then installed over the sand pack to seal off the screened interval from the remainder of the surficial aquifer. The remainder of the borehole was cement-bentonite grouted to the surface. A flush-mounted steel curb box was cemented over the well to prevent unauthorized access and to provide protection to the well. A detailed monitoring well completion log is provided in Appendix D.

Monitoring well OW-2 (boring SB-12) was constructed very similarly to OW-1 and completed to a depth of 27.3 feet below grade. The 0.020 slot PVC well screen was set from 21.3 to 27.3 feet below grade, with the #1 Morie sand pack extending 1.1 feet above the top of the screen. A 3.2 feet thick bentonite pellet seal was then installed in the annulus followed by the cement-bentonite grout and a flush mounted curb box. A detailed monitoring well completion log for OW-2 is located in Appendix D.

3.5.1.3. Phase II test borings

Subsequent to the supplemental GPR survey, a Phase II test boring program was implemented. The Phase II program's objective was to delineate the top of the low permeability unit and the extent of DNAPL in the southern parking lot.

The Phase II test boring program commenced on January 31, 1995 and concluded on February 9, 1995. A total of 14 borings were advanced to the top of the low permeability glacio-lacustrine silt and clay unit. The test borings in Phase II (designated SB-23 through SB-36) were drilled by Parratt-Wolff, Inc., utilizing a Mobile Drill 57B truck mounted drill rig. Hollow-stem auger drilling and continuous split barrel sampling techniques were used in the Phase II program. All drilling and associated activities implemented during the Phase II program were supervised by an O'Brien & Gere geologist.

3.5.1.4. Boring program within manufacturing buildings

Fifteen DNAPL soil borings were drilled on July 25 through August 3, 1995 inside the manufacturing building (buildings 25 and 27) (see Figure 1-2), utilizing a small skid-mounted drilling rig and a monopod. Soil borings were advanced by driving a 3-inch diameter flush joint casing through the unconsolidated materials. All reasonable attempts were made to advance the soil borings to the top of the low permeability glacio-lacustrine clay or till layer. However, due to the limitations of drilling at depth with this technique, the total depth of penetration is limited. Borings SB-53, SB-54, SB-56, SB-65, SB-66 and SB-69 were advanced into the glacio-lacustrine silt and clay unit, while borings SB-55 and SB-67 were advanced to the glacial till unit. Boring SB-57 through SB-60, SB-68, and SB-70 through SB-71 were advanced to bedrock.

3.5.1.5. Outside boring program

Eight DNAPL borings were drilled outside of the manufacturing building on August 17, 1995 through September 11, 1995 (Figure 1-2). Four borings, SB-61, SB-63, SB-64 and SB-72 were drilled in the driveway between the manufacturing building and the south parking lot. Three borings SB-73 through SB-75 were drilled in the south parking lot, and SB-62 was drilled near the former production well PW-2.

Drilling methods for these DNAPL borings were similar to the methods described in Section 3.4.2.2. In the event that DNAPL was encountered, drilling was terminated at the bottom of that unit to prevent migration of DNAPL into lower geologic units. If drilling was continued through the clay then the 4¼-inch ID HSA were advanced into the clay about 1 foot, helping to prevent contaminants from vertically migrating downward and then a drive casing was used to continue borehole advancement below the hollow-stem augers.

3.5.1.6. Till zone borings

Eleven till zone borings were also drilled on-site from August 15 to 23, 1995 (Figure 1-2), designated as TB-1 through TB-11. The till zone borings are located as follows: TB-5, TB-6, TB-7 and TB-10 are located by the former leach field, TB-3, TB-8 and TB-11 are located in the south parking lot, TB-1 and TB-2 are located in the vicinity of the old production well PW-1, and TB-4 and TB-9 are located in the driveway between the main manufacturing building and Building 30. The purpose of the additional soil borings was to provide information on the potential distribution of DNAPL in the glacial till layer. These soil borings were sampled continuously through the glacial till unit following ASTM Standard D-1586. Split barrel samples were field screened using a PID and the fluorescence of the sample, if any, was examined and noted. One monitoring well was installed within the till zone to determine relative PCB concentrations within this zone. This monitoring well is designated as OBG-26T, and is located in the southern portion of the site.

3.5.1.7. Transition zone borings and well installation

To further delineate both the lateral and vertical extent of PCBs and VOCs in ground water, several monitoring wells were installed within the "transition zone". The transitional zone consists of interbedded fine sand, silt and clayey-silt deposits between the overlying sand deposits and underlying glacio-lacustrine clay deposits in the southeastern portion of the facility. Four monitoring wells were installed during phase one of the RI between September 11-13, 1995. Monitoring well OBG-63, OBG-64, and OBG-65 are located along the southern edge of the facility along Park Avenue, and OBG-66 is located on the eastern edge of the parking lot in the southeastern portion of the facility.

Supplemental RI monitoring wells were installed between May 6 and May 14, 1996, and on September 23 and September 24, 1996. Wells OBG-80 and OBG-81 are located along the eastern edge of the facility, near Upper Broadway. Monitoring well OBG-82 and transition zone boring SB-80 are located in the southern parking lot near the southern property boundary. Monitoring wells OBG-76 and OBG-77 are located south of the facility across Park Avenue, on Broadway Lanes property. Monitoring wells OBG-78 and OBG-79 are located southeast of the facility, on Grand Union property. Exact locations of the transition zone wells are shown on Figure 1-2.

Drilling for the transition zone wells was performed in accordance with the methodologies already outlined in section 3.4.3.2. Detailed information for these soil borings is presented on soil boring logs in Appendix C.

Transition zone monitoring wells were installed in accordance with the methodologies outlined in section 3.4.3.3 except that transition zone well screens were 0.010-inch slot size and Morie grade 0 sand pack was used. For detailed information, refer to the well construction logs found in Appendix D. The screens for these wells were positioned such that the bottom of the screen and surrounding sandpack extends one or two feet into the underlying glacio-lacustrine clay unit. The screen extends up to within 2 or 3 feet of the top of the transition zone so as to not capture the ground water within the overlying sand unit. A 2 to 3-feet thick bentonite seal was used to seal off this overlying glacio-deltaic sand unit. Table 3-5 is a listing of the transition zone wells installed as part of the RI.

Table 3-5. *RI monitoring wells - transition zone.*

Phase I	Supplemental RI
OBG-63	OBG-76
OBG-64	OBG-77
OBG-65	OBG-78
OBG-66	OBG-79
	OBG-80
	OBG-81
	OBG-82

3.5.2. DNAPL field screening procedures

Split-barrel samples were field screened for the presence of DNAPL using a PID and unaided visual inspection. Subsequently, examination of the fluorescence of the sample was performed in a dark area (e.g., a UV light box, in a shaded location or in the back of a field vehicle) by scanning the sample with a UV light. The sample was left in the split-barrel sampler during the examination so that the sample interval of detected DNAPL, if any, could be determined. Bucket samples from hand augering were placed on aluminum foil and viewed under the ultraviolet light within the light box. If the samples had any odors they were also noted on the test boring log.

3.5.3. Decontamination procedures

Drilling and monitoring well installation program

The drilling program included decontamination procedures to prevent potential contaminants from being introduced into the borehole or transferred across the site. A temporary decontamination pad was constructed near the facility equalization basin. Decontamination took place at a location adjacent to the waste water treatment facility. Plastic sheeting was spread on the ground and a decontamination pit was constructed such that all decontamination wash water was contained and discharged into the equalization basin adjacent to the water treatment facility for treatment. At the conclusion of the drilling program, the decontamination pit was dismantled and the associated materials used to construct it (i.e., ground plastic) were containerized and characterized for disposal by the plant's EHS staff. Additionally, residual soils generated from steam cleaning that were deposited at the base of the decontamination pit were conveyed in a similar manner by the EHS staff.

Prior to drilling the first boring, the equipment used in drilling and well installation was cleaned to remove possible contaminants which may have been encountered during mobilization of drilling equipment to the site. Equipment which came into contact with the soil, as well as drill tools, augers, drill rod, hoses and the back of the drill rig, were initially cleaned. While working at the site, all drilling equipment coming in contact with soil was decontaminated between boring/well locations.

Well construction materials were transported to the site factory sealed in plastic. If the well construction materials were not sealed, they were decontaminated and sealed in plastic before beginning drilling at the first location.

The cleaning process involved the use of a high-pressure steam cleaner for all drill bits, augers, casings and split-barrel samplers between drilling each borehole. Split-barrel samplers and soil spatulas/hand tools were cleaned with a scrub brush and Alconox/or Liquinox and potable water solution. A rinse with potable water followed. This procedure was used in between each sampling interval. The UV lightbox was also cleaned with alconox/liquinox and potable water in between each borehole. Clean, potable water will be used for all decontamination and drilling procedures. Decontamination water was collected and treated at the facility wastewater treatment plant.

Additionally, test boring drilling equipment decontamination included a wipe down with a solution of hexane if DNAPLs were encountered. The hexane wipe down occurred after the initial steam cleaning and was subsequently followed by another steam cleaning.

Soil grab sampling program

The soil sampling program also included decontamination procedures to ensure that potential contaminants were not introduced to the borehole or transferred across the site. Prior to collecting the first soil sample, the equipment used in the sampling activities were cleaned to remove possible contaminants. Equipment that came into contact with the soil (i.e., hand augers and stainless steel scoops) underwent this initial cleaning process. While working at the site, the sampling equipment was decontaminated between samples. In addition, the equipment was decontaminated between sampling locations to prevent cross-contamination.

In order to prevent cross contamination, the following cleaning procedures were used:

- Non-disposable sampling equipment (i.e., hand augers, stainless-steel spoons, etc.) was scrubbed with potable water and a non-metallic detergent solution such as Liquinox^{TM};

- Each piece of equipment was rinsed in potable water;

- Each piece of equipment was rinsed with methanol;

- Each piece of equipment was then rinsed with distilled or deionized water;

- The sampling equipment was allowed to air dry; and

- The sampling equipment was placed in a labeled plastic bag and sealed to ensure that no outside contaminants were introduced prior to use at the next sample location or, in the event the sampling equipment was to be used shortly thereafter, the equipment was placed on a clean sheet of ground plastic.

Analytical soil sampling program

Decontamination procedures for the analytical soil sampling program were a combination of those used during drilling and monitoring well installation and those used during the soil grab sampling programs. All drilling equipment coming in contact with soil were cleaned with a high pressure steam cleaner. All non-disposable sampling equipment (i.e., bucket augers, split-barrels spoons and couplings, and steel hand spatulas were scrubbed with a potable water and non-metallic detergent solution (Liquinox^{TM}). Each piece of equipment was then rinsed with potable water and then with methanol, and allowed to dry. Each piece of equipment was then rinsed with distilled water and then allowed to air dry.

3.5.4. Observation well development

Observation wells OW-1 and OW-2 were developed using an inertial pump (i.e., Waterra pump) with an attached surge block to remove fine-grained materials from the sand pack and formation.

The inertial pumping technique utilized flexible polyethylene tubing and a check valve on the end. Well development proceeded by using a surge block attached to the foot valve to maximize the effectiveness of the surging action. The surging action forced water in and out of the screen/open borehole and pulled the fine-grained sediments in the sand pack/formation into the well. In conjunction with surging, ground water and sediments were removed from the well by the inertial pumping.

Monitoring wells OW-1 and OW-2 were developed on January 16, 1995 by O'Brien & Gere personnel. The volumes of water stored in the well casings of both wells were calculated prior to development. Observation well OW-1 was developed until approximately 60 gallons were removed. This represented approximately 24 well volumes.

Observation well OW-2 was developed until approximately 70 gallons were removed; which included an estimated 25 gallons of PCB DNAPL. This equates to approximately 30 well volumes.

3.6. Surveying

Relative elevations and locations for all newly-installed monitoring wells and soil borings completed in both the Phase I and the Supplemental RI drilling programs were surveyed by C.T. Male Associates, P.C., Latham, New York and by O'Brien & Gere. Monitoring well elevations were surveyed with an accuracy of 0.01 foot to a marked spot on the well casing. Surveying was tied into existing plant benchmarks and is compatible with previous surveying.

Surveyors from C.T. Male surveyed the 36 soil borings completed during the first two phases of the DNAPL drilling program in February 1995 (i.e., SB-1 through SB-36).

Surveyors from O'Brien & Gere were on site during four different occasions to survey both new and existing monitoring wells and borings at the Fort Edward plant site. New RI monitoring wells and borings, along with all previously existing on-site monitoring wells were surveyed from September 18 through 20, 1995. Previously existing monitoring wells were surveyed because of apparent discrepancies in the old survey data. O'Brien & Gere completed the survey of the RI monitoring wells and borings on November 16, 1995.

The Supplemental RI monitoring wells and borings were surveyed by O'Brien & Gere from June 11 through 12, 1996. The remaining two Supplemental RI monitoring wells, OBG-78 and OBG-79, which were installed on September 23 through 24, 1996, were surveyed on October 29, 1996.

3.7. Water level measurements

Water level measurements were obtained on a routine basis during the RI. Water levels were obtained bimonthly throughout the 1995 and 1996 calendar years with the exception of a portion of 1996, when they were obtained monthly between May and September 1996. Monitoring activities were performed by Specialized Environmental Monitoring (SEM) of Wilton, New York .

Dates of water level measurements are as follows: January 23, 1995; March 9, 1995; May 22, 1995; July 12, 1995; September 12, 1995; October 30, 1995; January 18, 1996; March 13, 1996; May 21, 1996; June 17, 1996;

July 30, 1996; August 27, 1996; September 23, 1996; and November 22, 1996.

Water level measurements were obtained with an electronic water level indicator. The depth to water was measured to the nearest 0.01 feet and, where present, the PVC riser pipe was used as the measuring point. The depth to water data were recorded on field data sheets with the approximate times of measurement. Depths to water were converted to water level elevations with respect to mean sea level using the surveyed elevations of the measuring points. The water level elevation data are presented in Appendix E.

3.8. Ground water sampling and analysis

3.8.1. Ground water sampling approach

As part of the remedial investigation program, ground water samples were collected from a total of 92 new and pre-existing monitoring wells, residential wells, and springs located in and around the GE Fort Edward facility. Ground water samples were obtained between October 30 and November 9, 1995 and submitted to the analytical laboratory for VOC and PCB analyses. In addition, two samples were collected and analyzed for semi-volatile organic compounds (SVOCs) analysis to comply with the regularly scheduled semi-annual sampling event. Seven of the monitoring wells scheduled to be sampled were dry. One monitoring well (GM-1) was inaccessible due to damage.

A confirmational ground water sampling event was performed as part of the remedial investigation on January 17, 1996. Ground water samples were collected from seven monitoring wells (i.e., GM-9D, GM-12D, OBG-56, OBG-63, OBG-64, OBG-65, and OBG-66) for VOC and PCB analysis. One additional sample was collected from monitoring well OBG-26T and analyzed for PCBs only.

As part of the supplemental remedial investigation program, ground water samples were collected from a total of 129 new and pre-existing monitoring wells, residential wells and springs located in and around the GE Fort Edward facility. Ground water samples were collected between June 17 and 26, 1996 and October 4, 1996 and submitted to the analytical laboratory for VOC and PCB analyses. In addition, three ground water samples were collected and analyzed for SVOC analysis to comply with the regularly scheduled semi-annual sampling event. Light non-aqueous phase liquid (LNAPL) was collected from two monitoring wells (i.e., FM-5 and FM-12) in Building 40 and analyzed for PCBs and product identification.

Five of the monitoring wells scheduled to be sampled were dry. Three ground water samples were only submitted for VOC analysis due to the limited volume of ground water in the monitoring well.

3.8.2. Monitoring well purging and purge water disposal

Ground water sampling was performed in accordance with the NYSDEC-approved RI FSP, (O'Brien & Gere, August 1995) and QAPP (O'Brien & Gere, August 1995).

For each well sampled, the volume of the water column in the well was calculated using the measured water level and known total depth. Ground water was then purged from each well to be sampled until three well volumes were removed or the well went dry, whichever came first. The wells were purged with dedicated Waterra(polyethylene) tubing and check valves, small diameter peristaltic (polyethylene) tubing, or dedicated bailers (polyethylene, teflon, or PVC). Depending on the depth of the well and volume required to evacuate, either the Waterra Hydrolift pump, centrifugal pump, or hand surging was used to remove the purge water from the well with the Waterra tubing. The ISCO peristaltic pump was utilized with the dedicated peristaltic tubing to remove the ground water from wells with low purge volumes (i.e., less than 6 gallons) and/or well diameters less than 2 inches. Dedicated bailers with nylon bailing line were also used to evacuate the water from slow recharging wells with small purge volumes.

The evacuated purge water was discharged into calibrated 5-gallon pails to keep an accurate account of the volume removed. Purge water removed from on-site and off-site monitoring wells was directly or indirectly added to the on-site equalization (EQ) basin for subsequent treatment at the Fort Edward Plant waste water treatment facility. However, purge water with a visible LNAPL or strong petroleum odor was containerized, labeled, and transported by the appropriate GE EHS staff for proper treatment and disposal.

The purge water in the 5-gallon pails was either directly added to the EQ basin or poured into one of the manholes or storm drainage grates which discharge into the EQ basin. The purge water in 5-gallon pails was also containerized in lined 55-gallon drums in remote or offsite locations and subsequently pumped into the EQ basin.

3.8.3. Sample collection

Each ground water sample was collected for VOCs first, followed by PCBs. Field QA/QC procedures included the collection of blind field duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples per 20 environmental samples. Trip blanks were included with each cooler transported to the laboratory. As specified in the QAPP, equipment blanks were not required to be collected because dedicated sampling equipment was used to collect the ground water samples. Each ground water sample was placed in a cooler containing wet ice immediately after sampling.

Sampling notes, including weather conditions, condition of the well, well purging and sampling details were recorded in the field notebook. Chain-of-custodies (COCs) were generated daily following procedures provided in the NYSDEC-approved QAPP. The COCs were signed by sampling personnel and the courier, sealed in a ziploc bag and placed in the cooler each evening. The cooler was sealed with two signed paper custody seals and clear tape. The sample cooler was transported to the laboratory by the courier the following morning. Upon laboratory receipt, the sample custodian documented and secured the samples in accordance with the QAPP.

3.8.4. Sample analysis

In accordance with the NYSDEC-approved RI FSP and QAPP, ground water samples were analyzed for VOCs using USEPA Method 624 modified to include additional volatile organic compounds from USEPA SW-846 Method 8021. These additional aromatic and halogenated compounds were included in the target compound list because a number of these constituents have been detected in previous ground water and soil sampling events conducted at the GE Fort Edward facility. The ground water samples were also analyzed for PCBs using USEPA Method 608 modified to achieve lower practical quantitation limits (PQLs) and SVOCs using USEPA Method 625. AES of Albany, New York performed the laboratory analyses. A discussion of the analytical results is provided in Section 6.3.

3.9. In-situ hydraulic conductivity testing

Hydraulic conductivity tests were conducted on each of the newly installed wells to estimate the hydraulic conductivity of geologic materials immediately surrounding each well. Hydraulic conductivity tests were performed on each well using either a solid PVC slug, a dedicated bailer, or a 1 to 2.5-gallon slug of deionized water to create the sudden perturbation in the water levels. In the majority of the monitoring wells, two tests were performed, either two slug or bail tests or one of each, depending on well construction and hydrogeologic conditions.

Testing was conducted by lowering a 5-feet long, 1½-inch diameter PVC slug into 2-inch PVC wells and observing the return of the water level back to static conditions or at least 90% recovery. Equipment lowered into monitoring wells was decontaminated prior to each test using a liquinox (a phosphate-free detergent)-distilled water wash and distilled water rinse. The second test was performed on each well immediately after the first by removing the PVC slug and monitoring the water level as it recovered to static conditions or at least 90% recovery. If the volume of water in a monitoring well was insufficient to test with a Teflon slug, or if the screen was only partly saturated, then water was bailed from the well using a dedicated Teflon bailer. The very quick recovery of some of the wells (i.e., some of the GM-series wells in the southeast parking lot) necessitated using 2.5-gallon slugs of deionized water, injected instantaneously, to create the perturbation in the water level. Water level recovery was measured using either a 5, 7 or 14 psi pressure transducer placed an appropriate depth below the water table. Transducer selection was based on the expected or potential range in water levels and availability and recorded with an AquiStar DL-12A 8-channel data logger. Data was recorded using TUBERs or an AquiStar data logger and associated pressure transducers manufactured by Instrumentation Northwest, Inc.

Due to very slow water level recovery rates in wells OBG-43BS, OBG-49BS and OBG-26T, only one test was conducted, and water levels were measured using an electric water level meter. If a significant volume of water was not available in a well to allow for a measurable perturbation in the water level, than the well was not tested. The following wells did not have a sufficient volume of water, and were therefore not tested; OBG-8b, OBG-42BS, OBG-56, OBG-83.

Interpretation of water level data from the hydraulic conductivity tests was performed using the Bouwer and Rice (1976) method for slug tests in an unconfined aquifer.

The principle behind the Bouwer and Rice (1976) method is that a plot of recovery data (S_o-S_t) versus time (t) theoretically follows a straight line on a semi-log plot. Horizontal hydraulic conductivity (K) is then calculated as follows:

$$K = [\ln(s_o)-\ln(s_t)]r^2_{ce}\ln(r_e/r_w)]/2Lt$$

where:

K = hydraulic conductivity;
L = length of well screen/sand pack (intake);
t = time since pumping began;
s_o = initial displacement in well;
s_t = displacement at time t;
r_e = equivalent radius over which head loss occurs
r_c = well casing radius;
r_w = well radius (borehole);

and,

$$r_{ce} = [r_c^2 + n(r_w^2-r_c^2)]^{1/2}$$

The Bouwer and Rice method assumes that the aquifer tested is unconfined, homogeneous and isotropic. This method is most appropriate for shallow wells cased in clean sands below the water table, but it is also applicable to aquifers that are not in strict accordance with the assumptions stated above. Additionally, application of the above equations to bedrock wells assumes that sufficient joints and bedding planes intersect the intake so as to behave like a porous medium with Darcian flow. Bouwer and Rice (1976) recommend computing an equivalent casing radius (r_{ce}) to correct for the porosity of the gravel pack when the height of the static water column in the well is less than the screen length.

A summary of hydraulic conductivity test results for wells tested during the RI are shown in Table 3-6. Additional details on data acquisition and analysis are presented in Appendix F.

3.10. Handling of investigation-derived material

The RI activities produced Investigation Derived Materials (IDM) which required appropriate management procedures. The various IDM included drill cuttings, ground water, drill rig decontamination fluids, sediments, and personnel protective equipment (PPE). The detailed handling procedures of this IDM are discussed below.

Table 3-6
Summary of Hydraulic Conductivity Data for Wells Tested During Remedial Investigation

General Electric Facility
Fort Edward, New York

Well ID	Hydraulic Conductivity (cm/sec)	(cm/sec)	Arithmetic Mean (cm/sec)	(ft/day)
Sand & Gravel Hydrogeologic Unit				
GM 12C	1.23E-03	NA	1.23E-03	3.49
GM 21	7.13E-02	9.74E-02	8.43E-02	239.09
GM 25	9.08E-02	5.27E-02	7.17E-02	203.34
GM 31	1.79E-02	1.65E-02	1.72E-02	48.69
GM 32	4.07E-02	3.79E-02	3.93E-02	111.47
GM 33	5.92E-02	6.10E-02	6.01E-02	170.33
GM 35	1.52E-02	2.88E-02	2.20E-02	62.36
Geometric Mean			**2.53E-02**	**cm/sec**
			71.73	**ft/day**
Sand Hydrogeologic Unit				
FM-1	5.42E-03	6.03E-03	5.72E-03	16.22
FM-2	8.71E-04	8.43E-04	8.57E-04	2.43
FM-6	5.56E-03	7.22E-03	6.39E-03	18.11
FM-7	3.83E-03	3.52E-03	3.67E-03	10.41
FM-8	2.41E-02	2.50E-02	2.46E-02	69.60
FM-9	9.34E-03	1.20E-02	1.07E-02	30.19
FM-10	7.22E-03	1.14E-02	9.28E-03	26.32
FM-11	1.34E-03	1.58E-03	1.46E-03	4.13
OBG-1A	1.73E-02	1.56E-02	1.65E-02	46.68
OBG-50	8.05E-04	1.16E-02	8.05E-04	2.28
OBG-51	2.10E-04	NA	2.10E-04	0.59
OBG-52	1.55E-04	NA	1.55E-04	0.44
OBG-53	8.71E-05	1.52E-02	7.62E-03	21.61
OBG-54	5.75E-03	7.50E-03	6.63E-03	18.79
OBG-55	1.41E-03	7.57E-03	4.49E-03	12.73
OBG-62	1.56E-03	NA	1.56E-03	4.41
OBG-67	1.34E-01	2.24E-02	7.82E-02	221.64
OBG-68	3.56E-03	1.89E-03	2.72E-03	7.72
OBG-69	2.30E-02	3.33E-02	2.81E-02	79.79
OBG-70	2.77E-02	2.09E-02	2.43E-02	68.90
OBG-71	8.55E-02	6.20E-02	7.37E-02	209.07
OBG-84	1.05E-02	1.13E-02	1.09E-02	30.96
OBG-85	4.01E-03	3.24E-03	3.63E-03	10.28
Geometric Mean			**5.17E-03**	**cm/sec**
			14.67	**ft/day**

Table 3-6
Summary of Hydraulic Conductivity Data for Wells Tested During Remedial Investigation

General Electric Facility
Fort Edward, New York

Well ID	Hydraulic Conductivity		Arithmetic Mean	
	(cm/sec)	(cm/sec)	(cm/sec)	(ft/day)
Transition Zone Hydrogeologic Unit				
OBG-42S	7.85E-04	5.26E-04	6.55E-04	1.86
OBG-63	3.27E-04	5.52E-04	4.40E-04	1.25
OBG-64	7.78E-05	2.92E-05	5.35E-05	0.15
OBG-65	1.81E-04	1.56E-04	1.69E-04	0.48
OBG-66	9.27E-05	8.09E-05	8.68E-05	0.25
OBG-76	2.87E-03	2.20E-03	2.54E-03	7.19
OBG-77	1.92E-03	2.56E-03	2.24E-03	6.35
OBG-80	4.19E-03	3.67E-03	3.93E-03	11.14
OBG-81	1.30E-03	1.84E-03	1.57E-03	4.46
OBG-82	1.51E-03	1.26E-03	1.39E-03	3.93
Geometric Mean			**6.37E-04**	**cm/sec**
			1.81	**ft/day**
Glacial Till Hydrogeologic Unit				
OBG-26T	3.04E-06	NA	3.04E-06	0.01
			3.04E-06	**cm/sec**
			8.62E-03	**ft/day**

Table 3-6
Summary of Hydraulic Conductivity Data for Wells Tested During Remedial Investigation

General Electric Facility
Fort Edward, New York

Well ID	**Hydraulic Conductivity**		**Arithmetic Mean**	
	(cm/sec)	**(cm/sec)**	**(cm/sec)**	**(ft/day)**
Bedrock Hydrogeologic Unit				
OBG-15BD	1.56E-05	1.32E-05	1.44E-05	0.04
OBG-15BS	7.74E-04	1.43E-03	1.10E-03	3.13
OBG-42BD	1.87E-03	1.47E-03	1.67E-03	4.73
OBG-43BD	2.75E-03	2.66E-03	2.70E-03	7.67
OBG-43BS	2.04E-07	6.47E-08	1.34E-07	0.00
OBG-46BD	2.02E-05	1.35E-04	1.35E-04	0.38
OBG-46BI	4.80E-06	5.37E-06	5.09E-06	0.01
OBG-46BS	1.12E-03	1.40E-03	1.26E-03	3.57
OBG-47BS	3.10E-05	3.66E-05	3.38E-05	0.10
OBG-49BD	2.14E-04	7.07E-05	1.42E-04	0.40
OBG-49BS	1.66E-07	NA	1.66E-07	0.00
OBG-72BI	2.71E-05	3.04E-05	2.87E-05	0.08
OBG-72BS	8.76E-06	8.76E-06	8.76E-06	0.02
OBG-73BI	6.24E-03	6.67E-03	6.45E-03	18.30
OBG-73BS	9.29E-06	9.17E-06	9.23E-06	0.03
OBG-74BI	6.59E-04	6.58E-04	6.59E-04	1.87
OBG-74BS	1.56E-04	1.11E-05	8.33E-05	0.24
OBG-75BI	1.73E-05	1.73E-05	1.73E-05	0.05
OBG-75BS	7.29E-05	8.76E-06	4.08E-05	0.12
Geometric Mean			**5.86E-05**	**cm/sec**
			0.17	**ft/day**

Table 3-6
Summary of Hydraulic Conductivity Data for Wells Tested During Remedial Investigation

General Electric Facility
Fort Edward, New York

Well ID	Hydraulic Conductivity		Arithmetic Mean	
	(cm/sec)	(cm/sec)	(cm/sec)	(ft/day)
Shallow Bedrock Hydrogeologic Unit				
OBG-15BS	7.74E-04	1.43E-03	1.10E-03	3.13
OBG-43BS	2.04E-07	6.47E-08	1.34E-07	3.81E-04
OBG-46BS	1.12E-03	1.40E-03	1.26E-03	3.57
OBG-47BS	3.10E-05	3.66E-05	3.38E-05	0.10
OBG-49BS	1.66E-07	NA	1.66E-07	4.71E-04
OBG-72BS	8.76E-06	8.76E-06	8.76E-06	0.02
OBG-73BS	9.29E-06	9.17E-06	9.23E-06	0.03
OBG-74BS	1.56E-04	1.11E-05	8.33E-05	0.24
OBG-75BS	7.29E-05	8.76E-06	4.08E-05	0.12
Geometric Mean			**1.88E-05**	**cm/sec**
			0.05	**ft/day**
Intermediate Bedrock Hydrogeologic Unit				
OBG-46BI	4.80E-06	5.37E-06	5.09E-06	0.01
OBG-72BI	2.71E-05	3.04E-05	2.87E-05	0.08
OBG-73BI	6.24E-03	6.67E-03	6.45E-03	18.30
OBG-74BI	6.59E-04	6.58E-04	6.59E-04	1.87
OBG-75BI	1.73E-05	1.73E-05	1.73E-05	0.05
Geometric Mean			**1.01E-04**	**cm/sec**
			0.29	**ft/day**
Deep Bedrock Hydrogeologic Unit				
OBG-15BD	1.56E-05	1.32E-05	1.44E-05	0.04
OBG-42BD	1.87E-03	1.47E-03	1.67E-03	4.73
OBG-43BD	2.75E-03	2.66E-03	2.70E-03	7.67
OBG-46BD	2.02E-05	1.35E-04	1.35E-04	0.38
OBG-49BD	2.14E-04	7.07E-05	1.42E-04	0.40
Geometric Mean			**2.62E-04**	**cm/sec**
			0.74	**ft/day**
Very Deep Bedrock Hydrogeologic Unit				
OBG-26BD	4.04E-07	1.35E-06	8.78E-07	2.49E-03
			8.78E-07	**cm/sec**
			2.49E-03	**ft/day**

3.10.1. Drill cuttings

The drill cuttings derived from the overburden and bedrock drilling were placed into 55-gallon steel drums. Each drum was labeled with the appropriate borehole identification(s), the dates on which the cuttings were generated, and a description of the type of waste (i.e., drill cuttings). Drum locations were reported daily to the GE EHS personnel at the facility, and the removal of the drums was completed by GE personnel. If water was present at the top of the drums after filling with drill cutting, speedy-dri was added to absorb excess water.

3.10.2. Ground water

Ground water produced during the development and sampling activities associated with the RI was temporarily containerized in 55-gallon steel drums with plastic liners. When a 55-gallon drum was 90% full, the drum was sealed and carefully transported to the equalization basin where the drums were pumped out by a sump pump into manhole 5. If the water was very turbid, containing a large quantity of suspended solids, then the sediment was allowed to settle prior to pumping into the equalization basin. Drilling fluids or development water from surging bedrock wells was containerized in 500 gallon poly tanks and sampled. All drilling fluids were discharged to the on-site EQ basin for treatment.

3.10.3. Decontamination materials

Solid decontamination materials (e.g., plastic sheeting, residual sediment) originating from RI activities or the drill rig decontamination pad were either containerized in 55-gallon steel drums or disposed of in the GE designated PCB roll-off, as requested by the GE EHS staff. The drums were labeled with the material description, origin of production, and date of containerization. Locations of these drums were similarly reported to GE EHS personnel and the removal of the drums were completed by EHS staff.

Decontamination fluids from the drill rig decontamination pad were pumped into manhole 5 during phase I drilling activities and directly into the equalization in the Supplemental RI.

3.10.4. PPE and associated debris

Used PPE, sample containers, aluminum foil, paper towels, etc. resulting from the RI activities (drilling, well installation, soil or ground water sampling, well development, hydraulic conductivity testing, hydraulic monitoring, water level monitoring, etc.) were either containerized in labeled 55-gallon drums and disposed of by GE staff or disposed of directly into the previously mentioned PCB roll-off.

3.11. Industrial sewer system assessment

The objective of the industrial sewer system assessment is to identify and evaluate the condition of select sewer pipes, manholes, and catch basins at the GE facility and assess the degree to which these sewer components may be serving as conduits for ground water migration or as reservoirs of contaminants that could potentially be released to the environment. In addition, the inspection is intended to satisfy the Corrective Action Provisions of the Part 373 permit regarding the performance of an integrity assessment of active industrial sewer lines which are suspected of having the potential to release hazardous constituents to environmental media.

3.11.1. Review and verification of existing facility plans

The initial task in the sewer system assessment was to review available facility drawings and piping plans in order to verify the location of sewer components and to develop a comprehensive, computerized map for use in subsequent phases of the RI. During this task, each of the manholes and pipe segments were assigned a number to facilitate identification of these components.

Field verification of manhole and catch basin locations was completed in August 1995. These components were then surveyed to define their horizontal location and surface elevation relative to established datums and existing benchmarks. Information obtained from the survey was transferred to the field map as it became available. Figure 3-1 is a map showing the underground storm and sanitary sewer piping identified during the industrial sewer assessment. In addition to active sewer lines, the map depicts the approximate location of abandoned sewer lines and manholes, both existing and removed.

3.11.2. Visual inspection of manholes and catch basins

After the initial verification step, on-site manholes and catch basins were opened and visually inspected from the surface. The visual inspections consisted of observing the interior of each manhole or catch basin and noting its construction and condition. The number of pipe inlets and outlets were identified and the depth to each of the pipe inverts was measured. Because of the configuration of the sewer system and the water elevation in the basin, much of the system was surcharged with water at the time of the initial visual inspection in November 1995. During subsequent inspections, in some cases involving manhole entries, detailed information on the condition of each manhole was obtained.

Field observations made during the inspections of the manholes and catch basins were recorded in field inspection sheets. Table 3-7 summarizes information on the configuration and construction of each manhole or catch basin inspected. The rim and invert elevations of the inlet and outlet pipes entering each manhole are included as well as the condition and approximate age of the structure. Table 3-8 presents information on the size and configuration of the pipe segments between each of the manholes. Pipe diameters, construction material, upstream and downstream pipe inverts, and pipe lengths are tabulated.

Table 3-7. *Manhole and catch basin inspection summary.*

Manhole ID	Rim elevation (ft msl)	Total depth (ft)	Outlet diameter (in)	Outlet invert (ft msl)	Year constructed	Matl. of construction
MH-1**	259.92	15.7	30	243.92	1946	CONC
MH-2**	260.15	14.0	30	246.53	1946	BRICK
MH-3**	261.32	13.0	30	248.34	1946	BRICK
MH-4	262.21	12.3	30	251.71	1946	BRICK
MH-5	262.38	10.3	30	251.71	1977	CONC
MH-6	263.44	10.5	30	252.25	1977	CONC
MH-7	263.15	11.3	30	251.75	1946	BRICK
CB-7A	260.46	5.0	6	256.17	1946	BRICK
CB-7B	260.64	4.0	6	256.67	1946	BRICK
CB-7C	260.34	3.8	6	55.92	1946	BRICK
CB-7D	260.54	4.0	6	256.04	1946	BRICK
CB-7E	260.34	4.0	6	256.36	1946	BRICK
CB-7F	260.50	6.0	6	257.42	1946	BRICK
CB-7G	260.73	4.3	6	258.4	1946	BRICK
CB-7H	260.83	6.8	6	258.16	1946	BRICK
MH-8	262.41	9.3	18	252.75	1946	BRICK
CB-8A	260.46	4.8	8	257.88	1946	BRICK
MH-9	262.67	8.7	18	253.17	1946	BRICK
MH-10	263.46	9.3	10	253	1946	BRICK
MH-11***	262	8.0	30	254	1977	BRICK
MH-12	260.85	5.2	24	255.77	1977	CONC
MH-12A	259.61	2.7	6	257.03	1977	CONC

Table 3-7. *Manhole and catch basin inspection summary.*

Manhole ID	Rim elevation (ft msl)	Total depth (ft)	Outlet diameter (in)	Outlet invert (ft msl)	Year constructed	Matl. of construction
MH-12B	260.00	1.0	8	259	1977	CONC
MH-13	262.36	6.0	24	256.69	1966	CONC
MH-14	263.07	6.7	18	256.57	1966	CONC
MH-14A	261.12	5.7	8	257.29	1966	CONC
MH-14B	261.19	6.2	10	257.02	1966	CONC
MH-15	262.73	11.0	12	251.55	1973	CONC
MH-16	262.89	11.2	12	251.74	1975	CONC
MH-17	262.46	10.7	12	252.39	1973	CONC
MH-21	261.32	4.3	12	257.24	1977	CONC
MH-22	262.45	5.3	14	257.37	1977	CONC
MH-23*	261.67	8.7	24	253	1966	CONC
MH-24***	262	8.5	24	253.5	1966	CONC
MH-25*	264.03	9.0	21	254.58	1966	CONC
MH-26*	261.43		21		1967	CONC
MH-27*	261.51	12.5	30	249.82	1946	BRICK
MH-28***	262.51	11.7	30	250.89	1946	BRICK
BASIN	262.10	14.6	6	-	1977	CONC

Footnotes:

* - abandoned manhole (inactive).

** - manhole removed during Outfall 004 in 1996 pipeline remediation project.

*** - manhole inaccessible (configuration estimated from historic maps).

Source: O'Brien & Gere Engineers, Inc.

Table 3-8. *Pipe segment inventory.*

Pipe segment ID	Upstream Junction	Downstream Junction	Length (ft)	Diameter (in)	Upstream Invert (ft msl)	Downstream Invert (ft msl)	Matl. of Construction
P-1	MH-5	BASIN	60	30	252.05	250.77	DIP
P-2	MH-6	MH-5	240	30	252.07	252.05	DIP
P-3	MH-7	MH-6	206	30	251.75	250.9	VCP
P-4	MH-8	MH-7	148	18	252.75	252.2	VCP
P-5	MH-9	MH-8	60	18	253.17	252.75	VCP
P-6	MH-10	MH-9	96	10	254.16	253.2	VCP
P-7	J-1	MH-7	236	10	254.71	252.56	VCP
P-8	J-2	J-1	100	8	255.42	254.71	VCP
P-9	J-3	J-2	110	6	255.89	255.42	VCP
P-10	J-4	J-3	37	6	256.08	255.89	VCP
P-11	CB-7E	J-4	75	6	256.36	256.08	VCP
P-12	CB-7F	CB-7E	86	6	257.42	257.01	VCP
P-13	CB-7G	CB-7F	86	6	258.4	257.5	VCP
P-15	MH-4	MH-5	321	24	251.71	251.96	DIP
P-16	MH-11	MH-4	93	30	254	253.71	DIP
P-17	MH-12	MH-11	331	24	255.68	253	DIP
P-18	MH-13	MH-12	53	24	256.69	255.7	DIP
P-19	J-6	MH-13	25	18	256.36	256.16	VCP
P-20	MH-14	J-6	34	18	256.57	256.36	VCP
P-21	J-7	MH-14	121	15	256.34	256.26	VCP
P-22	J-8	J-7	119	12	256.5	256.34	VCP
P-23	CB-14B	J-8	63	8	256.81	256.5	VCP
P-24	CB-14A	J-8	4	8	257.29	256.5	VCP

Table 3-8. *Pipe segment inventory.*

Pipe segment ID	Upstream Junction	Downstream Junction	Length (ft)	Diameter (in)	Upstream Invert (ft msl)	Downstream Invert (ft msl)	Matl. of Construction
P-25	MH-23	MH-4	110	24	253.13	252.44	VCP
P-26	MH-24	MH-23	139	24	254.59	253.43	VCP
P-27	MH-25	MH-24	136	24	254.58	254.21	VCP
P-28	MH-26	MH-25	33	24	255.27	254.58	VCP
P-29	MH-13	MH-26	52	24	256.69	255.27	VCP
P-30	MH-15	MH-4	115	12	251.53	249.96	DIP
P-31	MH-16	MH-15	33	12	251.72	251.7	DIP
P-32	CB-17	MH-16	128	12	252.29	251.81	DIP
P-33	BLDG-40	CB-17	140	12	253	252.38	DIP
P-34	MH-2	MH-1	295	30	246.53	244.73	VCP
P-35	MH-3	MH-2	285	30	248.31	246.67	VCP
P-36	MH-4	MH-3	60	30	248.43	248.34	VCP
P-37	MH-27	MH-4	309	30	249.26	248.51	VCP
P-38	MH-28	MH-27	219	30	250.9	249.34	VCP
P-39	MH-6	MH-28	10	24	250.9	250.9	VCP
P-40	BASIN	OUTFALL	1000	6	255	130	DIP
P-41	BLDG-40	MH-14	40	6	257.7	257.4	DIP
P-42	CB-12A	MH-12	33	6	257.39	257.35	DIP
P-43	CB-12B	CB-12A	77	6	259	257.36	DIP
P-44	BLDG-27	J-7	58	15	256.38	256.34	VCP
P-45	CB-7A	J-1	85	6	256.17	254.71	VCP
P-46	CB-7A	J-2	46	6	256.67	255.42	VCP
P-47	CB-7D	J-3	5	6	256.04	255.89	VCP
P-48	CB-7H	J-4	68	6	258.16	256.08	VCP
P-49	CB-7C	J-1	82	6	255.92	254.71	VCP
P-50	BLDG-27	J-5	180	12	257.5	256.34	VCP
P-51	BLDG-27	MH-13	180	12	257.14	256.69	VCP

Source: O'Brien & Gere Engineers, Inc.

3.11.3. Manhole sampling and analysis

Based on the identification of sewer lines which could potentially serve as ground water migration pathways or reservoirs of hazardous constituents, water samples were collected from a total of twelve manholes associated with these lines. Manhole sampling was conducted on January 10, 1996. Samples were collected in accordance with the RI field sampling plan (O'Brien & Gere 1995d) using a stainless steel beaker or by filling the sample bottle directly by lowering the container slowly into the standing water in the manhole. Table 3-9 provides a summary of the manhole samples collected.

Table 3-9. *Summary of wastewater sampling and analysis program.*

Manhole	Date	Analysis
MH-4	January 10, 1996	VOC, PCBs
MH-15	January 10, 1996	VOC, PCBs
MH-23[1]	January 10, 1996	VOC, PCBs
MH-25	January 10, 1996	VOC, PCBs
MH-13	January 10, 1996	VOC, PCBs
MH-14	January 10, 1996	VOC, PCBs
MH-5	January 10, 1996	VOC, PCBs
MH-7	January 10, 1996	VOC, PCBs
MH-8	January 10, 1996	VOC, PCBs
MH-9	January 10, 1996	VOC, PCBs
MH-10	January 10, 1996	VOC, PCBs

1. Sample of LNAPL also collected from MH-23
Source: O'Brien & Gere Engineers, Inc.

Analytical results of the sewer sampling and analysis are discussed in Section 6.4.

3.11.4. Television inspection of select sewer lines

Based on the results of the sewer sampling and analysis, many of the active-industrial sewer segments were identified as containing PCBs and VOCs. As described in the supplemental RI scope of work (O'Brien & Gere 1996), approximately 1500 feet of pipe along the west and southwest boundaries of the plant were intended to be video inspected, including both active and abandoned portions, to assess the condition of the pipelines having the potential to transport hazardous materials to the environment. Due to physical problems in gaining access to partially obstructed pipe segments, approximately 528 ft of abandoned sewer line could not be thoroughly video inspected. A total of 977 feet of pipe was video inspected. Video inspection of the industrial sewers at the Fort Edward plant was performed between July 24 and July 26, 1996. O'Brien & Gere retained Skanex Pipe Services, Inc. (Skanex) of Rochester, New York to document the condition of select sewer lines using closed-circuit television equipment.

Prior to the television inspection, the water level in the equalization basin was lowered to expose the invert of the basin inlet in order to drain as much water as possible from the storm sewer system. During a period of relatively dry weather, the water level was lowered to approximately 6 inches below the invert elevation of the 36-in diameter basin inlet pipe, leaving less than three feet of water in the basin.

With the level maintained at or below three feet, accessible segments of the pipeline were flushed using a high pressure hose fitted with a backflushing nozzle or jetting tool (hydrojet) to remove sediment and debris which may have accumulated in the pipe. Pipe clearing was typically accomplished by opening the downstream manhole cover of the segment to be cleared and deploying the hydrojet through the exposed end of the pipe. Because of standing water conditions in manhole MH-4, a temporary water dam was installed in the outlet pipe to keep the sump from backfilling with water as water was pumped over the dam toward the basin to expose the pipes. Water and debris was allowed to flow into downstream segments of the sewer and eventually into the equalization basin.

After the lines were cleared, a remote-controlled, chain-driven tractor with a mounted video camera was deployed into the pipe. The camera was operated remotely from a trailer parked next to the manhole. The cable reel was equipped with a counter so that as the camera moved along the pipe interior, the distance traveled was displayed on the video monitor and recorded on the videotape.

The video inspection allowed the interior of the active industrial sewer lines to be observed and the conditions noted, including any structural deficiencies, points of extraneous flow, and locations of laterals.

Based on the television inspection of selected segments of the active sewer lines and information obtained from visual inspection of accessible manholes, the integrity of the active industrial sewers at the GE Fort Edward plant appears to be tight. No inflow or infiltration of ground or surface water or other evidence that the sewers may be acting as conduits for ground water migration (i.e., leaky joints, cracked or offset pipes or damaged manholes) was observed. Results of the industrial sewer sampling and analysis activities are presented in Section 6.4.

4. Geologic conditions

4.1. Regional geology

4.1.1. Physiographic setting

The GE Fort Edward Plant is located in the Hudson-Champlain lowland physiographic province of New York. This lowland is a broad depression formed by erosion of soft shales and limestones of early paleozoic age, by the preglacial and interglacial Hudson River and by glacial scour during the Pleistocene. The region is characterized by open, sparsely wooded, flatlands with relatively low relief. Topographic elevations within the region are generally less than 400 feet above mean sea level. The principal drainage feature in the province is the southward flowing Hudson River from which the region derives its name. Unconsolidated glacial sediments composed of sand and clay comprise the floor throughout much of the valley. The long linear Hudson Valley extends for a significant distance to the south, and merges with the Champlain Valley to the north. East of the site, the New England Upland Physiographic Province is represented by the Taconic Mountains Subprovince. The Taconic Mountains consist of relatively resistant metamorphic slates and schists of Ordovician Age that have been transported in very large sheets (i.e., allochthonous sheets) from the ancestral mountain range which existed to the east. The entire allochthonous mountain mass is referred to as the Taconic Klippe and was transported by pushing along low angle thrust faults by compressional forces associated with the closing Iapetus ocean in a volcanic arc-continent collision during the Middle Ordovician "Taconic" orogeny (Chapple 1973; 1979; Rowley and Kidd 1981). West of the site, the Adirondack Upland Physiographic Province is represented by the Adirondack Mountains. The Adirondack Mountains consist of ancient (Pre-Cambrian) crystalline rocks which have resisted the effects of prolonged erosion. The Hudson-Champlain lowland is separated from the Adirondack uplands by major high angle faults produced by the tension occurring at the time of the opening of the early Atlantic Ocean. These high angle faults are expressed as many normal faults yielding tilted fault blocks and grabens (Piper 1985).

4.1.2. Glacial history

The Upper Hudson Valley Region of New York State was subjected to multiple glacial events during the Pleistocene Epoch. However, each glacial episode destroyed to a large degree the geologic record of the previous glaciation. Glacial deposits found in the northeastern portion of New York State were principally derived from the Late Wisconsin glaciation of the region. The Late Wisconsin or Woodfordian substage began approximately 20,000 years ago as evidenced by glacial drift on Long Island. The Laurentide ice sheet receded from New York State about 10,000 years ago. This retreat northward produced a series of proglacial lakes and recessional moraines. Landforms of New York have been reshaped only moderately by post-glacial processes, mainly along floodplains of streams and the adjacent valley walls (Cadwell et al. 1986).

The Late Wisconsin deposits in the upper Hudson-Champlain Valley are associated predominantly with the Hudson-Champlain Lobe of the Laurentide ice sheet. Glacial ice advanced generally from northeast to southwest along the bedrock structural grain (DeSimone and LaFleur 1985) depositing beneath it a dense layer of poorly sorted sediments and rock fragments known as lodgement till. As the Hudson-Champlain Glacial Lobe began to retreat, Glacial Lake Hudson formed in the lower Hudson Valley between the Terminal Moraine on Long Island and Staten Island and the margin of the retreating glacier (Cadwell, et al. 1986). With further retreat of the ice northward to the Hudson Highlands, this glacial lake continued to enlarge throughout the mid and upper Hudson Valley where it is known as Glacial Lake Albany (Cadwell, et al. 1986).

Further retreat of the Hudson-Champlain Lobe resulted in intervals of falling water levels coupled with six intervals of water level stability. The six stable water levels are: Lake Albany (360-380 feet and 340-350 feet), Lake Quaker Springs (300-320 feet), Lake Coveville (240-260 feet), Fort Ann I (200-220 feet), Fort Ann II (150-170 feet) and Fort Ann III (130-150 feet). It is believed that the transitions to lower lake levels were initiated by discharge through the glacial Mohawk Valley and eastern outlet channels (DeSimone and LaFleur 1985).

4.1.3. Regional bedrock stratigraphy

Figure 4-1 presents a generalized stratigraphic section of the bedrock stratigraphy in the Fort Edward area. The relative thickness shown for each of the formations is based on site specific information and published and unpublished information for the region (Fisher 1984, and Dames & Moore

1996). As shown in Figure 4-1, bedrock underlying the Fort Edward area is Late Cambrian [i.e., approximately 515 to 500 million years ago (mya)], and Lower and Middle Ordovician age (i.e.,. 500 to 445 mya).

The Late Cambrian and Lower Ordovician rocks in the Fort Edward region are represented by the Beekmantown Group. The Beekmantown Group is comprised of six formations. In ascending order, they are the Potsdam Sandstone, Ticonderoga, Whitehall, Great Meadows and the Fort Ann and Fort Cassin Formations (Fisher 1984). The Beekmantown Group ranges from 500 to 1600 feet in thickness and is composed of intermixed and interbedded quartz sands, carbonates and purer lime muds (Fisher 1984).

The Medial Ordovician age Isle LaMotte Limestone directly overlies the Beekmantown Group in the Glens Falls area. It is separated stratigraphically from the Beekmantown Group by the Knox unconformity. The Isle LaMotte Limestone ranges from 0 to approximately 65 feet in thickness and is composed of massive, fine grained, dark gray to black, sparsely fossiliferous and conchoidally fracturing limestone. In outcrop, the Isle LaMotte weathers to a light grey color.

The Glens Falls Limestone conformably overlies the Isle LaMotte Limestone. The Glens Falls Limestone is thin bedded, fine to medium grained, light and dark gray banded generally with horizontal bedding. In the Glens Falls area, this unit is typically 70 to 115 feet thick. The Glens Falls Limestone is very fossiliferous with brachiopods, bryozoans, gastropods and trilobites predominating (Fisher 1984).

The upper most bedrock unit in the vicinity of the Fort Edward Plant site is the Snake Hill Formation, a dark grey shale of Medial Ordovician age. The Snake Hill Formation consists primarily of dark gray to black calcareous shale, mudstone, with few siltstone beds. The Snake Hill Formation is contorted and crumpled throughout most of Washington County particularly to the east of Fort Edward. The unit is typically cut by cleavage planes and slip planes that often give it a glazed appearance. The Snake Hill Formation is reported to be up to 1,500 feet thick in the Glens Falls area (Fisher 1984).

4.2. Site geology

With the exception of fill, unconsolidated deposits of glacial origin unconformably overlie the bedrock throughout much of the Fort Edward Plant area. The glacial deposits are associated with the Hudson-Champlain Lobe of the late Wisconsin Laurentide ice sheet (Cadwell, et al. 1987).

Five types of unconsolidated sediments have been identified at the site. These include glacial till, glacio-lacustrine silt and clay, a transitional zone, glacio-deltaic sand and gravel and artificial fill. The unconsolidated deposits are underlain by the Snake Hill Formation.

Four geologic cross-sections have been prepared to illustrate the relationship between the unconsolidated glacial deposits and the underlying bedrock. Figure 4-2 is a cross-section (A-A') starting at well cluster OBG-46, located in the southwestern portion of the plant site, continuing eastward along the southern property line to well OBG-79, located on the Grand Union property, east of Upper Broadway. Figure 4-3 shows a cross-section (B-B') starting at well GM-36, located northeast of the Foil Mill, running southeastward diagonally through the Foil Mill, the railroad off-loading area, the main manufacturing building and continuing southeast through the parking lot ending at OBG-78, located on the Grand Union property, southeast of the plant site. Figure 4-4 shows a cross-Section (C-C') starting at well cluster OBG-48, located west of Lower Allen Street, near the Hudson River, running eastward through the former 004 area, the former leachfield area ending at well location OBG-66 adjacent to Upper Broadway. Figure 4-5 shows a cross-section (D-D') starting at well cluster OBG-46, located in the southwestern corner of the site adjacent to the equalization basin, running north along the western property boundary of the plant site ending at well location GM-38, located in the northwestern corner of the site. The locations of each of the cross-sections are also shown in Figure 4-6.

4.2.1. Unconsolidated deposits

Glacial till observed directly overlying bedrock at the site is composed of a poorly sorted mixture of sand, gravel, and sometimes cobbles in a matrix of fine sand and silt with occasional clay seams. The glacial till unit is absent in the area around the equalization basin, located in the southwestern portion of the site, where it appears to have been removed during the excavation activities associated with the construction of the basin. With the exception of well location OBG-49, the glacial till unit appears to be present across the remainder of the site and ranges in thickness from 0 to 18.7 feet at well location OBG-47.

Two different types of glacial till were observed at the site. The uppermost till is best described as grey clayey silt with some medium to fine sand and a trace of fine gravel. Blow counts were generally less than 10 and the field descriptions generally indicate that this till unit is soft, wet, and loose.

These characteristics are indicative of an ablation till which was deposited during melting of the overlying glacier. The other type of glacial till is typically described as a dark grey to black clayey silt with some coarse to fine sand and little medium to fine gravel. Blow counts for this till type were higher ranging from 10 to 50, and the field descriptions generally indicated that this till unit is hard, dry, dense, and somewhat crumbly. This till was encountered more often than the first and is characteristic of lodgement till which was deposited by the glacier and compacted in place due to the high pressures associated with the mass of the overlying glacier.

Both types of glacial till were observed in many of the borings in the vicinity of the Foil Mill and the former leachfield, which corresponds to the areas where bedrock is at its highest elevation. In general, where both types of glacial till were observed, the softer glacial till was found overlying the more dense till.

Glacio-lacustrine silt and clay deposits are generally observed overlying the glacial till unit. The glacio-lacustrine silt and clay unit ranges in thickness from 44.9 feet at well location OBG-42 at the northeast corner of the site adjacent to Upper Broadway and thins out to zero feet in the vicinity of the Foil Mill, the area of the former leachfield and the equalization basin where little to no glacio-lacustrine silt and clay unit is observed.

The glacio-lacustrine silt and clay unit also appears to be absent along the subsurface bedrock ridge which runs approximately N30°E along the western portion of the plant site (as shown on Figure 4-7) but is observed again along the westernmost property boundary and in the area west of Lower Allen Street.

The glacio-lacustrine silt and clay unit can best be described as dark grey silt and clay, with frequent clayey silt seams and occasional fine sand partings. Descriptions range from a dark grey to brown varved silty clay to grey clayey silt, with frequent silt and clay seams and fine sand partings. Generally this unit is brown to red at the top and gradually changes to grey over the top 1 to 2 feet of the unit.

Overlying the glacio-lacustrine silt and clay unit in the eastern and southeastern portions of the site is a sequence of light gray sand and silt interbedded with frequent seams and partings of clay and silt which become more frequent with depth. This zone has been designated the transition zone and represents a change in depositional environment from a deep water , low energy glacial lake environment to a higher energy , near shore environment.

The transition zone ranges in thickness from 22.3 feet at well location OBG-65 in the southeast corner of the site adjacent to Upper Broadway and pinches out to the west in the vicinity of recovery well RW-1A. As shown in Figures 4-2, 4-3 and 4-4, the transition zone is observed as a wedge shaped deposit which appears to thicken in a southeasterly direction reaching its maximum observed thickness in the vicinity of Upper Broadway. Within the southeast parking lot, the thickness varies from 1.0 to 22.3 ft, thickening quickly east of GM-27. In the central portion of the parking lot the transition zone thickness increases to a maximum observed thickness of 8.8 feet at SB-23 and then decreases again forming a lenticular shape, in a cross-sectional view.

The uppermost unconsolidated unit at the Fort Edward Plan is a 4.1 to 42.9 feet thick unconsolidated deposit of glacio-deltaic sand and gravel that thickens to the east and south across the study area. The glacio-deltaic sand and gravel unit is thinnest in the western portion of the site in the vicinity of the Foil Mill, equalization basin and former leachfield area and ranges from 4.1 to approximately 10 feet in thickness. As shown in Figures 4-2, 4-3 and 4-4, this unit thickens considerably to the east and is observed at a thickness of 28.4 feet at well location OBG-81, located along the eastern property boundary of the site. The thickest accumulation of the sand and gravel unit is observed south of the plant site with an observed thickness of 42.9 feet at well location OBG-61, located near Griffin Avenue.

The glacio-deltaic sand and gravel unit is ubiquitous throughout the site and is best described as brown coarse to fine sand with a little fine gravel. In general, the grain size varies slightly from the northern and western portions of the facility to the southeast portion of the facility. Generally, the sand becomes coarser and the gravel component increases in the southeast portion of the facility.

Natural and artificial fill materials were observed at well locations OBG-46 and OBG-56 located in the vicinity of the equalization basin and below the foundation of the Foil Mill and main manufacturing building. The fill materials consist predominantly of sand, however, there were varying amounts of broken rocks, gravel and masonry mixed in with the sand. In addition, where the main manufacturing building was built over old driveways and parking areas, asphalt and concrete were encountered.

4.2.1.1. Confining unit structure

In order to gain a better understanding of the distribution of DNAPL in the subsurface, geologic information collected during various drilling programs has been used to develop a top of low permeability unit (i.e., confining unit) contour map (see Figure 4-6). In general, the confining unit at the plant site is the glacio-lacustrine silt and clay unit, however, as discussed previously, this unit is not contiguous across the site. In the vicinity of the Foil Mill, former leach field and the equalization basin this unit is absent and the glacial till unit becomes the confining unit forming a glacial till ridge that trends in a north-northeast to the south-southeast direction.

As shown in Figure 4-6, the elevation of the top of the low permeability unit varies at the plant site from a high of 257.4 feet amsl at well FM-8 located in the Foil Mill to a low of 213.6 feet amsl at location OBG-78, located in the Grand Union parking lot southeast of the plant site. The top of the low permeability unit in the western and central portion of the facility manifests itself as a ridge oriented approximately N15°E, nearly coincident with the bedrock ridge described earlier. From this ridge, the top of the low permeability unit generally slopes fairly uniformly to the southeast. To the west of the glacial till ridge, the top of the low permeability unit generally slopes to the west to a low of 247.7 feet amsl at well location OBG-48, located near the former 004 outfall adjacent to the Hudson River. An exception to the general westerly slope occurs at the southwest corner of the Foil Mill where there is a significant depression in the top of the glacial till unit at boring location TB#4 where the glacial till unit was observed at an elevation of 248.1 feet amsl.

South of the main manufacturing building, the general slope in the top of the low permeability unit breaks and a flatter area is formed, including a small depression which is observed in the vicinity of soil borings SB-19 and SB-76 at an elevation less than 234 feet amsl. In general, this flatter area is where the accumulation of PCB DNAPL is observed.

4.2.2. Bedrock

4.2.2.1. Bedrock topography

Table 4-1 presents the depth to bedrock determined at numerous drilling locations and the top of bedrock elevations derived from borings drilled as part of this RI and previous investigations.

The depths to bedrock observed during boring completion ranged widely across the site from 5 to 85 feet BG. Generally, the depth to bedrock ranges from 5 to 25 feet BG in the vicinity of the Foil Mill, former leachfield, and the equalization basin. In the eastern and south central portion of the site, the depth to bedrock ranges from 20 to 45 ft below grade. In the parking lot in the southeastern corner of the site the top of bedrock drops off significantly and the depth to bedrock ranges from 40 to 85 ft below ground surface.

Figure 4-7 presents a generalized contour map of the bedrock surface at the Fort Edward plant and the surrounding area. The elevation of the top of bedrock varies at the plant site from a high of 256.2 feet amsl at boring W-10, located in the vicinity of the equalization basin to a low of 176.1 feet amsl at well GM-40D, located in the southeast corner of the plant site. In the western portion of the plant, there is a northeast-southwest trending bedrock ridge which extends from the equalization basin to the parking area just east of the Foil Mill. Northwest of this bedrock ridge the top of bedrock undulates somewhat but generally dips to the northwest at a gradual slope.

A bedrock low is observed between well location OBG-47BS and well cluster OBG-26 where top of bedrock elevations are 230.6 feet amsl and 233.8 feet amsl, respectively. As shown in Figure 4-7, with the exception of a sharp drop in elevation between boring TB-1 and former production well PW-1, the top of bedrock slopes fairly uniformly from the central portion of the plant site towards the southeast.

TABLE 4-1
DEPTH TO BEDROCK AND BEDROCK SURFACE ELEVATIONS

General Electric Facility
Fort Edward, New York

Well No.	Ground Elevation	Depth to Bedrock	Bedrock Elevation
GM 1(abandoned)	262.3	18.0	244.3
GM 2	262.9	15.8	247.1
GM 3	260.0	10.9	249.1
GM 8DR	261.2	28.0	233.2
GM 9D	263.0	18.5	244.5
GM 11D	262.1	12.5	249.6
GM 12D	260.9	60.0	200.9
GM 14	260.6	8.0	252.6
OBG-15BS	261.5	15.0	246.5
OBG-15BD	261.2	15.1	246.1
GM 26D	263.8	30.0	233.8
OBG-26T	263.7	29.3	234.4
OBG-26BD	263.7	25.0	238.7
GM 40D**	261.1	85.0	176.1
PW-1(abandoned)	261.7	38.0	223.7
PW-2(abandoned)	261.7		
OBG-42BS	266.4	45.2	221.2
OBG-42BD	267.0	46.5	220.5
OBG-43BS	262.6	13.2	249.4
OBG-43BD	262.7	13.0	249.7
OBG-44BS	261.4	14.9	246.5
OBG-44BD	261.2	16.0	245.2
OBG-45BS	261.0	22.0	239.0
OBG-45BD	261.1	23.0	238.1
OBG-46BS	260.3	7.0	253.3
OBG-46BI	260.2	8.0	252.2
OBG-46BD	260.2	8.0	252.2
OBG-47BS	262.7	32.1	230.6
OBG-48BS	261.0	22.9	238.1
OBG-48BD	260.9	22.0	238.9
OBG-49BS	262.3	19.0	243.3
OBG-49BD	262.3	19.0	243.3
OBG-52	260.7	11.7	249.0
OBG-53	262.8	8.4	254.4

TABLE 4-1
DEPTH TO BEDROCK AND BEDROCK SURFACE ELEVATIONS

General Electric Facility
Fort Edward, New York

Well No.	Ground Elevation	Depth to Bedrock	Bedrock Elevation
OBG-54	261.2	10.9	250.3
OBG-55	263.2	14.0	249.2
OBG-56	260.4	6.3	254.1
OBG-72BS	261.9	11.5	250.4
OBG-72BI	262.0	12.4	249.6
OBG-73BS	260.2	10.2	250.0
OBG-73BI	260.4	10.6	249.8
OBG-74BS	262.1	14.7	247.4
OBG-74BI	262.0	14.7	247.3
OBG-75BS	262.8	20.8	242.0
OBG-75BI	262.9	20.8	242.1
OBG-84	258.6	9.7	248.9
OBG-85	258.5	8.7	249.8
SB-37	262.4	17.2	245.2
SB-39	262.7	14.0	248.7
SB-42	260.6	7.4	253.2
SB-47	262.8	7.9	254.9
SB-48	262.7	7.9	254.8
SB-49	261.7	9.4	252.3
SB-50	262.9	10.0	252.9
SB-57	263.5	17.8	245.7
SB-58	263.5	19.2	244.3
SB-59	260.6	12.5	248.1
SB-60	261.0	13.7	247.3
SB-61	260.7	17.3	243.4
SB-62	261.7	38.7	223.0
SB-63	260.8	48.8	212.0
SB-68	263.5	33.7	229.8
SB-70	263.5	17.8	245.7
SB-71	263.5	19.1	244.4
SB-72	261.5	49.0	212.5
SB-73	261.2	53.7	207.5
SB-74	261.1	54.3	206.8
FM-4	264.1	11.7	252.4

TABLE 4-1
DEPTH TO BEDROCK AND BEDROCK SURFACE ELEVATIONS

General Electric Facility
Fort Edward, New York

Well No.	Ground Elevation	Depth to Bedrock	Bedrock Elevation
TB-1	262.4	20.0	242.4
TB-2	261.9	43.0	218.9
TB-3	261.4	34.9	226.5
TB-4	261.2	13.3	247.9
TB-5	262.0	11.6	250.4
TB-6	261.2	14.5	246.7
TB-7	263.2	15.3	247.9
TB-8	263.8	27.0	236.8
TB-9	262.9	20.0	242.9
TB-10	262.8	14.2	248.6
TB-11	262.7	18.2	244.5
B-2-95	260.8	22.9	237.9
B-4-95	261.3	22.5	238.8
B-5-95	261.1	23.5	237.6
B-6-95	261.2	19.9	241.3
B-7-95	260.6	21.4	239.2
B-8-95	260.0	22.5	237.5
B-9-95	260.3	23.5	236.8
B-10-95	259.6	22.0	237.6
B-11-95	260.9	21.0	239.9
B-12-95	261.0	16.0	245.0
B-13-95	260.3	14.5	245.8
B-14-95	260.9	14.5	246.4
B-15-95	261.1	13.0	248.1
B-16-95	260.9	17.5	243.4
B-18-95	260.0	22.9	237.1
B-19-95	261.5	13.0	248.5
B-20-95	260.6	17.0	243.6
B-21-95	260.2	21.3	238.9
B-22-95	260.8	13.0	247.8
B-23-95	260.8	13.0	247.8
B-24-95	261.0	12.0	249.0
B-25-95	260.7	13.5	247.2

TABLE 4-1
DEPTH TO BEDROCK AND BEDROCK SURFACE ELEVATIONS

General Electric Facility
Fort Edward, New York

Well No.	Ground Elevation	Depth to Bedrock	Bedrock Elevation
TB #1	262.5	20.0	242.5
TB #2	262.4	18.0	244.4
TB #3	262.1	18.0	244.1
TB #4	262.1	17.0	245.1
TB #5	260.0	15.0	245.0
TB #6	261.5	17.0	244.5
TB #7	260.5	9.0	251.5
TB B-1	262.6	19.8	242.8
TB B-2	261.4	19.0	242.4
TB B-4	263.3	16.5	246.8
TB B-5	260.1	11.8	248.3
TB B-6	261.6	15.5	246.1
W-5	261.4	7.0	254.4
W-6	261.5	7.5	254.0
W-7	260.6	5.5	255.1
W-8	261.1	6.5	254.6
W-9	260.5	7.3	253.2
W-10	261.2	5.0	256.2
W-11	259.6	13.0	246.6
W-12	260.4	23.0	237.4
W-13	259.9	19.5	240.4
W-14	260.1	21.5	238.6
W-15	260.4	22.5	237.9
W-16	261.1	24.0	237.1
W-201	261.3	85.0	176.3
W-202	265.7	45.5	220.2
W-203A	262.7	39.5	223.2
W-215A	261.8	23.0	238.8
W-217A	260.4	61.5	198.9

Notes:
1. All depths in feet below grade
2. All elevations in feet above mean sea level
3. Only wells and/or borings which encountered bedrock are shown

4.2.2.2. Bedrock lithology

The bedrock immediately underlying the unconsolidated deposits in the vicinity of the Fort Edward plant are the shales of the Middle Ordovician Snake Hill Formation. Bedrock cores were collected during the RI activities from well locations OBG-15, OBG-42, OBG-43, OBG-46, OBG-47, OBG-49, OBG-72, OBG-73, OBG-74 and OBG-75. In addition, bedrock core logs were obtained from previous investigations performed at the plant site.

The most complete and comprehensive rock core obtained is from the boring of deep well OBG-26BD, which was obtained as part of the Deep Bedrock Ground Water Evaluation. OBG-26BD is located along the southern boundary of plant site and was drilled to a total depth of 599 feet BG, thus, making it the deepest corehole drilled at or near the Fort Edward plant. This corehole penetrates the greatest stratigraphic range of rock and represents a type section for the study area. All other borings drilled at or in the vicinity of the Fort Edward plant fall within this range and may be correlated based on formation lithology, character and thickness. In addition to deep well OBG-26BD, former production wells PW-1 and PW-2 are deep wells that were drilled to total depths 587 and 573 feet BG, respectively. As discussed in Section 3.2.1, geophysical logging of former production well PW-1 was performed prior to its decommissioning. The results of the geophysical logging has been used in conjunction with the rock core from OBG-26BD to formulate the type section for the study area.

The Snake Hill Formation is the highest and youngest formation encountered in the study area. Based on the results of the rock core from well OBG-26BD, the geophysical log from former production well PW-1 and investigations being performed in the Hudson Falls area, the Snake Hill Formation has been differentiated into three distinct units, these are the Upper, Middle and Lower Snake Hill Shale. The Upper Snake Hill Formation consists of approximately 200 feet of dark grey to black, fine grained, moderately folded, massive to moderately jointed shale. The shale is smooth to rough textured, sub-horizontally bedded, with occasional calcite and pyrite filled stringers and seams. The rock quality designation is typically good to excellent ranging from 75 to 100%. In core obtained at the Fort Edward plant, fossils were essentially unobserved, however, published literature suggests that some fossils exists in the occasional siltstone beds which occur in the Snake Hill (Fisher 1984). With the exception of wells OBG-26BD, PW-1 and PW-2, all of the bedrock wells at the Fort Edward Plant are screened within the Upper Snake Hill Formation.

The Middle Snake Hill Shale is approximately 35 feet thick, is characteristically banded and exhibits high angle cleavage planes, although the bedding is still horizontal. The Middle Snake Hill is typically cut by many minor cleavage planes and slip planes that are often observed as slickensided surfaces. Two major slip planes were encountered, one near the upper and one near the lower bounds of this unit. The lower fault plane is highly calcitic and approximately 4 feet beneath the lower fault plane there is a regionally correlated gray banded pyrite filled zone (Dames & Moore 1996).

The Lower Snake Hill Shale consists of approximately 130 feet of a harder calcareous argillite with conchoidal fracturing and pyrite layers. The shale is smooth textured, moderately to highly jointed, exhibits angular bedding, with occasional calcite and pyrite filled stringers and seams. In core obtained at the Fort Edward plant, pyrite nodules were observed, most likely representing pyritized trilobites, graptolites and lingulid brachiopods that were indicated to be present in the published literature (Fisher 1984). Near the base of this unit, two prominent mineralized shear zones were observed in the OBG-26BD core at 405.1 and 417.4 feet BG. These two shear zones were also correlated with the geophysical log from PW-1.

The Glens Falls Limestone lies below the Snake Hill Formation. Based on the geophysical log from former production well PW-1, this unit is 115 feet thick and in core consists of dark grey to black, fine to medium grained, massive to moderately jointed limestone. This unit is thinly bedded, and fossil-rich (mainly brachiopods). The Glens Falls limestone is a shallow water carbonate (approximately 25% carbonate), with an increased mud content. A volcanic ash fall layer (Siltstone Marker) exists at 15 to 17 below the contact between the Lower Snake Hill Formation and Glens Falls Limestone.

The Isle LaMotte Limestone lies below the Glens Falls Limestone. The Isle LaMotte Limestone ranges from approximately 20 to 45 feet in thickness and is composed of massive, fine grained, dark gray to black, sparsely fossiliferous and conchoidally fracturing limestone.

Underlying the Isle LaMotte Limestone is the Beekmantown Group. The Beekmantown Group consists of massively jointed, coarse to fine grained, dolomitic limestone and dolostone. The Fort Ann Formation is the highest and youngest formation within the Beekmantown group identified at the Fort Edward plant and consists of massive, medium to thick bedded, mottled, fossiliferous, medium to dark grey dolomitic limestone and calcitic dolostone. The Fort Ann Formation is the lowest bedrock formation penetrated at the Fort Edward facility and was encountered at a depth of approximately 565 feet BG.

4.2.2.3. Bedrock structure

As part of the bedrock investigation, a photolinear analysis was completed. Several sets of air photos were examined to assist in determining regional trends of bedrock fracturing. Due to the dense urbanization in the immediate vicinity of the site, only larger more regional photoliners were recorded. The preferred orientation of approximately N30E was observed. It is believed that the pattern observed is related to the regional faulting patterns in the area.

In addition to the photo linear analysis, a field joint orientation analysis was conducted. Joint orientations were measured from three bedrock exposures along a half-mile stretch of the Hudson River. Approximately 50-75 joints were measured at each site. The principal joint sets identified trended roughly N30E, N/S and N80W. Joint spacing at all three locations averaged between 0.5 to 1.0 feet.

5. Hydrogeology

5.1. Climate and water budget

Daily climatic data regarding precipitation and temperature has been obtained for the 1995 calendar year and from January 1 to September 30, 1996 from the Glens Falls Airport, in Glens Falls, New York. This data was obtained from the Northeast Regional Climate Center located in Ithaca, New York. The Glens Falls weather station is located approximately five miles north-northwest of the Fort Edward facility.

The total precipitation for the 1995 calendar year was 30.99 inches and the average temperature was 46.1 degrees Fahrenheit (F). Based on data from the Glens Falls Airport collected over a 30 year period (i.e., 1961 to 1990) the normal annual precipitation in the vicinity of the Fort Edward facility is 36.16 inches and the normal average temperature is 44.9 degrees F. Therefore, the total precipitation for 1995 was approximately 5-inches less than normal and temperature was approximately one degree above normal. Figure 5-1 graphically summarizes the monthly precipitation and temperature data versus normal monthly precipitation and temperatures for the 1995 calendar year, and January through September 1996.

The available climatic data have been used to perform a water budget for the 1995 year. In a water budget, mean monthly potential evapotranspiration (PET) and overland run-off are subtracted from mean monthly precipitation to obtain a water surplus or deficit value. Ultimately, an estimate of ground water recharge can be developed. Normally, a water surplus exists from January through May and from September through December. During such times ground water recharge can occur. The high PET during late spring and summer creates water deficit conditions which normally prevent significant recharge. During this period of high PET, the moisture content of the soil can drop well below field capacity. The soil moisture deficit must be overcome before recharge can again occur.

As stated above, the average annual precipitation is 36.16 inches in the vicinity of the facility. The average annual PET is estimated to be 24.42 inches using Hamon's (1961) methodology. Thus, an average of 11.74

inches is available for run-off and recharge and to overcome soil moisture deficits. Figure 5-2 shows the average calculated water budget for 1995 on a month-by-month basis. Water budget conditions change from year to year as actual climatic conditions deviate from normal. The total annual precipitation at the Glens Falls Airport was 30.99 inches in 1995. The estimated total annual PET for this year was 25.56 inches. The estimated annual surplus for 1995 was 5.43 inches.

During the first three quarters of 1996 (January-September), 27.88 inches of precipitation was recorded at the Glens Falls weather station. This is slightly greater than the normal precipitation for the same period (27.22 inches).

5.2. Hydrogeologic system

The conceptualization of the hydrogeologic system at the Fort Edward facility has been developed based on information obtained during various investigations performed at the facility and includes four hydrogeologic units: the shallow unconsolidated unit, the transition zone unit, the low permeability confining unit and the shallow bedrock unit. As discussed below, these units differ in their physical properties, ground water flow patterns, seasonal climatic changes and response to pumping and precipitation events.

The shallow unconsolidated unit is composed of glacio-deltaic sand and gravel and has a thickness ranging from 4.1 to 42.9 feet. The water table generally occurs in this unit under unconfined conditions and is free to rise and fall in response to ground water recharge and discharge. With the exception of less permeable surface areas (e.g., parking lots, roads and buildings), precipitation generally results in uniformly distributed (i.e., diffuse) recharge to the shallow unconsolidated unit. The discharge zones for ground water flow within the shallow unconsolidated unit are local and will be discussed in detail in Section 5.3

The physical properties of the shallow unconsolidated unit are variable across the site and can be further differentiated as a sand hydrogeologic unit and a sand and gravel hydrogeologic unit. The sand hydrogeologic unit consists of medium to fine sand and is found across most of the facility. The sand and gravel hydrogeologic unit is located in the southeast parking area where the unit coarsens upward from the top of the low permeability silt and clay and transition zone units. Between approximately 13 and 18 feet this consists of coarse to fine sand and fine gravel. Above approximately 13 feet the sand unit becomes finer upward and is similar to the shallow unconsolidated sand unit observed across the site.

The results of the hydraulic conductivity testing supports the different nature of these units. The results of the hydraulic conductivity tests for seven wells screened within the sand and gravel hydrogeologic unit ranged from 9.74E-02 cm\sec (276 ft/day) in well GM-21 to a low of 1.23E-03 cm/sec (3.5 ft/day) in well GM-12C. The mean hydraulic conductivity for the sand and gravel hydrogeologic unit is 2.53E-02 cm/sec (71.7 ft/day). The results for the 23 wells screened in the sand hydrogeologic unit ranged from 1.34E-01 cm\sec (379.8 ft/day) in well OBG-67 to a low of 8.71E-05 cm/sec (0.25 ft/day) in well OBG-53. The mean hydraulic conductivity for the sand hydrogeologic unit is 5.17E-03 cm/sec (14.7 ft/day).

The transition zone hydrogeologic unit lies stratigraphically between the shallow unconsolidated unit and the shallow bedrock unit. The transition zone is limited in its extent across the site and is only found in the eastern portion of the site. This unit is composed of fine sand and silt interbedded with frequent seams and partings of clay and silt which become more frequent with depth. This unit is less permeable than the overlying unconsolidated hydrogeologic unit and the results of the hydraulic conductivity tests ranged from 4.19E-03 cm\sec (11.88 ft/day) in well OBG-80 to a low of 2.92E-05 cm/sec (0.08 ft/day) in well OBG-64. The mean horizontal hydraulic conductivity for the transition zone hydrogeologic unit is calculated to be 6.37E-04 cm/sec (1.81 ft/day).

Water levels in the transition zone as measured in on-site wells are generally higher than water levels in the overlying shallow unconsolidated unit in the vicinity of the shallow ground water recovery system. Recharge to the transition zone is principally from leakage from the overlying shallow unconsolidated unit and through lateral flow from areas where the transition zone is truncated due to erosion. Although the vertical hydraulic conductivity of the transition zone is relatively low due to the interbedded seams and partings of clay and silt, vertical movement of ground water between the unit is still likely to occur. The lateral recharge from the shallow unconsolidated unit appears to occur as evidenced by the observation of DNAPL within this unit.

The shallow unconsolidated unit and the transition zone is generally hydraulically separated from the shallow bedrock unit by a low permeability till and clay-rich aquitard. The results of the hydraulic conductivity tests performed in till zone well OBG-26T indicate that the till unit has a hydraulic conductivity of 3.04E-06 cm/sec (.0086 ft/day).

The shallow bedrock hydrogeologic unit is composed of black, dense shale of the Snake Hill Formation. With the exception of well OBG-46BS, ground water in the shallow bedrock hydrogeologic unit is generally observed under confined conditions at the Fort Edward facility. At well location OBG-46, the confining layer is missing and the ground water in the bedrock is in direct contact vertically with the atmosphere through open pore spaces in the shallow unconsolidated unit and is best described as unconfined. At many locations across the facility, bedrock water levels are observed to be higher than the top of the bedrock, (i.e., GM-12D, OBG-15BS, GM-26D, GM-40D, OBG-44BS, OBG-47BS, OBG-72BS, OBG-73BS and OBG-73BI) indicating that the ground water in these wells is under pressures higher than atmospheric pressure. The elevation to which ground water rises in wells completed in the bedrock is termed the potentiometric level. Under confined conditions, the potentiometric level represents the confining pressure or hydrostatic head and is analogous to the water table in an unconfined unit.

Ground water flow within the shallow bedrock hydrogeologic unit occurs principally through secondary porosity features such as fractures, joints and bedding planes. The horizontal hydraulic conductivity for the bedrock wells installed during the RI ranged from 6.67E-03 cm\sec (18.9 ft/day) in well OBG-73BI to a low of 6.47E-07 cm/sec (0.0002 ft/day) in well OBG-43BS. The mean hydraulic conductivity for the shallow bedrock hydrogeologic unit is 5.86E-05 cm/sec (0.17 ft/day).

5.3. Ground water flow

5.3.1. General

Water level measurements were obtained from the facility monitoring wells on a bimonthly basis throughout 1995 until May of 1996. Water levels were then collected monthly until the conclusion of RI related field work in October 1996 and then bimonthly once again starting in November 1996. Ground water level measurements were obtained during both pumping and non-pumping conditions in the shallow unconsolidated unit, the transition zone and the shallow bedrock unit on the following dates: January 23, March 9, May 22, July 12, September 12 and October 30, 1995 and in 1996, on January 17 to 18, March 13, May 21, June 17, July 30, August 27, September 23 and November 22, 1996. The water level elevations are presented in Appendix E.

5.3.2. Ground water flow within the shallow unconsolidated hydrogeologic unit

The water level measurements were obtained during the investigation during both pumping and non-pumping conditions and during both high and low recharge conditions. Historical data shows that ground water flow within the shallow unconsolidated unit does not change appreciably between high and low recharge conditions. However, in the vicinity of the ground water recovery system along the south property boundary, ground water flow is altered as a result of pumping. Therefore, ground water table contour maps for the shallow unconsolidated unit have been prepared for both pumping and non-pumping conditions, July 12, 1995 and June 17, 1996, and are shown in Figures 5-3 and 5-4, respectively.

As shown in Figures 5-3 and 5-4, ground water flow within the shallow unconsolidated unit at the facility is controlled by a ground water table divide which trends northeast to southwest between monitoring well location OBG-54 and GM-5. The ground water table divide continues in the southwestern portion of the facility and shifts to a roughly north-south orientation. Ground water flow in the northwest, western and southwestern portion of the facility is generally to the west towards the Hudson River. Flow in the central and southeastern portion of the facility is generally to the southeast toward Park Avenue. The ground water table divide generally coincides with the glacial till and bedrock ridge identified in the western portion of the facility.

As a result of pumping, ground water flow in the shallow unconsolidated unit has been altered in the southeastern portion of the facility. A trough of depression, shown in Figure 5-3, has been formed in the vicinity of the shallow ground water recovery system. Water levels have been drawn down in the area between recovery well RW-3 and monitoring well GM-29 and indicate that ground water immediately south of Park Avenue is being pulled back (i.e., north) toward the shallow ground water recovery system.

Ground water flow within the shallow unconsolidated unit in the area south of Park Avenue is generally to the south and is shown in Figure 5-5. A component of flow to the southeast is evident in the area between the wastewater equalization basin and well OBG-57. The southeastern component of flow identified is most likely due to the ground water table divide which trends roughly north to south in the area between Sullivan Parkway and the railroad tracks.

Ground water flow in the central portion of the off-site ground water plume (i.e., areas west of Putnam Avenue and Ethan Allen) is generally to the south and shifts toward the southwest in the area west of Broadway, south of well OBG-60. In the southwestern portion of the off-site area ground water flow is controlled by the topography which slopes from Hillview Avenue and Griffin Avenue areas downward towards the railroad tracks to the west. The unconsolidated sand deposit inches out along the base of this slope and the ground water discharges in a series of surface water springs along the eastern side of the railroad tracks.

Based on the ground water level measurements and ground surface topography, a component of ground water flow to the southeast is proposed in the southeastern portion of the study area near Harrison Street. The southeastern component of flow identified is most likely due to a ground water table divide which trends north to south along Broadway between Stevens Lane and Griffin Avenue. This ground water table divide is likely controlled by the topography east of Burgoyne Avenue which slopes downward to the east toward the Champlain Canal area.

Based on the June 17, 1996 water level elevations, the rate of ground water flow, or average linear velocity, within the shallow unconsolidated unit ranged from 0.456 to 0.882 feet/day across the site depending on varying hydraulic gradients calculated along ground water flow paths at different locations on-site. The ground water flow velocity decreases somewhat in the shallow unconsolidated unit due to the thickening of the unit toward the shallow ground water recovery system which acts as a ground water discharge zone, and ranges from 0.405 to 0.607 ft/day. The ground water flow velocity south of the facility in the central portion of the off-site plume ranged from 0.304 to 0.456ft/day. These velocities are based on Darcy's law, modified to account for porosity as follows:

$$v = K\,I / n$$

where v is the average linear velocity (feet/day), K is the hydraulic conductivity of the shallow unconsolidated unit wells presented previously (14.7 ft/day for the western and central portions of the facility and the area south of the state wells and 71.7 feet/day in the vicinity of the shallow ground water recovery system), I is the hydraulic gradient (ranging from 0.008 to 0.012 across the facility and 0.006 to 0.009 feet/feet in the central and southwestern portions of the off-site study area, respectively) and n is the effective porosity (20 to 30 percent assumed).

5.3.3. Ground water flow within the transition zone

Ground water flow within the transition zone is principally horizontal through the fine sand and silt layers and seams within this unit. As shown in Figure 5-6, based on ground water elevations in wells screened within the transition zone [i.e., OBG-42S, OBG-63, OBG-64, OBG-65, OBG-66, OBG-76, OBG-77, OBG-80, OBG-81 and OBG-82 obtained on November 22, 1996 (see Appendix E)] ground water appears to flow to the southwest.

Based on the November 22, 1996 water level elevations, the ground water flow velocity in the transition zone has been calculated to range from 0.019 to 0.051 ft/day in the area between well OBG-79 and Broadway Lanes. These velocities are based on a hydraulic conductivity of 1.81 ft/day, an assumed effective porosity of 20% and a hydraulic gradient of 0.006 feet/feet.

5.3.4. Ground water flow within the shallow bedrock hydrogeologic unit

Ground water flow in the shallow bedrock hydrogeologic unit is discussed in terms of shallow, intermediate, and deep bedrock zones. These zones do not represent different hydrogeologic units, but instead reflect zones of equal elevation so that a comparison of potentiometric heads can be made across the site with a minimum of influence from vertical hydraulic head differences from location to location. Shallow bedrock wells generally consist of wells screened within the upper 30 feet of the bedrock, intermediate bedrock wells are located in the western portion of the facility and consist of wells generally screened between 45 and 75 feet BG. Deep bedrock wells generally consist of wells screened at a depth greater than 100 feet BG.

Figures 5-7 and 5-8 depict the potentiometric surface within the shallow bedrock unit during pumping and non-pumping conditions on September 23 and October 2, 1996, respectively. As shown in Figures 5-7 and 5-8, ground water flow in the shallow bedrock is controlled by a hydrogeologic divide which trends north-northwest to the south-southeast in the vicinity of Lower Allen Street. Ground water flow in the area west of Lower Allen Street is generally to the west towards the Hudson River. In the area east of Lower Allen Street ground water in the shallow bedrock flows west to east across the facility. Ground water flow directions and hydraulic gradients do not appear to change appreciably from high to low recharge conditions within the shallow bedrock unit.

The effect of ground water pumping from recovery wells GM-8DR and GM-11D is observed in the southwestern portion of the facility. Water levels have been drawn down in the immediate vicinity of these two wells and indicates that ground water immediately east of pumping well GM-11D is being pulled back (i.e., west) toward the pumping well.

An estimate of the ground water flow velocity within the shallow bedrock unit has been calculated using the modified form of Darcy's Law presented previously. However, due to the nature of ground water flow within secondary porosity features such as fractures, joints and horizontal bedding planes, the actual ground water flow velocity varies considerably within individual features. Based on the October 2, 1996 water level elevations obtained during non-pumping conditions, the ground water flow velocity in the shallow bedrock at the facility has been calculated to range from 0.056 to 0.228 ft/day in the western portion of the facility and from 0.083 to 0.168 ft/day in the area west of Lower Allen Street. These velocities are based on a hydraulic conductivity of 0.166 ft/day, presented in Section 5.2, an assumed effective porosity of 10 to 20% and hydraulic gradients of 0.034 and 0.1 feet/feet for the central portion of the facility and the area west of Lower Allen Street, respectively.

Figures 5-9 and 5-10 depict the potentiometric surface within the intermediate bedrock unit during pumping and non-pumping conditions on two dates of measurements, respectively (i.e., September 23 and October 2, 1996, respectively). As shown in Figures 5-9 and 5-10, in the area east of Lower Allen Street intermediated bedrock ground water in the southeast portion of the facility flows west to east across the facility.

The effect of ground water pumping from recovery wells GM-8DR and GM-11D is observed in the southwestern portion of the facility. Water levels have been drawn down significantly and indicate that ground water immediately east of pumping wells GM-11D and GM-8DR is being pulled back (i.e., west) toward the pumping wells. As indicated previously, the intermediate wells are screened at the same relative elevation as pumping wells GM-8DR and GM-11D. As shown in Figure 5-9, the capture zone created by pumping appears to extend out further than seen in the shallow bedrock, this is attributed to horizontal bedding planes which appear to interconnect the screens.

An estimate of the ground water flow velocity within the intermediate bedrock unit has been calculated using the modified form of Darcy's Law presented previously. Based on the October 2, 1996 water level elevations obtained during non-pumping conditions, the rate of flow in the intermediate bedrock at the facility has been calculated to range from 0.067 to 0.335 ft/day southwestern portion of the facility. These velocities are based on a hydraulic conductivity of 0.166 ft/day, presented in Section 5.2, an assumed effective porosity of 10 to 20% and a hydraulic gradient of 0.04 feet/feet.

Figure 5-11 depicts the potentiometric surface within the deep bedrock unit on June 17, 1996. As shown in Figure 5-11, ground water flow within the deep bedrock is controlled by a hydrogeologic divide which trends north to south between well OBG-15BD through the area of the Foil Mill towards well location OBG-26. Ground water flow in the western portion of the facility and west of Lower Allen Street is generally to the west towards the Hudson River. Ground water in the central and eastern portion of the facility flows west to east across the facility towards Upper Broadway. Ground water flow directions and hydraulic gradients do not change appreciably from high to low recharge conditions within the shallow bedrock unit.

An estimate of the ground water flow velocity within the deep bedrock unit has been calculated using the modified form of Darcy's Law presented previously. Based on the June 17, 1996 water level elevations, ground water flow velocities in the deep bedrock at the facility have been calculated to range from 0.246 to 0.492 ft/day in the area west of Lower Allen Street and from 0.132 to 0.659 ft/day in the eastern portion of the facility. These velocities are based on a hydraulic conductivity of 0.166 ft/day, presented in Section 5.2, an assumed effective porosity of 10 to 20% and hydraulic gradients of 0.3 to 0.08 feet/feet for the area west of Lower Allen Street and the eastern portion of the facility, respectively.

5.4. Response of the hydrogeologic system

5.4.1. Seasonal fluctuations

Water levels fluctuate seasonally in the shallow unconsolidated hydrogeologic unit, these fluctuations are variable across the site and range from approximately five feet to a low a of approximately one foot. Figure 5-12 shows the water level fluctuations at wells GM-19, GM-31, GM-32 and GM-33 from March 1992 to September 1996. These wells are located in the eastern portion of the facility and consist of shallow unconsolidated unit wells. As shown on Figure 5-12, the seasonal range in water levels is typically between 4 to 5 feet. High water levels generally occur in the late spring and early summer. Water levels begin to drop in the mid to late summer when water deficit conditions begin due to higher ET rates.

Figure 5-13 shows the water level fluctuations at wells GM-7, GM-14, GM-17, GM-22 and GM-24 from March 1992 to September 1996. These wells are located in the southwestern portion of the facility and consist of shallow unconsolidated unit wells. Figure 5-14 shows the water level fluctuations at wells GM-9, GM-10 and GM-15 for the same period. These wells are located in the northwestern portion of the facility and also consist of shallow unconsolidated unit wells.

As shown on Figures 5-13 and 5-14, the seasonal range in water levels is generally lower than the fluctuations observed in the eastern portion of the facility and are typically between 1 to 2.6 feet. Consistent with the eastern portion of the site, high water levels generally occur in the late spring and early summer and begin to drop in the mid to late summer when water deficit conditions begin due to higher ET rates.

Figure 5-15 shows the water level fluctuations at bedrock wells GM-9D, GM-12D, GM-26D, OBG-49BS, OBG-49BD and OBG-46BS from March 1992 to September 1996. These wells are located across the facility and consist of shallow and deep screened wells. As shown on Figure 5-15, no trends in the seasonal fluctuations are apparent between 1992 and 1995. However, based on the late 1995 and 1996 water level elevations, it appears that bedrock ground water elevations are higher in the late winter and early summer and decrease towards mid to late summer.

5.4.2. Response to pumping from shallow unconsolidated unit

As a result of pumping, ground water flow in the shallow unconsolidated unit has been altered in the southeastern portion of the facility. A trough of depression, shown in Figure 5-3, has been formed in the vicinity of the shallow ground water recovery system. Water levels have been drawn down in the area between recovery wells RW-3 and GM-29 and indicate that ground water immediately south of Park Avenue is being pulled back (i.e., north) toward the shallow ground water recovery system. The capture zone created by pumping appears to extend across the entire southeastern portion of the facility and indicates that contaminated ground water in the shallow unconsolidated unit is being captured and prevented from flowing off-site to the south.

5.4.3. Response to pumping from shallow bedrock unit

As discussed in Section 5.3.4, and shown in Figures 5-7 and 5-9, the effect of ground water pumping from bedrock recovery wells GM-8DR and GM-11D is observed in the southwestern portion of the facility. Water levels have been drawn down significantly in the shallow and intermediate bedrock units in the immediate vicinity of these two wells and indicates that ground water immediately east of bedrock pumping wells GM-11D and GM-8DR is being pulled back (i.e., west) toward each of the pumping wells.

5.4.3.1. Area of influence

As discussed in Section 3.3.5, in order to assess the hydraulic effects of pumping bedrock recovery wells GM-8DR and GM-11D on the surrounding bedrock and unconsolidated hydrogeologic units, hydraulic monitoring was performed in the west and southwest area of the facility. As discussed previously, two HMPs were performed during the RI. The results of the first HMP indicated that ground water extraction from bedrock recovery wells GM-8DR and GM-11D has an impact on both the shallow and intermediate bedrock ground water levels in the southwestern portion of the facility. Based on the results of the supplemental RI activities performed in the southwestern portion of the site and the previous HMP, a second more extensive HMP was performed. The results of the second more extensive HMP are discussed in this section.

Monitoring wells GM-15 and OBG-15BS were designated as background monitoring wells in order to assess the hydraulic response due to recharge events which occurred between September 23 and October 8, 1996. Monitoring wells GM-15 and OBG-15BS are shallow unconsolidated unit and shallow bedrock monitoring wells, respectively. Figure 5-16 shows the water level fluctuations in these background wells. In addition, Figure 5-16 shows precipitation during the hydraulic monitoring period.

The results of the hydraulic monitoring at bedrock recovery wells GM-8DR and GM-11D are shown on Figure 5-17. As would be expected, the bedrock pumping wells exhibit the greatest water level fluctuations associated with operation of the bedrock ground water recovery system. As shown on Figure 5-17, recovery well GM-11D exhibits the greatest change in ground water level and ranged from approximately 24 to 27 feet between pumping and non-pumping conditions. The change in ground water level at recovery well GM-8DR ranged from approximately 13.5 to 21.5 feet.

Figure 5-18 shows the water level data collected at shallow unconsolidated unit monitoring wells GM-7, OBG-8B, GM-14 and GM-22. In addition, Figure 5-18 shows precipitation during the hydraulic monitoring period. As shown in Figure 5-18, well GM-14 displays a substantial response to the turning off and the restarting of the bedrock recovery wells. It appears that wells GM-11 and GM-22 respond to turning off of the recovery wells. However, these wells do not appear to show a strong response following the restarting of the bedrock recovery wells. The strong response of shallow unconsolidated unit monitoring well GM-14 to operation of the bedrock recovery wells is attributed to the absence of a confining layer overlying the bedrock in the vicinity of the equalization basin.

The water level data collected at bedrock wells GM-26D, OBG-47BS, OBG-49BS and OBG-49BD in addition to precipitation data is shown on Figure 5-19. Monitoring wells GM-26D and well pair OBG-49 are located south and west of the bedrock recovery wells. Well OBG-47BS is located adjacent to recovery well GM-8DR. As shown in Figure 5-19, wells GM-26D, OBG-47BS and OBG-49BD respond to pumping, with well OBG-47BS exhibiting the greatest response. The stronger response to pumping a OBG-47BS is attributed to is location adjacent to pumping well GM-8DR.

Figure 5-20 shows the water level data collected at bedrock wells OBG-44BS, OBG-72BS, OBG-72BI, OBG-73BS and OBG-73BI. These wells are located north and west of bedrock recovery wells GM-8DR and GM-11D. As seen in Figure 5-20, the response to the shut down and the restart of the recovery wells is greatest in well OBG-72BI and OBG-73BI. Both OBG-72BI and OBG-73BI are screened in the intermediate bedrock. Although the other bedrock wells clearly respond to the shut down and restart of the bedrock recovery wells, the response is considerably less than the intermediate wells. The water level data collected at well OBG-73BS appears anomalous between September 24 and 30, 1996. However, the water level data appears to be representative from September 30 to October 8, 1996. The reason for the anomalous data is uncertain, but based on the data obtained during the restart of the recovery wells, it appears that this well responds similar to OBG-72BS.

Figure 5-21 shows the water level data collected at bedrock wells GM-9D, OBG-74BS, OBG-74BI, OBG-75BS and OBG-75BI. These wells are located north and east of bedrock recovery well GM-8DR and northeast and east of bedrock recovery well GM-11D. As seen in Figure 5-21, the response to the shut down and the restart of the recovery wells is again greatest in intermediate bedrock wells OBG-74BI and OBG-75BI. Bedrock well GM-9D appears to have a delayed response to the shut down of the recovery wells. However, it does not appear to respond to the restart of the recovery wells, this may be due in part to the precipitation events between October 4 and 7, 1996. As shown in Figure 5-21, bedrock wells OBG-74BS and OBG-75BS do not appear to respond to pumping.

5.4.3.2. Capture zone

The area of influence of bedrock recovery wells GM-8DR and GM-11D has been observed to extend several hundred feet radially around the bedrock recovery wells in the shallow and intermediate bedrock at the facility. However, the area of influence is not synonymous with the capture zone under typical conditions of natural ground water flow. The capture zone of a pumping well is that area from which the pumped ground water is being drawn, sometimes known as the area of contribution. Within the zone of capture, hydraulic gradients toward the pumping wells are maintained.

Potentiometric surface maps for the shallow and intermediate bedrock were constructed from data measured on September 23, 1996 prior to shutting the pumps off and on October 2, 1996 prior to restarting the pumps again. Figures 5-7, 5-8, 5-9 and 5-10 show ground water flow in the shallow and intermediate bedrock during pumping conditions, respectively.

The potentiometric surface map for the shallow bedrock under pumping conditions on September 23, 1996, shows a capture zone that is approximately 200 feet wide centered on GM-11D. Similarly, a capture zone that is less than 100 ft wide can be observed centered on GM-8DR. The drawdown in the vicinity of GM-8DR is less in the shallow bedrock because of the lower flow rate (GM-11D approximately 4 gpm and GM-8DR approximately 1.2 gpm), and possibly because GM-8DR is screened in the intermediate bedrock zone.

The potentiometric surface maps of the intermediate bedrock under non-pumping conditions (Figure 5-10) show similar hydraulic gradients and flow directions as the shallow bedrock potentiometric maps under non-pumping conditions. The capture zone in the intermediate bedrock appears slightly larger for GM-11D, having an approximate width of 250 feet, centered on GM-11D. The capture zone for GM-8DR in the intermediate bedrock is larger than for the shallow bedrock extending approximately 300 feet wide, centered on GM-8DR. The cone of depression for GM-8DR is greater in the intermediate zone than the shallow zone because of the positioning of the screen in the intermediate zone, intercepting the fractures preferentially oriented within the intermediate zone.

Dye test

The results of the dye test indicate that ground water from the abandoned sewer lines P-27 and P-38 is being drawn to both bedrock recovery wells GM-11D and GM-8DR. Table 5-1 is a summary of the measured dye concentrations in samples collected from manhole MH-27, well GM-8DR and well GM-11D over the duration of the test. The dye concentrations measured in manhole MH-27 are used to approximate the dye concentration within the storm sewer lines. The dye concentration in manhole MH-27, was approximately 165 μg/L, 24 hours after the dye was injected. The manhole was sampled on October 10, 16 and 25, 1996 and showed an initial increase between October 10 and 16 to 207 μg/L, presumably due to higher dye concentrations in water within the sewer lines mixing with the initially less concentrated ground water in the manhole. After nine days, dye concentrations decreased to 54 μg/L, which can be attributed to the dilution of water in the manhole and sewer lines with ground water from the shallow unconsolidated unit.

Table 5-1. *Dye test concentrations.*

		Dye Concentration		
Sampling Date	**Sampling Time**	**GM-8DR**	**GM-11D**	**MH-27**
10/10/96	9:00 AM	0.04	0.01	165
	5:30 PM	0.08	-0.01	
10/11/96	10:05 PM	0.15	0.02	
	3:55 PM	0.15	0.02	
10/14/96	11:20 AM	0.16	0.08	
	4:00 PM	0.14	0.07	
10/15/96	9:36 AM	0.12	0.03	
	4:00 PM	0.12	0.07	
10/16/96	10:15 AM	0.25	0.23	207
	5:15 PM	0.27	0.15	
10/17/96	10:00 AM	0.29	0.16	
	5:00 PM	0.48	0.18	
10/18/96	12:00 PM	0.28	0.13	
	4:15 PM	0.28	0.14	
10/21/96	12:33 PM	0.28	0.18	
	9:43 AM	0.33	0.21	54

Notes:
1. All concentrations are in μg/L.

Prior to initiation of the dye test, the natural florescence of the bedrock ground water was determined on October 9, 1996. The natural or background fluorescence was used in the calculation of dye concentration throughout the duration of the test. Dye concentrations were corrected for the natural background florescence by using the following equation:

$$Cu = \frac{Ru - Rb}{Rs - Rb} \times Cs$$

Where:

Cu = Sample concentration
Cs = Standard concentration
Ru = Fluorometer reading of sample
Rs = Fluorometer reading of standard
Rb = Fluorometer reading of reagent blank

The reagent blank is the initial bedrock ground water collected from GM-8DR prior to dye injection. This sample is characteristic of the natural flourescence of the ground water and was analyzed on each sample analyses. Prepared standards with known concentrations were also analyzed on each day of sample analyses. The dye concentration calculation for each sample analysis included the measurements of the associated reagent blank and standard, minimizing variations in the fluorometer.

The sensitivity of the fluorometer varies with the natural background flourescence, hence the daily fluctuations in the fluorometer readings of the reagent blank (Rb). If fluorometer readings of the samples (Ru) were greater than the fluorometer reading of the reagent blank (Rb), then the flourescence of the sample would be considered a positive indication of the presence of Rhodomine WT dye. Fluorometer readings of the standards varied from 64 to 83, and were in the upper half of the instrument range. Reagent blank fluorometer readings had a mean value of 42, and varied slightly over the test period with a percent relative standard deviation (% RSD) of 6.8%.

The dye concentrations calculated for samples obtained from well GM-8DR increased in approximately 48 hours after dye injection to a level of 0.15 µg/L on October 11, 1996. The ground water in GM-8DR showed detectable dye shortly after injection (2 days), as compared to samples from well GM-11D, which showed detectable dye concentrations approximately five days after injection. The difference in the time of the first arrival of dye in the well is attributed to the relative proximity of GM-8DR to the old sewer lines. Recovery well GM-8DR is approximately ten feet from the storm sewer line P-38, while GM-11D is over 100 feet from the southern end of P-37 and MH-27. The concentration of dye increased in GM-8DR to a level of 0.27 µg/L on October 16, 1996. The concentration remained relatively consistent through test completion on October 25, 1996.

The concentration in GM-11D increased in approximately five days after dye injection to a level of 0.08 µg/L on October 14, 1996. The dye concentration increased in GM-11D to a level of 0.15 µg/L on October 16, 1996 and then again increased slightly to 0.21 μg/L by test completion on October 25, 1996.

The presence of the rhodamine WT dye in recovery wells GM-8DR and GM-11D indicates that ground water from abandoned storm sewer lines P-37 and P-38, and manhole MH-27 is being drawn into the shallow bedrock (Figure 3-1). A comparison of the maximum bedrock ground water dye concentrations observed in well GM-8DR to the initial dye concentration in ground water from manhole MH-27 can be used to give an approximation of the volume of water reaching the shallow and intermediate bedrock from the abandoned sewer. The result of the comparison indicates that for every 1,000 gallons of ground water pumped from well GM-8DR, approximately 2.9 gallons is from the storm sewer lines and manhole MH-27.

6. Nature and extent of contamination

6.1. Soil gas survey analytical results

The analytical results for the soil gas samples collected during the RI/FS are presented in this section. As described in section 3.4., a total of 119 soil gas points were installed around Building 40, along the western property line, and surrounding monitoring well GM-10. The soil gas point locations are shown on Figure 6-1. The samples were screened for total VOCs using a portable PID and for chlorinated VOCs, specifically TCE and 1,1-DCA, and kerosene constituents (i.e., naphthalene and trimethylbenzenes) using a portable GC located on-site. The sample odors were also noted. The following subsections include a description of the VOC screening results and a discussion of the distribution of VOCs in the soil gas in each area of investigation.

Area between Buildings 27 and 40

Soil gas samples were collected from 26 points installed in the area between Buildings 27 and 40. The most commonly detected compound was identified as TCE. Two other constituents detected were tentatively identified as tetrachloroethene (PCE) and an unknown organic compound, likely chlorinated. No kerosene pattern, characteristic constituents, or petroleum odors were detected in this area.

TCE was detected throughout the area between Buildings 27 and 40 at concentrations ranging from an estimated 0.04 to 5.5 parts per million as vapor (ppmv). The highest concentrations of TCE were measured in the vicinity of the south-central portion of the area between the buildings as shown on Figure 6-1. Although PCE was tentatively identified in this central area, the highest relative concentrations were detected along the eastern side of Building 40, outside the loading bay, as shown on Figure 6-1.

Area between Building 40 and Lower Allen Street

Soil gas points were installed at 38 locations between Building 40 and Lower Allen Street. Kerosene was identified in 15 of the 37 soil gas sampling locations. As shown in Figure 6-1, the strongest indications of kerosene were identified in two locations; one area is in the vicinity of the former mineral oil tank in the area of GM-2. The second area is located south of an aboveground storage tank area on the west side of Building 40.

Relatively high concentrations of an unknown chlorinated VOC were detected at the soil gas point located in the vicinity of the northwest corner of Building 40. Upon receipt of the ground water sampling results in this area, this unknown chlorinated VOC was tentatively identified as 1,1,1-trichloroethane (1,1,1-TCA). Three additional soil gas points were installed approximately 50 feet to the south, east, and north of the northwest corner of Building 40 to assist identifying the source of the 1,1,1-TCA. Greater concentrations of the tentatively identified chlorinated VOC (1,1,1-TCA) were detected in each of the additional points. The highest concentration of chlorinated VOCs was detected in the soil gas point located outside the loading dock. The area in the vicinity of the northwest corner of Building 40 with the detections of the chlorinated VOC is presented in Figure 6-1.

Area south of Building 40

Soil gas samples were collected from 27 points installed south of Building 40. As presented on Figure 6-1, the presence of chlorinated VOCs or kerosene were limited to two areas. TCE was detected in one area located in the vicinity of the former leachfields. Kerosene was identified in the other area located near the southwest corner of Building 40.

Area along the western boundary

Soil gas samples were collected from 12 points installed along the western property boundary. No significant VOCs or kerosene constituents were determined to be present in the soil gas samples collected from this area.

Area surrounding monitoring well GM-10

Soil gas samples were collected from 16 points installed in the vicinity of monitoring well GM-10. No 1,1-DCA or other VOCs were detected in the soil gas samples collected in this area. Therefore, the source of the 1,1-DCA detected in monitoring well GM-10 was not identified in the soil gas survey. It should be noted that although chlorinated VOCs were detected in the soil gas and ground water samples collected from wells and soil gas points southeast of monitoring well GM-10, 1,1-DCA was not identified as a soil gas or ground water constituent.

6.2. Soil boring program analytical results

The analytical results for soil samples collected during the RI/FS are presented in the following sections. A total of seven environmental soil samples were collected from seven soil borings installed in the soil disposal area (i.e., SWMU #16), a total of 32 environmental soil samples were collected from 17 soil borings drilled around Building 40, a total of 21 environmental soil samples were collected from 12 soil borings drilled under Building 40, and a total of four environmental soil samples were collected from four soil borings installed in the former leachfield area. The samples were submitted for VOC and PCB analyses. In addition, three environmental soil samples were collected from three soil borings drilled along the western boundary and submitted for PAH analyses. The results of the soil analyses are presented in tabular form in Appendix G, the soil analytical laboratory data forms are presented in Appendix J, and presented graphically in Figure 6-2.

The following subsections include a description of the VOCs, PCBs, and PAH analytical results and a discussion of the distribution of the detected constituents in the soil at the plant. There are currently no promulgated soil standards in New York State. Therefore, a comparison to risk-based concentrations developed by USEPA Region III for soils at industrial sites is presented (USEPA 1996). These risk-based concentrations are constituent concentrations which do not pose significant risks to human receptors as a result of exposure scenarios consistent with industrial settings. Given that the site is currently an industrial facility, and that future use is expected to remain industrial, the USEPA's industrial risk-based concentrations were used for comparison purposes in order to evaluate whether soils at the facility exhibit concentrations which may warrant evaluating remedial measures.

6.2.1. Distribution of VOCs in the soil disposal area (SWMU #16)

As shown in Figure 6-2, seven soil borings, designated SS-1 through SS-7, were installed in the soil disposal area located north of Building 40. Soil borings SS-1 and SS-2 were installed in relatively recent soil piles, whereas soil borings SS-3 through SS-7 were installed in soil piles which were created in the past. Methylene chloride was the only VOC detected in the soil samples collected from the soil disposal area designated as SWMU #16. Methylene chloride was detected at 0.006 mg/kg in the soil samples collected from 18 to 24 inches below soil pile surface in boring SS-7. Methylene chloride is not a characteristic constituent of the chlorinated VOCs or kerosene detected in the ground water in other areas of the facility and is a notorious laboratory artifact at the concentrations reported in SS-7.

6.2.2. Distribution of PCBs in the soil disposal area (SWMU #16)

PCBs detected in the soil samples collected in the soil disposal area (SWMU #16) were reported as Aroclor-1242 and Aroclor-1254. As shown in the analytical tables in Appendix G, four soil samples collected from the following locations contained detectable concentrations of Aroclor-1242: SS-1, SS-2, SS-3, and SS-5. The four soil samples exhibited concentrations of Aroclor-1242 ranging from an estimated 0.29 to 1.30 mg/kg. Soil boring locations SS-1, SS-2, and SS-3 exhibited detectable concentrations of Aroclor-1254 which ranged from an estimated 0.16 to 1.6 mg/kg.

As described above, the PCBs were detected in soil samples collected from two relatively recent soil piles (i.e., SS-1 and SS-2) and two piles created in the past (i.e., SS-3 and SS-5). The highest concentrations of total PCBs were detected at 2.17 mg/kg in soil boring SS-1 and 2.56 mg/kg in soil boring SS-2, both located in the soil piles created more recently. Lower concentrations of total PCBs were detected at an estimated 0.66 mg/kg in soil boring SS-3 and an estimated 0.29 to 0.32 mg/kg in soil boring SS-5, collected from the area of past soil disposal.

The concentrations of Aroclor-1242 plus the Aroclor-1254 are well below USEPA's industrial risk-based value of 41 mg/kg for Aroclor-1254. It should be noted that USEPA's Risk-Based Concentration Table only provides industrial risk-based values for Aroclor-1016 (140 mg/kg) and Aroclor-1254 (41 mg/kg). The industrial risk-based value for Aroclor-1254 is less than the value for Aroclor-1016. Therefore, the industrial risk-based value for Aroclor-1254 can be used as a conservative risk-based value for Aroclor-1242, which is less chlorinated than Aroclor-1254.

6.2.3. Distribution of VOCs in the vicinity of Building 40

A total of 30 environmental soil samples were collected from 17 soil borings installed around Building 40 during the RI shallow unconsolidated study. The soil samples were collected from depths ranging from approximately 2 to 12 feet below ground surface. The soil boring locations were identified as SB-37 through SB-43, SB-47 through SB-50, and OBG-50 through OBG-55 and are presented in Figure 6-2. The soil samples were submitted for VOC and kerosene analyses. VOCs were detected in 13 soil samples collected from 11 of the 17 soil borings. Kerosene was detected in 14 soil samples collected from 11 of the 17 soil borings. The analytical results of the soil samples collected from the vicinity of Building 40 are provided in tabular form in Appendix G, presented graphically on Figure 6-2 and are discussed in detail below.

Kerosene was frequently detected during the shallow unconsolidated investigation in the vicinity of Building 40. Concentrations of kerosene ranged in concentration from an estimated 0.008 mg/kg in SB-40 (1.5 to 2.5 feet) to 61,000 mg/kg in SB-43 (5 to 6 feet). The highest kerosene concentrations ranging from 10,000 to 61,000 mg/kg were detected in the following soil borings and sample depth intervals: SB-37 S-1 (3 to 5 feet), SB-40 S-5 (5 to 6 feet), SB-43 S-4 (5 to 6 feet), OBG-50 S-3 (4 to 6 feet), and OBG-51 S-4 (5 to 6 feet) and it's field duplicate X-2. These soil borings are located off the northwestern corner, western perimeter, and southwestern corner of Building 40.

Four soil samples were reported with kerosene concentrations less than 10,000 mg/kg; SB-41 S-9 (9 to 11 feet), SB-47 S-3 (5 to 6 feet), OBG-52 S-2 (2 to 4 feet), and OBG-55 S-3 (4 to 6 feet).

The lowest concentrations of kerosene ranged from an estimated 8.0 mg/kg to 96 mg/kg in the following five soil samples: SB-40 S-2 (1.5 to 2.5 feet), SB-38 S-6 (4 to 5 feet), OBG-52 S-5 (8-10 feet), OBG-53 S-4 (5.9 to 6.1 feet), and OBG-53 S-3 (4 to 6 feet).

No kerosene was detected in the remaining 16 soil samples collected: SB-38 S-4 (2 to 3 feet), SB-39 S-1 (2 to 4 feet), SB-39 S-2 (4 to 6 feet), SB-42 S-2 (2 to 4 feet), SB-47 S-2 (4 to 5 feet), SB-48 S-3 (4 to 5 feet), SB-49 S-4 (5 to 6 feet), SB-49 S-6 (8 to 9.4 feet), SB-50 S-2 (2 to 4 feet), SB-50 S-3 (4 to 6 feet), OBG-50 S-5B (8.5 to 10 feet), OBG-51 S-2 (3 to 4 feet), OBG-51 S-5B (7 to 8 feet), OBG-54 S-2 (2 to 4 feet), OBG-54 S-4 (6 to 8 feet), and OBG-55 S-6 (10 to 12 feet).

As presented in the analytical data tables in Appendix G, the following kerosene-related VOCs were detected in eight of the soil samples collected from this area; naphthalene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, isopropylbenzene, n-butylbenzene, n-propylbenzene, p-cymene, sec-butylbenzene, toluene, ethylbenzene, and total xylenes. A chlorinated VOC, trichloroethene, was detected in one soil sample. One soil sample contained concentrations of trichlorobenzenes. A few soil samples contained concentrations of acetone and/or 2-butanone, which are recognized laboratory contaminants and are not characteristic constituents of the facility.

As shown on Figure 6-2, the highest concentrations (i.e., greater than 10 mg/kg) of total VOCs characteristic of kerosene were detected between 14.1 and 66.0 mg/kg in the following four soil boring locations and depth intervals; SB-37 S-1 (3 to 5 feet), SB-43 S-4 (5 to 6 feet), OBG-50 S-3 (4 to 6 feet), and the field duplicate of OBG-55 S-3 (4 to 6 feet). These soil borings are located off the northwestern and southwestern corners of

Building 40, a few of which are the same locations where the highest concentrations of kerosene were detected in the soil.

Six soil samples were reported with concentrations of total VOCs characteristic of kerosene less than 10 mg/kg; SB-40 S-5 (5 to 6 feet), SB-41 S-9 (9 to 11 feet), OBG-50 S-5B (8.5 to 10 feet), OBG-51 S-4 (5 to 6 feet) and it's field duplicate X-2, OBG-52 S-2 (2 to 4 feet), and OBG-55 S-6 (10 to 12 feet).

No kerosene-related VOCs were detected in the following 21 soil samples; SB-38 S-4 (2 to 3 feet), SB-38 S-6 (4 to 5 feet), SB-39 S-1 (2 to 4 feet), SB-39 S-2 (4 to 6 feet), SB-40 S-2 (1.5 to 2.5 feet), SB-42 S-2 (2 to 4 feet), SB-47 S-2 (4 to 5 feet), SB-47 S-3 (5 to 6 feet), SB-48 S-3 (4 to 5 feet), SB-49 S-4 (5 to 6 feet), SB-49 S-6 (8 to 9.4 feet), SB-50 S-2 (2 to 4 feet), SB-50 S-3 (4 to 6 feet), OBG-51 S-2 (3 to 4 feet), OBG-51 S-5B (7 to 8 feet), OBG-52 S-5 (8 to 10 feet), OBG-53 S-3 (4 to 6 feet), OBG-53 S-4 (5.9 to 6.1 feet), OBG-54 S-2 (2 to 4 feet), OBG-54 S-4 (6 to 8 feet), and OBG-55 S-6 (10 to 12 feet).

Trichloroethene was detected at 0.025 mg/kg in one soil sample collected from the 8.5 to 10 foot depth interval in boring OBG-50, located off the southwest corner of Building 40.

1,2,3-Trichlorobenzene and 1,2,4-trichlorobenzene were detected at 15.0 and 47.0 mg/kg in one soil sample collected from the 8 to 9.4 foot depth interval in boring SB-49, located between Buildings 27 and 40.

In general, the highest concentrations of kerosene and kerosene-related VOCs were detected 4 to 6 feet below ground surface, within the upper few feet of the ground water surface. Similarly, kerosene and characteristic kerosene VOCs were absent or detected at lower concentrations in the soil samples collected above the ground water table and/or 7 to 10 feet below the ground surface, below the upper few feet of the ground water surface. USEPA has not established an industrial risk-based concentration for kerosene; therefore, the individual VOCs characteristic of kerosene are discussed in detail below and compared to associated industrial risk-based concentrations.

A comparison of analytical results from soil samples collected in the vicinity of Building 40 indicates that the results for each VOC detected were below USEPA's available industrial risk-based concentrations. A summary of the industrial risk-based concentrations and maximum VOC concentrations observed in the soil samples are summarized in Table 6-1. As noted in Table 6-1, USEPA has not established industrial risk-based concentrations for a few of the detected VOCs; therefore, the industrial risk-based concentrations for similar compounds are used for screening purposes.

Table 6-1. *Screening values for soil around Building 40.*

Constituent	Industrial Risk-Based Concentrations	Maximum Observed Concentration
naphthalene	8.20e+04	56.0
isopropylbenzene	8.20e+04	0.69 J
n-propylbenzene	8.20e+04[1]	1.7
1,3,5-trimethylbenzene	1.00e+05	2.6
1,2,4-trimethylbenzene	1.00e+05	5.7
sec-butylbenzene	2.00e+04	2.5
n-butylbenzene	2.00e+04[2]	5.1
p-cymene	8.20e+04[1]	0.67 J
ethylbenzene	2.00e+05	0.095
toluene	4.10e+05	0.013 J
total xylenes	1.00e+06	0.65
trichloroethene	520	0.025
2-butanone	1.00e+06	0.12
acetone	2.00e+05	0.12
1,2,4-trichlorobenzene	2.00e+04	15.0
1,3,5-trichlorobenzene	2.00e+04[3]	47.0

Notes:
Units are in mg/kg.
Industrial risk-based concentrations (RBCs) from USEPA Region III.
J designates an estimated concentration.
1 This RBC is for isopropylbenzene, because USEPA Region III has not established one for this compound.
2 This RBC is for sec-butylbenzene, because USEPA Region III has not established one for this compound.
3 This RBC is for 1,2,4-trichlorobenzene, because USEPA Region III has not established one for this compound.

6.2.4. Distribution of PCBs in the vicinity of Building 40

A total of 30 environmental soil samples were collected from 17 soil borings installed around Building 40 during the RI shallow unconsolidated study. The soil samples were collected from depths ranging from approximately 2 to 12 feet below ground surface. The soil boring locations were identified as SB-37 through SB-43, SB-47 through SB-50, and OBG-50 through OBG-55 and are presented on Figure 6-2. The soil samples were submitted for PCB analyses. The specific soil sample depths selected for analysis were based on field observations. As described in detail below, PCBs were detected in nine of the 30 soil samples collected in the vicinity of Building 40.

As shown in the analytical data tables in Appendix G and graphically on Figure 6-2, Aroclor-1242 and Aroclor-1254 were the specific PCBs detected in the soil samples. Aroclor-1242 was identified in eight of the soil samples, the highest concentration reported is at 36.0 mg/kg in the soil sample collected from 8 to 9.4 feet below ground surface from soil boring location SB-49, located between Buildings 27 and 40.

The next highest concentrations of Aroclor-1242 were detected at 15.0 and 16.0 mg/kg in soil samples SB-41 S-9 (9 to 11 feet) and OBG-50 S-3 (4 to 6 feet). These soil borings are located near the southwest corner of Building 40.

Five soil samples were reported with Aroclor-1242 concentrations of less than 10.0 mg/kg; SB-40 S-5 (5 to 6 feet), SB-42 S-2 (2 to 4 feet), OBG-51 S-4 (5 to 6 feet) and it's field duplicate X-2, OBG-53 S-3 (4 to 6 feet), and OBG-53 S-4 (5.9 to 6.1 feet). Aroclor-1254 was detected at an estimated 0.30 mg/kg in the one soil sample collected from the 5 to 6 foot depth interval in boring SB-43, located along the southern wall of Building 40.

No PCBs were detected in the remaining 21 soil samples collected from the following soil borings and depth intervals; SB-37 S-1 (3 to 5 feet), SB-38 S-4 (2 to 3 feet), SB-38 S-6 (4 to 5 feet), SB-39 S-1 (2 to 4 feet), SB-39 S-2 (4 to 6 feet), SB-40 S-2 (1.5 to 2.5 feet), SB-47 S-2 (4 to 5 feet), SB-47 S-3 (5 to 6 feet), SB-48 S-3 S-4 5 to 6 feet), SB-49 S-4 (5 to 6 feet), SB-50 S-2 (2 to 4 feet), SB-50 S-3 (4 to 6 feet), OBG-50 S-5B (8.5 to 10 feet), OBG-51 S-2 (3 to 4 feet), OBG-51 S-5B (7 to 8 feet), OBG-52 S-2 (2 to 4 feet), OBG-52 S-5 (8 to 10 feet), OBG-54 S-2 (2 to 4 feet), OBG-54 S-4 (6 to 8 feet), OBG-55 S-3 (4 to 6 feet), and OBG-55 S-6 (10 to 12 feet).

The comparison of analytical results from soil samples collected in the vicinity of Building 40 indicates that all concentrations of the Aroclor-1242 and Aroclor-1254 detected were well below USEPA's industrial risk-based concentration of 41.0 mg/kg for Aroclor-1254, as described in Section 6.2.2.

6.2.5. Distribution of semi-VOCs in the vicinity of Building 40

Three soil samples were collected from approximately 2 to 3 feet below ground surface in three soil borings (OBG-69, OBG-70, and OBG-71) and analyzed for PAHs. As shown in Figure 6-2, these three soil borings were drilled in the area west of Building 40 along the fence separating the plant from the railroad right-of-way. As presented in the summary table in Appendix G, no PAHs were detected in the three soil samples.

One soil sample was collected from 9 to 11 feet below ground surface in soil boring SB-41 located in the area of a former mineral oil storage tank and analyzed for semi-VOCs. As shown in the analytical data presented in Appendix J, 2-methylnaphthalene, a characteristic constituent of kerosene, and bis(2-ethylhexyl)phthalate were the only semi-VOCs detected in this soil sample. 2-Methylnaphthalene was detected at an estimated concentration of 0.29 mg/kg. An industrial risk-based screening value for 2-methylnaphthalene has not been established by USEPA's Region III; however, the concentration detected as well below the industrial risk-based concentration of 82,000 mg/kg for naphthalene. Bis(2-ethylhexyl)phthalate was detected at an estimated 0.42 mg/kg, which is well below USEPA's industrial risk-based concentration of 410 mg/kg for this compound.

6.2.6. Distribution of VOCs under Building 40

Twelve (12) soil borings, designated FM-1 through FM-12, were completed under Building 40, as shown in Figure 6-2. Twenty-one (21) soil samples were collected from the 12 soil borings from depths ranging from 0.5 to 15 feet below ground surface. As described in detail below, VOCs were detected in 18 of the 21 soil samples collected under Building 40. No VOCs were detected in soil samples FM-3 S-8 (13 to 15 feet), FM-7 S-2 (2 to 4 feet) and FM-9 S-2 (2 to 4 feet).

As shown in the analytical data tables in Appendix G, the following kerosene-related VOCs were detected in the majority of the soil samples; naphthalene, isopropylbenzene, n-propylbenzene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, sec-butylbenzene, n-butylbenzene, p-cymene, ethylbenzene, toluene, and total xylenes. A chlorinated VOC, 1,1,1-trichloroethane, was detected in one soil sample and 1,2,3-trichlorobenzene was detected in one soil sample.

The highest concentrations of VOCs characteristic of kerosene were reported for the soil sample collected from 6 to 7 feet below ground surface from soil boring location FM-9, located under the central portion of Building 40. The concentration of total VOCs was reported at 151 mg/kg in this sample and contained naphthalene, 1,2,4-trimethylbenzene, sec-butylbenzene, n-butylbenzene, p-cymene, isopropylbenzene, n-propylbenzene, total xylenes, and ethylbenzene. The shallower sample collected from 2.0 to 4.0 feet in boring FM-9, did not contain detectable concentrations of VOCs.

The next highest concentrations of kerosene related VOCs were detected in the soil samples collected from soil borings FM-1 and FM-6, ranging in total concentrations from 62.1 to 79.7 mg/kg. The soil samples were collected from similar depths at these locations, 6 to 7 feet below ground surface in boring FM-1 and 7 to 9 feet below ground surface in boring FM-6. No other soil samples were collected from either of these soil borings. Soil boring FM-1 is located in the southwestern corner of Building 40 and soil boring FM-6 is located northwest of soil boring FM-9, described above, in the central portion of Building 40.

The remaining soil boring locations inside Building 40 (i.e., FM-2, FM-3, FM-4, FM-5, FM-7, FM-8, FM-10, FM-11, and FM-12) exhibited lower concentrations of kerosene constituents ranging from an estimated 0.009 to 34.1 mg/kg. The lowest total kerosene-related VOC concentrations ranged from an estimated 0.009 to 7.5 mg/kg in the following soil samples: FM-5 S-2 (2 to 4 feet), FM-10 S-1 (1.5 to 3 feet), FM-10 S-3 (5 to 7 feet), FM-11 S-2 (3 to 5 feet), and FM-12 S-2 (3 to 5 feet). As shown in Figure 6-2, these borings are located throughout Building 40.

A concentration of 1,1,1-trichloroethane was detected at 2.0 mg/kg in one soil sample collected from 6.0 to 6.5 feet below ground surface in soil boring FM-11, located in the northwest portion of Building 40. In addition, one soil sample collected from 3 to 5 feet below ground surface in soil boring FM-12 contained 1.2 mg/kg of 1,2,3-trichlorobenzene. There was one anomalous detection of acetone at 0.019 mg/kg in soil sample FM-5 S-2 (2 to 4 feet).

In general, the highest concentrations of VOCs were detected in soil samples collected from 5 to 9 feet below ground surface, which coincides with the upper 1 to 3 feet of the ground water surface in the majority of the wells. Similarly, the lower concentrations of VOCs were reported in the soil samples collected from shallower depths (i.e., 0.5 to 4 feet below ground surface), which were collected from above the water table. The deepest sample collected, 13 to 15 feet below ground surface in boring FM-12, also did not contain detectable VOCs.

Comparatively higher concentrations of kerosene characteristic VOCs are limited to two areas underneath Building 40 (in the southwest corner, characterized by boring FM-1 and central portion, characterized by borings FM-9 and FM-6). As described above, the detection of the chlorinated VOC, 1,1,1-trichloroethane, was limited to one boring (FM-11) located in the northwestern portion of Building 40. Similarly, the detection of the 1,2,3-trichlorobenzene was limited to one boring (FM-12) located in the southeast corner of Building 40.

The comparison of analytical results from soil samples collected under Building 40 indicates that all results for each VOC detected were below USEPA's available industrial risk-based concentrations. A summary of the industrial risk-based concentrations and maximum VOC concentrations observed in soil samples are summarized in Table 6-2. As noted in Table 6-2, USEPA has not established industrial risk-based for a few of the detected VOCs; therefore, the industrial risk-based concentrations for similar compounds are used for screening purposes.

Table 6-2. *Screening values for soil under Building 40.*

Constituent	Industrial Risk-Based Concentrations	Maximum Observed Concentration
naphthalene	8.20e+04	67.0 J
isopropylbenzene	8.20e+04	2.4
n-propylbenzene	8.20e+04[1]	5.2
1,3,5-trimethylbenzene	1.00e+05	0.36 J
1,2,4-trimethylbenzene	1.00e+05	40.0
sec-butylbenzene	2.00e+04	6.5
n-butylbenzene	2.00e+04[2]	15.0
p-cymene	8.20e+04[1]	8.3
ethylbenzene	2.00e+05	3.1
toluene	4.10e+05	0.35 J
total xylenes	1.00e+06	4.3
1,1,1-trichloroethane	7.20e+04	2.0
1,2,3-trichlorobenzene	2.00e+04[3]	1.2
acetone	2.00e+05	0.019

Notes:
Units are in mg/kg.
Industrial risk-based concentrations (RBCs) from USEPA Region III.
J designates an estimated concentration.
1 This RBC is for isopropylbenzene, because USEPA Region III has not established one for this compound.
2 This RBC is for sec-butylbenzene, because USEPA Region III has not established one for this compound.
3 This RBC is for 1,2,4-trichlorobenzene, because USEPA Region III has not established one for this compound.

6.2.7. Distribution of PCBs under Building 40

Twelve (12) soil borings, designated FM-1 through FM-12, were completed under Building 40, as shown in Figure 6-2. Twenty-one (21) soil samples were collected from the 12 soil borings from depths ranging from 0.5 to 15 feet below ground surface. The specific soil sample depths selected for analysis were based on field observations. As described in detail below, PCBs were detected in 17 of the 21 soil samples collected under Building 40. One soil boring, FM-11, from which two soil samples were collected, did not contain detectable PCBs.

As shown in the analytical data tables in Appendix G, Aroclor-1242 and Aroclor-1254 were the specific PCBs detected in the soil samples. The highest concentration of Aroclor-1242 was reported at 14 mg/kg in the soil sample collected from 7 to 9 feet below ground surface from soil boring location FM-6, located under the central portion of Building 40. The highest concentration of Aroclor-1254 was detected at an estimated 1.1 mg/kg in the soil sample collected from the 7 to 9 foot depth interval in boring FM-12, located in the southeast corner of Building 40.

The next highest concentrations of Aroclor-1242 ranged from an estimated 1.0 to 8.9 mg/kg in soil samples collected from the following borings and depth intervals: FM-1 S-4 (6 to 7 feet), FM-9 S-4 (6 to 7 feet), FM-10 S-1 (0.5 to 3 feet), FM-10 S-3 (5 to 7 feet), and FM-12 S-4 (7 to 9 feet). Concentrations of Aroclor-1254 ranged from an estimated 0.10 to an estimated 0.94 mg/kg in soil samples collected from the following borings and depth intervals: FM-1 S-4 (6 to 7 feet), FM-4 S-4 (7.0 to 7.4 feet), FM-8 S-5 (6 to 8 feet), FM-9 S-2 (2 to 4 feet), and FM-12 S-2 (3 to 5 feet).

Several soil samples were reported with Aroclor-1242 concentrations of less than 1.0 mg/kg; FM-2 S-4 (5 to 7 feet), FM-3 S-4 (5.0 to 6.4 feet), FM-3 S-5 (7.0 to 7.4 feet), FM-4 S-3 (5 to 7 feet), FM-4 S-4 (7.0 to 7.4 feet), FM-5 S-4 (5 to 7 feet), FM-7 S-4 (6 to 7 feet) and it's blind duplicate X-1, FM-8 S-5 (6 to 8 feet), FM-9 S-2 (2 to 4 feet), and FM-12 S-2 (3 to 5 feet). In addition, several soil samples were reported with Aroclor-1254 concentrations of less than 0.10 mg/kg: FM-2 S-4 (5 to 7 feet), FM-4 S-3 (5 to 7 feet), FM-5 S-4 (5 to 7 feet), FM-7 S-2 (2 to 4 feet), FM-7 S-4 (6 to 7 feet) and it's blind duplicate X-1, FM-10 S-1 (0.5 to 3 feet), and FM-10 S-3 (5 to 7 feet).

No PCBs were detected in the soil samples collected from the 13 to 15 foot depth interval in soil boring FM-3 and from the 2 to 4 foot depth interval in soil boring FM-5, and from either soil sample (3 to 5 feet and 6.0 to 6.5 feet) collected in soil boring FM-11. Soil boring FM-11 was located in the northwest portion of Building 40.

The comparison of analytical results from soil samples collected under Building 40 indicates that the total PCB concentrations for each sample were below USEPA's industrial risk-based concentration of 41 mg/kg for Aroclor-1254 as described in Section 6.2.2. The concentrations detected are also below the 25 mg/kg Toxic Substance Control Act spill cleanup policy for restricted access locations.

6.2.8. Distribution of VOCs in the leachfield area

As shown in Figure 6-2, four soil borings, designated LF-1 through LF-4, were drilled in the former leachfield area located south of Building 40 and west of the main manufacturing building. Soil boring LF-4 was subsequently completed as a monitoring well (OBG-83) and labelled as such on Figure 6-2. One sample was collected from each boring and analyzed for VOCs. No VOCs were detected in any of the four soil samples collected in the former leachfield area.

6.2.9. Distribution of PCBs in the leachfield area

Soil samples collected from the four soil borings described above were also analyzed for PCBs. Concentrations of Aroclor-1242 and/or Aroclor-1254 were detected in three of the four soil samples collected from the former leachfield area at locations LF-1, LF-3, and LF-4. The soil sample collected from 6 to 7.9 feet below ground surface in soil boring LF-1 contained the highest PCB concentrations; Aroclor-1242 at 63 mg/kg and Aroclor-1254 at 140 mg/kg. This boring was located in the grassy area directly north of monitoring well GM-22, south of the former leachfield area and in the vicinity of an abandoned sewer line.

The soil sample collected from the deepest interval, 8.0 to 9.6 feet below ground surface, from soil boring LF-3 contained the next highest concentration of PCBs. This soil sample contained concentrations of Aroclor-1242 at an estimated 0.72 mg/kg and Aroclor-1254 at 1.6 mg/kg. A blind duplicate sample was also collected from this soil boring and the PCB results were similar; an estimated concentration of 0.37 mg/kg of Aroclor-1242 and an estimated concentration of 0.67 mg/kg of Aroclor-1254.

The lowest concentration of PCBs was detected in the soil sample collected from 4 to 5.9 feet below ground surface in soil boring LF-4 (OBG-83), also located within the former leachfield area. Aroclor-1254 was detected at an estimated concentration of 0.043 mg/kg in this soil sample.

The total PCB concentrations detected in the soil samples collected from soil borings LF-3 and LF-4 were well below USEPA's industrial risk-based concentration of 41 mg/kg for Aroclor-1254. One soil sample, LF-1 (6-7.9 feet), was reported to contain a total PCB concentration (203 mg/kg) which exceeded USEPA's industrial risk-based concentration of 41 mg/kg for Aroclor-1254.

6.2.10. Distribution of VOCs in DNAPL borings

As shown in Figure 6-2, one soil boring, designated SB-79, was drilled south of Building 27. Eleven (11) soil samples were collected from 1 to 22 feet below ground surface and submitted to the laboratory for compositing and VOC analysis. Two composite soil samples were created in the laboratory, one containing soils from the 1 to 9 foot depth interval and the other from the 12 to 22 foot depth interval. Trichloroethene was the only VOC detected in either sample. A concentration of 13 mg/kg of trichloroethene was detected in SB-79 S-1 (1 to 9 feet), which is well below USEPA's industrial risk-based concentration of 520 mg/kg.

6.2.11. Distribution of PCBs in DNAPL borings

As shown in Figure 6-2, one soil boring, designated SB-79, was drilled south of Building 27. Two composite soil samples were collected; one containing soils from the 1 to 9 foot depth interval and the other from the 12 to 22 foot depth interval. No PCBs were detected in either of the composite soil samples analyzed from boring SB-79.

6.3. Ground water analytical results

This section includes a presentation of shallow unconsolidated and bedrock ground water quality conditions. Analytical data discussed in this section includes the reported analytical results of the shallow unconsolidated and bedrock (i.e., shallow, intermediate, and deep) ground water samples collected from new and pre-existing monitoring wells during the following ground water sampling events: the original RI sampling event conducted from October 30 to November 9, 1995; the confirmational RI sampling event on January 17, 1996; and, the supplemental RI and Second Quarter Annual sampling event from June 17 to 26, and October 4, 1996. The following sections also discuss the analytical results in comparison with NYSDEC Class GA ground water standards (NYSDEC 1993).

Ground water samples were collected from a total of 108 monitoring wells located on-site, and 22 monitoring wells and four springs located off-site. The RI analytical data for the ground water are summarized in tabular form in Appendix H. The RI ground water analytical laboratory data are provided in Appendix K. The shallow unconsolidated and bedrock monitoring well locations are shown in Figures 6-3, 6-4, and 6-5.

VOCs detected in the shallow unconsolidated unit and bedrock ground water during the RI included trichloroethene, cis-1,2-dichloroethene, tetrachloroethene, 1,1-dichloroethane, 1,1,1-trichloroethane, vinyl chloride, naphthalene, sec-butylbenzene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, n-butylbenzene, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, toluene, total xylenes, chloroform, methylene chloride, bromodichloromethane, chloroethane, p-cymene, ethyl benzene, isopropylbenzene, and n-propylbenzene. Aroclor-1242 and Aroclor-1254 were the specific PCBs detected in the ground water samples collected from the shallow unconsolidated and bedrock monitoring wells. The SVOCs detected in the shallow unconsolidated unit ground water during the RI included naphthalene and 2-methylnaphthalene. The following sections discuss the shallow unconsolidated unit and bedrock ground water analytical results in detail.

6.3.1. Distribution of VOCs in shallow unconsolidated ground water

This section presents the shallow unconsolidated unit ground water quality conditions, specifically with respect to VOCs. The analytical data for the shallow unconsolidated unit ground water are presented in tabular form in Appendix H and are shown graphically on Figures 6-3 and 6-4. The shallow unconsolidated unit monitoring well locations are presented in Figure 1-2. The analytical data discussed in this section includes the reported results from new and pre-existing on-site and off-site shallow unconsolidated ground water monitoring wells and springs located in and around the Fort Edward plant.

Vicinity of Building 40

The shallow unconsolidated unit monitoring wells in the vicinity of Building 40 include F-2, F-3, F-4, GM-2, GM-3, GM-4, GM-5, GM-6, GM-7, GM-9, GM-10, GM-15, GM-36, GM-37, GM-38, GM-39, OBG-1A, OBG-44S, OBG-45S, OBG-48S, OBG-50, OBG-51, OBG-52, OBG-53, OBG-54, OBG-55, OBG-62, OBG-67, OBG-68, OBG-69, OBG-70, and OBG-71. VOCs were detected in eight of the 32 monitoring wells located in the vicinity of Building 40 and are discussed in detail below.

Naphthalene, a component of kerosene, was the most frequently detected VOC. The other most frequently detected VOCs are also characteristic constituents of kerosene and include the following: p-cymene; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; sec-butylbenzene; n-butylbenzene; isopropylbenzene; n-propylbenzene; toluene; and, total xylenes.

Concentrations of one or more VOCs characteristic of kerosene were detected above the NYSDEC Class GA ground water standards or guidance values in monitoring wells GM-5, OBG-50, OBG-52, OBG-55, and OBG-68 and ranged in total concentrations from 11 to 1,250 μg/L. With the exception of naphthalene at 10 μg/L, each of the kerosene-related VOCs listed above have a NYSDEC Class GA ground water standard of 5 μg/L. Concentrations of naphthalene were detected below NYSDEC Class GA ground water guidance value of 10 μg/L in monitoring wells OBG-1A and OBG-62 and ranged from an estimated 1 to 7 μg/L.

Concentrations of chlorinated VOCs, 1,1-dichloroethane and/or 1,1,1-trichloroethane, were detected at or above NYSDEC Class GA ground water standards (5 μg/L each) in monitoring wells OBG-55 and OBG-68 and ranged in total concentrations from 5 to an estimated 1,310 μg/L. Cis-1,2-dichloroethene was detected at 2 μg/L in OBG-48S, below the NYSDEC Class GA ground water standard of 5 μg/L. It should be noted that this well has since been destroyed.

VOCs were not detected in the following remaining 24 shallow unconsolidated unit monitoring wells located in the vicinity of Building 40: F-2; F-3; F-4; GM-2; GM-3; GM-4; GM-6; GM-7; GM-9; GM-10; GM-15; GM-36; GM-37; GM-38; GM-39; OBG-44S; OBG-45S; OBG-51; OBG-53; OBG-54; OBG-67; OBG-69; OBG-70; and, OBG-71.

Under Building 40

The shallow unconsolidated unit monitoring wells under Building 40 include FM-1, FM-2, FM-5, FM-6, FM-7, FM-8, FM-9, FM-10, FM-11, and FM-12. VOCs were detected in eight of the ten monitoring wells located inside Building 40 and are discussed in detail below.

Naphthalene, a component of kerosene, was the most frequently detected VOC. The other frequently detected VOCs are also characteristic constituents of kerosene and include the following: p-cymene; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; isopropylbenzene; n-propylbenzene; n-butylbenzene; ethyl benzene; and, total xylenes.

Concentrations of one or more VOCs characteristic of kerosene were detected above NYSDEC Class GA ground water standards or guidance values in monitoring wells FM-1, FM-5, FM-7, FM-9, FM-10, FM-11, and FM-12 and ranged in total concentration from 63 to 251 μg/L. With the exception of naphthalene at 10 μg/L, each of the kerosene-related VOCs listed above have a NYSDEC Class GA ground water standard of 5 μg/L. Naphthalene was detected at a concentration at 6 μg/L in monitoring well FM-8, which is below the NYSDEC Class GA ground water guidance value of 10 μg/L. However, chloroform was detected at 29 μg/L in this well, above the NYSDEC Class GA ground water standard of 7 μg/L.

Concentrations of one or more chlorinated VOCs were detected above NYSDEC Class GA ground water standards in monitoring wells FM-9 and FM-11 and ranged in total concentration from 216 to 1,521 μg/L. The chlorinated VOCs detected above the NYSDEC Class GA ground water standards in these two wells include chloroethane, 1,1-dichloroethane, cis-1,2-dichloroethene, and 1,1,1-trichloroethane, each of which has a Class GA ground water standard of 5 μg/L.

VOCs were not detected in wells FM-2 and FM-6 located inside Building 40.

Leachfield

One shallow unconsolidated unit monitoring well, OBG-83, was installed in the leachfield area as part of the Supplemental RI scope of work. VOCs were not detected in the ground water sample collected from this well during the supplemental RI sampling event.

Eastern property boundary

As shown on Figure 6-3, one shallow unconsolidated unit monitoring well, OBG-42S, is located on the northeastern property boundary. VOCs were not detected in the ground water sample collected from this well during the supplemental RI sampling event.

Transition zone

As described previously, monitoring wells were installed in the shallow unconsolidated unit in the area described as a transition zone. Seven on-site transition zone wells are located in the southeastern corner of the facility and are designated as OBG-63, OBG-64, OBG-65, OBG-66, OBG-80, OBG-81, and OBG-82. Four off-site transition zone wells are located east and south of the facility and are designated OBG-76, OBG-77, OBG-78, and OBG-79.

Trichloroethene was the most frequently detected VOC in the transition zone wells. Trichloroethene was detected in three of the seven on-site and one of the four off-site transition zone wells and are discussed in detail below. The next most frequently detected VOCs included cis-1,2-dichloroethene, benzene, and chloroform.

Concentrations of trichloroethene and/or cis-1,2-dichloroethene were detected above NYSDEC Class GA ground water standards (5 μg/L each) in on-site transition zone wells OBG-63, OBG-64, and OBG-82 and ranged in total concentrations from 8 to 4,300 μg/L. Trichloroethene was detected above the NYSDEC Class GA ground water standard of 5 μg/L at concentrations of 29 and 30 μg/L in one off-site transition zone well, OBG-76, located in the area of the off-site overburden plume south of the facility. Cis-1,2-dichloroethene was detected at an estimated concentration of 3.0 μg/L in one off-site well, OBG-76, and is below the NYSDEC Class GA ground water standard of 5 μg/L.

Benzene was detected in one on-site well, OBG-65, at a concentration of 6 μg/L. However, benzene was not detected at or above the laboratory practical quantitation limit (PQL) of 5 μg/L in the samples collected during the October/November 1995 and January 1996 events, and is therefore, considered unconfirmed.

Chloroform was detected at an estimated concentration of 1.0 and 5.0 μg/L in the samples collected from on-site transition zone well OBG-65 in

October/November 1995 and June 1996. However, the detection of chloroform was not confirmed by the field duplicate collected from well OBG-65 in the fall of 1995, or the sample collected from this well in January 1996. Chloroform was detected at concentrations below the NYSDEC Class GA ground water standard of 7 μg/L.

VOCs were not detected in on-site transition zone wells OBG-80 and OBG-81, and off-site transition zone wells OBG-77, OBG-78, OBG-79.

Southern portion of the facility

Twenty-five (25) shallow unconsolidated unit monitoring wells are located within the southern portion of the facility and include the following: GM-11; GM-12A; GM-12B; GM-12C; GM-14; GM-16; GM-17; GM-18; GM-19; GM-21; GM-22; GM-23; GM-24; GM-25; GM-28; GM-29; GM-30; GM-31; GM-32; GM-33; GM-34; GM-35; OBG-8B (formerly GM-8A); OBG-26T; and, OBG-56. As detailed below, VOCs were detected in 14 of the 25 shallow unconsolidated unit monitoring wells located in the southern portion of the facility.

Trichloroethene and cis-1,2-dichloroethene were the most frequently detected VOCs in the shallow unconsolidated unit ground water collected from the southern portion of the facility. The other less frequently detected VOCs include tetrachloroethene, vinyl chloride, 1,1,1-trichloroethane, 1,1-dichloroethane, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, chloroform, and methylene chloride.

Concentrations of one or more chlorinated VOCs were detected at or above NYSDEC Class GA ground water standards in shallow unconsolidated unit monitoring wells GM-8A, GM-12A, GM-12B, GM-12C, GM-21, GM-22, GM-23, GM-24, GM-25, GM-30, GM-32, GM-33, and GM-35 and ranged in total concentrations of 5 to 10,000 μg/L. The chlorinated VOCs which were detected include trichloroethene, cis-1,2-dichloroethene, tetrachloroethene, vinyl chloride, 1,1,1-trichloroethane, and 1,1-dichloroethane, each with the NYSDEC Class GA ground water standard of 5 μg/L, with the exception of vinyl chloride at 2 μg/L.

Concentrations of several chlorobenzenes were reported above NYSDEC Class GA ground water standards in shallow unconsolidated unit monitoring wells GM-8A, OBG-8B (formerly GM-8A), and GM-25 and ranged in total concentrations of 139 to 723 μg/L. With the exception of the detection of trichlorobenzenes in well OBG-8B, the same constituents and similar concentrations were detected in former monitoring well GM-8A and its replacement OBG-8B. However, it should be noted that chlorobenzenes were not detected in monitoring well GM-25 during the October/November 1995 sampling event and have not been detected in this well historically.

The individual chlorobenzenes detected and associated NYSDEC Class GA ground water standards include the following: chlorobenzene (5 μg/L); 1,2-dichlorobenzene and 1,4-dichlorobenzene (4.7 μg/L); 1,3-dichlorobenzene (5 μg/L); 1,2,4-trichlorobenzene (5 μg/L); and, 1,3,5-trichlorobenzene (5 μg/L). Concentrations of each of these individual chlorobenzenes detected in the ground water samples listed above, exceeded the associated NYSDEC Class GA ground water standard.

Benzene was detected at 5μg/L in monitoring well OBG-56 in October 1995; however, it was not detected in ground water samples collected from this well in January or June 1996. Therefore, the detection of benzene is considered unconfirmed. In addition, benzene is not a typical ground water constituent at the facility.

VOCs were not detected in the remaining 11 shallow unconsolidated unit monitoring wells located in the southern portion of the facility: GM-11; GM-14; GM-16; GM-17; GM-18; GM-19; GM-28; GM-29; GM-31; GM-34; and, OBG-26T.

Off-site

Shallow unconsolidated unit ground water monitoring wells and springs located off-site include the following 18 wells and four springs: SW-1; SW-2; SW-3; SW-4; SW-5; SW-6; OBG-57; Rencor #2; OBG-58; OBG-59; OBG-60; OBG-61; Dobroski; Glens Falls National Bank; Hillman; Hughes; Griffin Avenue spring; Hillview Avenue spring; spring #1; and, spring #3. As shown in Figure 6-4, VOCs were detected in seven of the 18 off-site monitoring wells and the four off-site springs and are discussed below.

Trichloroethene and cis-1,2-dichloroethene were the most frequently detected VOCs in shallow unconsolidated unit ground water samples collected off-site. The other VOCs detected include chloroform and bromodichloromethane.

Concentrations of trichloroethene and/or cis-1,2-dichloroethene were detected above NYSDEC Class GA ground water standards (5 μg/L each) in off-site monitoring locations SW-3, SW-4, SW-5, GFNB, Dobroski, Griffin Avenue spring, Hillview Avenue spring, OBG-59, and OBG-61 and ranged in total concentrations from 8 to 3,920 μg/L.

Concentrations of trichloroethene were detected below the NYSDEC Class GA ground water standard of 5 μg/L in spring #1 (0.9 μg/L) and spring #3 (1.0 μg/L) during the October/November 1995 sampling event. However, trichloroethene was not detected at or above the practical quantitation limit (PQL) of 5.0 μg/L in the surface water samples collected from Springs #1 and #3 during the June 1996 sampling event.

Bromodichloromethane was detected in one off-site well, OBG-59, at an estimated concentration of 3 μg/L. However, bromodichloromethane was not detected at or above the laboratory PQL of 5 μg/L in the samples collected during the June 1996 event, and is therefore, considered unconfirmed. In addition, bromodichloromethane is not a known characteristic constituent of the facility.

Chloroform was detected at estimated concentrations of 25 and 14 μg/L in the samples collected from off-site well OBG-59 in the October/November 1995 and June 1996, respectively. These concentrations of chloroform are above the NYSDEC Class GA ground water standard of 7 μg/L.

6.3.2. Distribution of PCBs in shallow unconsolidated ground water

The nature and extent of PCBs in the shallow unconsolidated unit ground water is discussed in this section. The analytical data discussed in this section includes the reported results from new and pre-existing on-site and off-site shallow unconsolidated unit ground water monitoring wells and springs located in and around the Fort Edward facility. The analytical data for the shallow unconsolidated unit ground water are presented in tabular form in Appendix H and presented graphically in Figures 6-3 and 6-4.

Vicinity of Building 40

Ground water samples were collected from the following shallow unconsolidated unit monitoring wells located in the vicinity of Building 40: F-2, F-3, F-4, GM-2, GM-3, GM-4, GM-5, GM-6, GM-7, GM-9, GM-10, GM-15, GM-36, GM-37, GM-38, GM-39, OBG-1A, OBG-44S, OBG-45S, OBG-48S, OBG-50, OBG-51, OBG-52, OBG-53, OBG-54, OBG-55, OBG-62, OBG-67, OBG-68, OBG-69, OBG-70, and OBG-71. PCBs were detected in 15 of the 32 monitoring wells located in the vicinity of Building 40.

Concentrations of Aroclor-1242 and/or Aroclor-1254 were detected above NYSDEC Class GA ground water standard of 0.10 μg/L in monitoring wells F-2, F-3, GM-2, GM-5, OBG-44S (destroyed), OBG-48S (destroyed), OBG-50, OBG-51, OBG-52, OBG-53, OBG-1A(replaced GM-1), OBG-54 and OBG-68 and ranged in total concentrations of 0.12 to 60 μg/L.

Concentrations of Aroclor-1242 were detected below the NYSDEC Class GA ground water standard of 0.10 μg/L in GM-2, GM-9, and OBG-55, ranging from an estimated 0.041 to 0.091 μg/L.

PCBs were not detected in the ground water samples collected during the sampling events from the following remaining 17 shallow unconsolidated wells located in the vicinity of Building 40: F-4, GM-3, GM-4, GM-6, GM-7, GM-10, GM-15, GM-36, GM-37, GM-38, GM-39, OBG-45S, OBG-62, OBG-67, OBG-69, OBG-70, and OBG-71.

Under Building 40

The shallow unconsolidated unit monitoring wells inside Building 40 include FM-1, FM-2, FM-5, FM-6, FM-7, FM-8, FM-9, FM-10, FM-11, and FM-12. PCBs were detected in each of the ten monitoring wells located under Building 40.

Concentrations of Aroclor-1242 and/or Aroclor-1254 were detected above the NYSDEC Class GA ground water standard of 0.10 μg/L in each of the 10 wells and ranged in total concentration of 0.264 to 310 μg/L. Additionally, Aroclor-1242 was detected at concentrations of 4.4 and 220 mg/L in the LNAPL samples collected from monitoring wells FM-5 and FM-12, respectively.

Leachfield

One shallow unconsolidated unit monitoring well, OBG-83, is located in the leachfield area. Aroclor-1242 was detected at an estimated concentration of 0.059 μg/L in the ground water sample collected from this well during the supplemental RI sampling event. The concentration of Aroclor-1242 detected in this well is below the NYSDEC Class GA ground water standard of 0.10 μg/L.

Eastern property boundary

One shallow unconsolidated monitoring well, OBG-42S, is located on the northeastern property boundary. PCBs were not detected in the ground water sample collected from this well during the supplemental RI sampling event.

Transition zone

Seven on-site transition zone wells are located in the southeastern corner of the facility and are designated as OBG-63, OBG-64, OBG-65, OBG-66, OBG-80, OBG-81, and OBG-82. Four off-site transition zone wells are located east and south of the facility and are designated OBG-76, OBG-77, OBG-78, and OBG-79.

Aroclor-1242 was the most frequently detected PCB. Aroclor-1242 was detected in five of the seven on-site and two of the four off-site transition zone wells. Additionally, Aroclor-1254 was detected in four of the seven on-site transition zone wells and none of the four off-site transition zone wells.

Aroclor-1242 and/or Aroclor-1254 were detected above the NYSDEC Class GA ground water standard of 0.10 μg/L in one off-site well, OBG-76, at 0.39μg/L and five on-site wells, OBG-63, OBG-64, OBG-65, OBG-66, and OBG-82, and ranged in total concentration from 2.0 to 28.1 μg/L. Aroclor-1242 was detected in off-site well OBG-79 at an estimated concentration of 0.055 μg/L, well below the ground water standard of 0.10 μg/L.

It should be noted that a few of the PCB results varied by an order of magnitude between the October/November 1995 and June 1996 sampling events in the transition zone wells sampled during both events (i.e., OBG-63, OBG-64, OBG-65, OBG-66). Specifically, samples collected from wells OBG-64 and OBG-66 exhibited concentrations of Aroclor-1242 at 26 and 15 μg/L, respectively, in October/November 1995. The concentrations of Aroclor-1242 decreased to 3.8 and 4.5 μg/L, respectively, in the samples collected from these wells in June 1996.

Aroclor-1254 increased in concentration from not detected at 0.065 μg/L to 1.2 μg/L in the samples collected from well OBG-63 in October/November 1995 and June 1996, respectively. Concentrations of Aroclor-1254 in the samples collected from wells OBG-64 and OBG-66 decreased from 2.1 and 4.5 μg/L, respectively, in October/November 1995, to 0.23 and 0.40 μg/L, respectively, in June 1996.

PCBs were not detected in on-site transition wells OBG-80 and OBG-81, and off-site transition wells OBG-77 and OBG-78.

Southern portion of the facility

Twenty-five shallow unconsolidated unit monitoring wells are located within the southern portion of the facility and include the following: GM-11; GM-12A; GM-12B; GM-12C; GM-14; GM-16; GM-17; GM-18; GM-19; GM-21; GM-22; GM-23; GM-24; GM-25; GM-28; GM-29; GM-30; GM-31; GM-32; GM-33; GM-34; GM-35; OBG-8B (formerly GM-8A); OBG-26T; and, OBG-56. As detailed below, PCBs were detected in 19 of the 25 shallow unconsolidated unit monitoring wells located in the southern portion of the facility.

Concentrations of Aroclor-1242 and/or Aroclor-1254 were detected at or above the NYSDEC Class GA ground water standard of 0.10 μg/L in GM-8A, OBG-8B (GM-8A replacement), GM-12A, GM-12B, GM-12C, GM-21, GM-22, GM-24, GM-25, GM-28, GM-30, GM-32, GM-33, GM-35, OBG-26T(till zone), and OBG-56 and ranged in concentration from 0.10 to 77 μg/L. It should be noted that PCBs were not confirmed in OBG-56 in January or June 1996.

Concentrations of Aroclor-1242 and/or Aroclor-1254 were reported below the NYSDEC Class GA ground water standard in GM-11, GM-16, GM-29, and GM-31, ranging from an estimated 0.055 to 0.093 μg/L.

PCBs were not detected in the ground water samples collected from the remaining six shallow unconsolidated unit wells located in the southern portion of the facility: GM-14; GM-17; GM-18; GM-19; GM-23; and, GM-34.

Off-site

Shallow unconsolidated unit ground water monitoring wells and springs are located off-site and include the following 18 wells and four springs: SW-1; SW-2; SW-3; SW-4; SW-5; SW-6; OBG-57; Rencor #2; OBG-58; OBG-59; OBG-60; OBG-61; Dobroski; Glens Falls National Bank; Hillman; Hughes; Griffin Avenue spring; Hillview Avenue spring; spring #1; and, spring #3. As shown on Figure 6-3, PCBs were detected in seven of the 18 off-site monitoring wells and the four off-site springs and are discussed below.

Aroclor-1242 and/or Aroclor-1254 were reported above NYSDEC Class GA ground water standard of 0.10 μg/L in monitoring wells SW-3, SW-4, GFNB, OBG-57, and Rencor #2, ranging from total concentrations of 0.14 to 1.9 μg/L. However, concentrations of PCBs in OBG-57 located on the Rencor property have shown a decrease since January 1995 and PCBs were not detected in Rencor #2 in June 1996. Specifically, the following total PCB concentrations were detected in monitoring well OBG-57; estimated concentration of 8.3 μg/L in early January 1995, an average concentration of 10 μg/L later in January 1995, 7.2 μg/L in May 1995, 1.7 μg/L in October 1995, and 0.47 μg/L in June 1996.

Aroclor-1242 and/or Aroclor-1254 were reported in monitoring well OBG-59 at an estimated concentration of 0.056μg/L, the Hughes well at an estimated 0.046μg/L, and the Griffin Avenue spring at an estimated concentration of 0.031 μg/L in October 1995, all below the NYSDEC Class GA ground water standard of 0.10 μg/L. The results of samples collected in June 1996 from the sampling points listed above were all below the practical quantitation limit.

6.3.3. Distribution of SVOCs in the shallow unconsolidated unit

This section presents the analytical results of the laboratory SVOC analyses performed on ground water samples collected from three shallow unconsolidated unit monitoring wells, OBG-1A, GM-4, and GM-5, located west of Building 40 as shown in Figure 1-2. SVOCs were not detected in the samples collected from monitoring wells OBG-1A or GM-4 during the sampling events. It should be noted that GM-1 was damaged and inaccessible during the October/November 1995 sampling event.

Naphthalene and 2-methylnaphthalene were the only SVOCs detected in shallow unconsolidated unit monitoring well GM-5. Naphthalene was detected at 70 and 54 μg/L during the October/November 1995 and June 1996 events, respectively. Both of these concentrations are greater than the NYSDEC Class GA naphthalene ground water standard of 0.10 μg/L. Concentrations of 2-methylnaphthalene were detected at 83 and 65 μg/L in monitoring well GM-5 during the fall of 1995 and summer of 1996 sampling events. A NYSDEC Class GA ground water standard or guidance value for 2-methylnaphthalene was not reported in the October 1993 revision of NYSDEC's *Ambient Water Quality Standards and Guidance Values* memorandum.

6.3.4. Distribution of VOCs in bedrock ground water

This section includes a discussion of the analytical results and distribution of VOCs in shallow, intermediate and deep bedrock ground water monitoring wells located throughout the site. The RI analytical data for the bedrock ground water quality is summarized in tabular form in Appendix H. The bedrock monitoring well locations are presented in Figure 6-5.

Shallow bedrock

The shallow bedrock unit monitoring wells discussed in this section include GM-9D, GM-26D, OBG-15BS, OBG-43BS, OBG-44BS, OBG-45BS, OBG-46BS, OBG-47BS, OBG-48BS, OBG-49BS, OBG-72BS, OBG-73BS, OBG-74BS, and OBG-75BS. VOCs were detected in seven of the 14 monitoring wells located throughout the site and are discussed in detail below.

Benzene was detected at 6 μg/L in well GM-9D in October 1995, but was not confirmed in January or June 1996. During the June 1996 sampling event, benzene was detected at 11μg/L in monitoring well OBG-74BS. The detected concentration is above the NYSDEC Class GA ground water standard of 0.7 μg/L; however, benzene is not a typical VOC observed at the Fort Edward plant. Because well OBG-74BS was installed as part of the Supplemental RI scope of work, confirmational sampling of this well was not conducted.

Chloroform was detected below the Class GA ground water standard at 1 and 2 μg/L in OBG-43BS, OBG-47BS and OBG-49BS in October 1995, but was not confirmed in June 1996. Chloroform was also detected at 1 and 7 μg/L in OBG-72BS and OBG-75BS in June 1996.

VOCs were not detected in the remaining seven shallow bedrock unit monitoring wells: GM-26D, OBG-15BS, OBG-44BS, OBG-45BS, OBG-46BS, OBG-48BS, and OBG-73BS.

Intermediate bedrock

Ground water samples were collected in June 1996 from five intermediate bedrock unit monitoring wells (OBG-46BI, OBG-72BI, OBG-73BI, OBG-74BI, and OBG-75BI), which were installed as part of the Supplemental RI. As shown in Figure 6-5, these intermediate bedrock unit monitoring wells are located in the southwestern portion of the facility. In addition, one pre-existing intermediate bedrock monitoring well (GM-12D) and two shallow bedrock recovery wells, GM-11D and GM-8DR, which are sampled monthly pursuant to a SPDES permit, are also included in this discussion. VOCs were detected in three of the eight intermediate bedrock monitoring wells and are discussed in detail below.

Trichloroethene and cis-1,2-dichloroethene were detected at 4 and 1 μg/L, respectively, in well GM-12D in October 1995, below the NYSDEC Class GA ground water standards (5 μg/L each). The presence of trichloroethene and cis-1,2-dichloroethene were not confirmed in either the January or June 1996 sampling round.

Cis-1,2-dichloroethene and vinyl chloride were detected above NYSDEC Class GA ground water standards of 5 μg/L and 2 μg/L, respectively, in the shallow bedrock recovery wells GM-8DR and GM-11D. The concentrations of cis-1,2-dichloroethene and vinyl chloride ranged from 6 to 7 μg/L and from 10 to 14 μg/L, respectively, in October 1995. The presence of cis-1,2-dichloroethene and vinyl chloride was not confirmed in the June 1996 sampling of GM-8DR and GM-11D. However, these VOCs have typically been detected at similar concentrations in other monthly monitoring events.

VOCs were not detected in the ground water samples collected from the five intermediate bedrock unit monitoring wells (OBG-46BI, OBG-72BI, OBG-73BI, OBG-74BI, and OBG-75BI), which were installed as part of the Supplemental RI.

Deep bedrock

The deep bedrock unit monitoring wells discussed in this section include GM-40D, OBG-15BD, OBG-42BD, OBG-43BD, OBG-44BD, OBG-45BD, OBG-46BD, and OBG-49BD. Three of these deep bedrock monitoring wells are pre-existing wells (GM-40D, OBG-44BD, OBG-45BD) and the remaining wells were installed as part of the original RI. These wells are located throughout the facility and are shown on Figure 6-4. No VOCs were detected in the ground water samples collected from the eight deep bedrock monitoring wells listed above.

As described previously, one deeper bedrock unit monitoring well, OBG-26BD, was installed along the southern boundary of the facility as part of the RI. The ground water samples collected in October/November 1995 and June 1996 did not contain detectable concentrations of VOCs.

6.3.5. Distribution of PCBs in bedrock ground water

This section includes a discussion of the analytical results and distribution of PCBs in shallow, intermediate, and deep bedrock ground water monitoring wells located throughout the site. The RI analytical data for the bedrock ground water quality is summarized in tabular form in Appendix H and shown graphically on Figure 6-5.

Shallow bedrock

The shallow bedrock unit monitoring wells discussed in this section include GM-9D, GM-26D, OBG-15BS, OBG-43BS, OBG-44BS, OBG-45BS, OBG-46BS, OBG-47BS, OBG-48BS, OBG-49BS, OBG-72BS, OBG-73BS, OBG-74BS, and OBG-75BS. PCBs were detected in three of the 14 monitoring wells and are discussed in detail below.

Concentrations of Aroclor-1242 were detected from 0.14 to 0.92 μg/L in wells GM-9D, OBG-47BS and OBG-75BS, which are above the NYSDEC Class GA ground water standard of 0.10 μg/L. The reported concentrations of 0.14 μg/L in well OBG-47BS in the October 1995 sampling was not confirmed in the June 1996 sampling. As shown on Figure 6-5, these wells are located in the central portion of the site.

PCBs were not detected in the remaining 11 shallow bedrock monitoring wells GM-26D, OBG-15BS, OBG-43BS, OBG-44BS, OBG-45BS, OBG-46BS, OBG-48BS, OBG-49BS, OBG-72BS, OBG-73BS, and OBG-74BS.

Intermediate bedrock

Ground water samples were collected in June 1996 from the five intermediate bedrock unit monitoring wells (OBG-46BI, OBG-72BI, OBG-73BI, OBG-74BI, and OBG-75BI), which were installed as part of the Supplemental RI. As shown in Figure 6-5, these intermediate bedrock unit monitoring wells are located within the southwestern portion of the facility. In addition, one pre-existing intermediate bedrock monitoring well (GM-12D) and two shallow bedrock recovery wells, GM-11D and GM-8DR, which are sampled monthly pursuant to a SPDES permit, are also included in this discussion. PCBs were detected in four of the eight intermediate bedrock unit wells and are described in detail below.

Aroclor-1242 was detected above the NYSDEC Class GA standard in wells GM-8DR and GM-11D and ranged from 36 to 76 μg/L in the October 1995 and June 1996 sampling events.

Aroclor-1242 was detected below the ground water standard of 0.10 μg/L in wells GM-12D (0.091 μg/L) and OBG-72BI (estimated 0.037 μg/L). PCBs were not detected in the four remaining intermediate bedrock unit monitoring wells OBG-46BI, OBG-73BI, OBG-74BI, and OBG-75BI.

Deep bedrock

The deep bedrock unit monitoring wells discussed in this section include GM-40D, OBG-15BD, OBG-42BD, OBG-43BD, OBG-44BD, OBG-45BD, OBG-46BD, and OBG-49BD. Aroclor-1242 was detected at an estimated concentration of 0.041 and 0.068 μg/L in the October 1995 and June 1996 sampling events of well OBG-44BD. The reported concentrations are below the NYSDEC Class GA ground water standard of 0.10 μg/L.

One deeper bedrock unit monitoring well, OBG-26BD, was installed along the southern boundary of the facility as part of the original RI. The ground water samples collected in October/November 1995 and June 1996 did not contain detectable concentrations of PCBs.

6.3.6. Packer testing/ground water sampling results

The ground water results from the samples collected from discrete intervals in wells OBG-26BD and GM-11D through the use of inflatable packers are discussed in this section.

6.3.6.1. Monitoring well OBG-26BD

Ground water samples were collected from seven discrete intervals during the installation of monitoring well OBG-26BD. Each interval was sampled for VOCs and both filtered and unfiltered PCBs. Additionally, three samples were collected for inorganic analysis. Refer to Table 3-1 in Section 3 for depth of sampling intervals and corresponding sample designations.

VOC results

The only volatile organic compound detected during the discrete ground water sampling of OBG-26BD was toluene. Toluene was detected in three of the sampling intervals, zone E at 33 µg/L, zone C at 11 µg/L and zone B at 15 µg/L. A repair to the packer assembly was made the day before sampling zones C and E which may account for the toluene detection. A small amount of silicone sealer was needed to repair a hole in the packer assembly. No repairs, however, were made to the packers prior to sampling zone B. Follow-up sampling of the completed monitoring well OBG-26BD did not detect toluene or any other VOCs.

PCB results

No PCB detections were reported in any of the ground water samples collected from the discrete sampling intervals during the packer testing/ground water sampling of monitoring well OBG-26BD.

Inorganic parameters

As previously stated, samples were collected and analyzed for several inorganic parameters during the packer testing/ground water sampling of monitoring well OBG-26BD. Table 6-3 summarizes the results of the three sets of inorganic parameters.

Table 6-3. *Inorganic analytical results from packer testing/ground water sampling of monitoring well OBG-26BD.*

	Sampling Interval		
Inorganic Parameter	**Zone B (170-220 ft)**	**Zone C (375-420 ft)**	**Zone G (485-535 ft)**
Bicarbonate Alkalinity as $CaCO_3$	300	56	90
Carbonate Alkalinity as $CaCO_3$	<2	588	335
Total Dissolved Solids	203	765	478
Chloride	45	41	44
Sulfate	40	25	38
Nitrate-N	0.73	1.1	1.1
Nitrite-N	0.03	0.06	0.05
Calcium	102	196	171
Magnesium	18.3	0.62	6.3
Potassium	9.0	92	32.5
Sodium	29.2	74	59.3
Iron	28.0	2.12	4.0
Manganese	0.48	0.04	0.005

Notes:
Units in mg/L.
ft designates feet below ground surface.

6.3.6.2. Monitoring well GM-11D

Ground water samples were collected from four discrete sampling intervals during the packer testing/ground water sampling program of GM-11D. Refer to Section 3.3.2.1 of this report for the sampling intervals. Each interval was sampled for VOCs and PCBs. All ground water sampling results for the packer testing can be found in tabular form in Appendix H.

VOC results

Volatile organic compounds were detected in all four sample intervals. Toluene was detected in all four intervals at concentrations of 180 $\mu g/L$ in intervals S-3, 33 $\mu g/L$ in interval S-2, 16 $\mu g/L$ in interval S-4, and 9 $\mu g/L$ in interval S-1. The blind duplicate sample, collected from S-2, had a toluene concentration of 35 μg/L. Toluene is not considered a site-related compound. These concentrations, however, are all above the Class GA ground water standard of 5 μg/L for this compound.

Cis-1,2-dichloroethene was detected in three samples (two different intervals and the blind duplicate). Detections were in the following concentrations: 24 μg/L in interval S-4, 6 μg/L in interval S-2, and 6 μg/L in the blind duplicate (S-2). These concentrations are above the Class GA ground water standard of 5 μg/L for this compound.

1,3-Dichlorobenzene was detected at a concentration of 5 μg/L in interval S-2 and the blind duplicate sample. The Class GA ground water standard for this compound is also 5 μg/L.

PCB results

As previously stated, ground water samples from discrete intervals were collected and analyzed for PCBs. Five samples were collected, including one sample from each of the four discrete intervals and one blind duplicate sample from interval S-2, labeled X-1.

Low level concentrations of PCBs were detected in all five samples. Specifically, Aroclor-1242 was detected in all five samples in the following concentrations: 85 μg/L in the blind duplicate sample (interval S-2), 79 μg/L in the S-2 sample, an estimated concentration of 6.8 μg/L in the S-1 sample, an estimated concentration of 2.4 μg/L in the S-3 sample, and an estimated concentration of 1.1 μg/L in the S-4 sample. All of these detections are above the Class GA ground water standard for this compound, which is 0.1 μg/L.

6.3.7. Historical VOC concentrations in off-site shallow unconsolidated ground water

This section presents a discussion of historical off-site shallow unconsolidated ground water conditions. Data evaluated includes analytical results from semi-annual sampling events conducted off-site from 1983 through the present, in addition to the October/ November 1995 and June 1996 RI sampling events. Off-site wells and springs which have been monitored since the early 1980's include SW-1, SW-2, SW-3, SW-4, SW-5, SW-6, Glens Falls National Bank (GFNB), Dobroski, Hughes, Hillman, Griffin Avenue spring, Hillview Avenue spring, spring #1, and spring #3. Locations of these wells are presented on Figure 6-4. Analytical results have been presented and summarized in annual reports, as well as the Five Year Review of Off-Site Remedial Program (O'Brien & Gere, July 1995).

VOC analyses

As discussed in detail below, there appears to be decreasing trends in total VOC concentrations in ground water samples collected from several off-site locations over the 13-year period beginning in 1983. The most frequently detected constituents in the off-site monitoring locations include trichloroethene and cis-1,2-dichloroethene.

Consistent with historical results, VOCs were not detected or detected at a low concentration (i.e., less than 5 μg/L) in spring #3 during the 1995 and 1996 RI sampling events. Spring #3 is the southernmost spring location off-site. Similarly, no VOCs were detected in the Hughes well during the 1995 and 1996 RI sampling events. The Hughes well is the southernmost well location monitored historically. Historically, VOCs were detected in the Hughes well at concentrations of up to 23 μg/L in the 1980s. More recently, VOC concentrations have dropped significantly to the levels observed in the RI sampling.

Historical trends in the total VOC concentrations in two springs (spring #1 and Griffin Avenue spring) are presented graphically in Figure 6-6. Consistent with results reported since 1991, total VOC concentrations were not detected or detected at a low concentration (i.e., less than 1 μg/L) in spring #1 during the 1995 and 1996 RI sampling events. Figure 6-6 shows a significant decreasing trend in total VOC concentrations from the historical reported concentrations in excess of 1,000 μg/L obtained in 1985 to the current VOC levels.

Ground water samples obtained from the Griffin Avenue spring during the 1995 and 1996 RI sampling events exhibited total VOC concentrations ranging from 300 to 444 μg/L. As shown on Figure 6-6, the total VOC concentrations quantified in the Griffin Avenue spring were relatively consistent between 1983 and 1995. The results of the 1996 sampling seem to indicate somewhat decreased concentrations of total VOCs in the Griffin Avenue spring. The total VOC concentrations appear to have decreased from slightly less than 1000 μg/L over the 1985-1995 period to approximately 300 to 400 μg/L in 1996.

Ground water samples collected from the Hillview Avenue spring during the 1995 and 1996 RI sampling events exhibited total VOC concentrations ranging from 46 to 61 μg/L. These results are similar to 1994-95 results, and represent significant reduced VOC concentrations from the historical concentration of 892 μg/L observed in January 1983.

Historical trends in the total VOC concentrations in two off-site shallow unconsolidated unit monitoring wells (Dobroski and GFNB) are also presented graphically in Figure 6-6. Total VOC concentrations in the Dobroski well ranged from 33 to 42 μg/L during the 1995 and 1996 RI sampling events. These concentrations are consistent with the 1988 through 1995 results, but are lower than results reported in 1986 and 1987. No VOCs were reported in the ground water samples collected from the GFNB well during the 1995 and 1996 RI sampling events, which appears to confirm the decreasing trend in total VOC concentrations observed since sampling began in January 1983. Total VOC concentrations reported for the GFNB well in the early 1980's were greater than 5,000 μg/L.

Consistent with historical results, no VOCs were detected in the Hillman well during the 1995 and 1996 RI sampling events.

A graph depicting historical trends in the total VOC concentrations in off-site shallow unconsolidated unit state monitoring wells SW-3, SW-4, SW-5, and SW-6 is presented in Figure 6-7. As depicted in Figure 6-7, the total VOC concentrations in state wells SW-3, SW-4, SW-5, and SW-6, which are located in the vicinity of off-site ground water recovery wells RW-2, have been reduced as a result of the operation of the unconsolidated unit ground water recovery system. Consistent with recent historical results, no VOCs were detected in monitoring wells SW-1 and SW-2 during the 1995 and 1996 RI sampling events.

The total VOC concentrations detected during the 1995 and 1996 RI sampling events in monitoring wells SW-3 and SW-5 are consistent with those detected between 1991 and 1995. Similarly, no VOCs were detected in monitoring well SW-6 during the 1995 and 1996 RI sampling events, which is consistent with historical results reported since 1991. The total VOC concentrations in monitoring well SW-4 have fluctuated the most over time; however, the total VOC concentrations reported for the 1995 and 1996 RI sampling events are within historical ranges.

6.3.8. Historical ground water quality in on-site bedrock ground water

This section includes a discussion of historical on-site shallow bedrock ground water conditions. Data evaluated includes analytical results from quarterly and monthly sampling events conducted on shallow bedrock recovery wells, GM-8DR and GM-11D, from 1986 through the present. Locations of these wells are presented on Figure 6-5. Analytical results have been presented and summarized in annual reports, as well as the Five Year Review of Off-Site Remedial Program (O'Brien & Gere, July 1995).

VOC analyses

A graph depicting historical trends in the total VOC concentrations in on-site shallow bedrock recovery wells GM-8DR and GM-11D are presented in Figure 6-8. Total VOCs concentrations in both shallow bedrock recovery wells were consistent throughout monthly 1996 sampling events. Total VOC concentrations in recovery wells GM-8DR and GM-11D range from 7 to 31 μg/L and 5 to 16 μg/L, respectively, from January through November 1996 sampling events. The principal VOCs detected in the bedrock recovery wells are cis-1,2-dichloroethene and vinyl chloride. With the exception of the lower concentrations detected in the winter of 1992-93, the total VOC concentrations appear to be consistent between 1992 and the present, and on average, appear to have decreased from the total VOC concentrations detected between 1987 and 1991.

PCB analyses

Figure 6-9 depicts the historical concentrations of PCBs in shallow bedrock recovery wells GM-8DR and GM-11D. The analytical results from the ground water samples collected in 1996 from recovery well GM-8DR ranged from 37 to 85 μg/L. Historically, the concentrations of PCBs in well GM-8DR have decreased significantly since 1989. The concentrations of PCBs in well GM-11D ranged from 49 to 88 μg/L in 1996. The concentrations observed are consistent with the analytical results of the last few years. These levels, however, are significantly greater than the PCB concentrations observed prior to initiation of ground water recovery from well GM-11D in 1988.

6.4. Industrial wastewater sampling analytical results

Analytical results from the industrial wastewater sampling program indicate that PCBs are present throughout the sewer system at the GE Fort Edward plant. PCBs were detected in every sample of industrial wastewater collected; concentrations ranged from 1.3 μg/L to 1200 μg/L. The sample of LNAPL collected from manhole MH-23 contained 102,000 μg/L PCBs.

VOCs were detected in wastewater samples collected from manholes MH-5, MH-7, MH-8, MH-9, and MH-23. Total VOC concentrations in these samples ranged from 3 to 94 μg/L. Compounds detected in manholes MH-5, MH-7, MH-8, and MH-9 included bromodichloromethane, chlorobenzene, chloroform, and dichlorobenzene. The sample collected from manhole MH-23 contained benzene, xylene, n-butylbenzene, and naphthalene. Analytical laboratory data for the samples collected from the industrial sewer manholes are contained in Appendix K.

6.5 Distribution of DNAPL

As shown in Figure 4-6, DNAPL was observed in the southeast portion of the facility in the vicinity of the parking lot extending north to the area under buildings 23, 25 and 27. Based on the results of the RI soil boring program and previous investigations performed at the site, it appears that the likely source of the DNAPL was the rail car off-load area, the bulk storage tank farm and the CCO treat area in Building 23. The DNAPL has generally migrated south-southeast and pooled in the area of the parking lot located south of the main manufacturing building.

Evidence of residual DNAPL was observed in soil borings SB-53, SB-54, SB-55, SB-56, SB-59, SB-61, SB-63 and SB-65 just above the interface between the glacio-deltaic sand and the low permeability silt and clay deposits. In these soil borings, the thickness of DNAPL stained soil ranged from approximately 4 feet in soil boring SB-59, located in the bulk storage tank farm, to approximately 0.2 feet at soil borings SB-53 and SB-56.

South of Building 23, in the vicinity of observation wells OW-1 and OW-2 and oil recovery well ORW-2, recoverable (pooled) DNAPL was observed directly overlying the low permeability silt and clay deposits in soil borings SB-8 (OW-1), SB-12 (OW-2), SB-19, SB-64, SB-76, SB-77, SB-78, SB-79 and ORW-2. The area of recoverable DNAPL is shown on Figure 4-6, and ranges in thickness from 0 to approximately 3.5 feet (SB-19).

In soil borings SB-13, SB-16, SB-30, SB-66 and SB-75, DNAPL was observed within seams of fine sand interbedded with seams of silt and clay within the transition zone which is present in the eastern portion of the parking lot. As shown in Figure 4-6, eight soil borings were drilled in the southeastern portion of the parking lot (SB-28, SB-29, SB-31, SB-32, SB-

33, SB-34, SB-35 and SB-35) south and east of the borings where DNAPL was observed. No evidence of DNAPL was observed in any of these borings.

DNAPL was observed within seams of fine sand and silt interbedded with seams of silt and clay within the low permeability silt and clay deposit in soil borings SB-62 and TB-2, . As shown in cross section C-C' (Figure 4-4), the DNAPL is believed to have migrated east from the area of pooled DNAPL along horizontal seams of fine sand and silt within the silt and clay deposit. Additionally, DNAPL was observed within the glacial till deposit at boring TB-4.

In the southern portion of the parking lot, DNAPL is observed in a relatively small area in the immediate vicinity of ORW-1 and DGC-41. No evidence of DNAPL was observed in borings drilled south of the property boundary along Park Avenue. More recently, DNAPL thickness measurements indicate no measurable DNAPL was observed in oil recovery well ORW-1 and monitoring well DGC-41.

7. Risk assessment

This section presents the results of a risk assessment (RA) of potential impacts to public health related to the presence of chemical substances at the General Electric Company (GE) Transmission Systems facility located in Fort Edward, New York. The RA focuses on chemical substances detected in soil and ground water at the facility and site related chemical substances detected hydraulically down gradient of the facility. The assessment does not address the Hudson River, since the Hudson River is being investigated and evaluated separately.

The RA was prepared at the request of GE to facilitate the consideration and evaluation of possible future remedial actions at the site. The following United States Environmental Protection Agency (USEPA) documents were used as principal guidance in the preparation of the RA:

- *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A) Interim Final*, EPA/540/1089/002
- *Guidelines for Exposure Assessment* (57 FR 104, May 29, 1992)
- *Guidance on Risk Characterization for Risk Managers and Risk Assessors*, February 26, 1992, USEPA Memorandum from Henry Habicht, Deputy Administrator, to Assistant Administrators and Regional Administrators.

7.1. Methodology

A chemical substance may pose a risk to human health only if receptor populations have the potential to be exposed to the chemical substance in sufficient quantities to affect their health. As such, a site specific RA involves the identification of site related chemical substances the site, the evaluation of potential pathways to receptors, the estimation of the concentrations of the chemicals that may be present at locations where receptors may contact them (exposure point concentrations), and the evaluation of potential adverse effects that may result from the estimated dose of the chemicals if absorbed by receptors.

Consistent with the cited guidance, the RA was conducted in the following phases:

1. *Characterization of exposure setting.* The first step in the assessment process was to characterize the site with respect to its physical characteristics as well as those of the human populations at or near the site. The output of this step was a qualitative evaluation of the site and surrounding populations with respect to those characteristics that potentially influence exposure.

2. *Data evaluation.* The objective of the data evaluation step was to organize the data into a form appropriate for use in the assessment, to evaluate the quality of the data for RA purposes and identify chemicals of potential concern (COPCs).

3. *Exposure assessment.* In the exposure assessment, the pathways by which receptors may be exposed to on-site chemical substances were identified, and exposure point concentrations of COPCs were estimated for each complete exposure pathway. Exposure point concentrations were estimated directly from analytical data collected at the site and down gradient locations.

4. *Toxicity assessment.* In the toxicity assessment, available toxicological data for site related compounds were gathered and reviewed. Dose-response relationships between the extent of potential exposure and the occurrence/severity of potential adverse health effects were evaluated.

5. *Risk characterization.* In the risk characterization step, the toxicity and exposure assessments were integrated into quantitative expressions of potential human health risk. The resultant estimates of potential carcinogenic and non-carcinogenic health effects were characterized.

6. *Uncertainty analysis.* In this section, the major uncertainties in the calculated risk estimates were discussed.

7.2. Characterization of exposure setting

The key elements of the site with respect to the human health considerations are summarized below.

7.2.1. Chemical and physical site characteristics

A brief description of the site characteristics relevant to the human health risk assessment is presented below. A more detailed description of the characteristics is presented in Sections 4, 5 and 6 of this report.

Physical setting

The GE Fort Edward plant is situated approximately 800 feet east of the Hudson River between the Villages of Hudson Falls to the north and Fort Edward to the south. The facility occupies approximately 32 acres of land and is bounded by Broadway on the east, the Delaware and Hudson Railroad on the west, and Park Avenue on the south. Residential and commercial areas are located immediately to the south and east of the plant.

Site hydrogeology

Unconsolidated deposits of glacial origin unconformably overlie shale bedrock throughout much of the Fort Edward Plant area. Unconsolidated deposits consist primarily of glacio-deltaic sand overlying lacustrine clay and silts.

Ground water at the plant is observed in unconsolidated deposits under unconfined or water table conditions. The water table is free to rise and fall in response to ground water recharge and discharge. Depth to ground water in the shallow unconsolidated unit ranges from 5 - 10 ft. The shallow unconsolidated unit, which consists of sand with minor amounts of gravel, is typically hydraulically separated from the shallow bedrock unit by a low permeability till and clay rich aquitard. Shallow ground water flow in the northwest and western portion of the facility is generally to the west and northwest towards the Hudson River. Ground water flow in the central and southeastern portion of the facility is generally to the southeast toward Park Avenue.

Ground water flow within the shallow bedrock unit is principally through secondary porosity features such as fractures, joints and horizontal bedding planes. Based on ground water elevations in bedrock monitoring wells, ground water within the shallow bedrock unit flows from west to east at the facility.

Nature and extent of site related chemical substances

To facilitate potential future remedial decisions at the site, the site was organized according to the following areas for the purposes of the risk assessment. Risk estimates were developed for each area individually.

Area A (north of Foil Mill)

Area A represents the undeveloped area located north of the Building 40. This area was used for disposal of soil excavated during construction activities at the facility. Seven surface soil samples were collected from Area A and analyzed for PCBs and VOCs. As shown on Table 7-1, low concentrations of PCBs (< 2 ppm) were detected in surface soil in Area A. In addition, six shallow ground water monitoring wells were installed at the perimeter of Area A. The wells were sampled and analyzed for PCBs and VOCs. PCBs and VOCs were not detected in the monitoring wells at Area A.

Area B (Foil Mill)

Area B represents the areas located in the vicinity of Building 40. Kerosene was stored in above ground storage tanks located to the west of Building 40. Historical releases of kerosene during plant operations have resulted in elevated kerosene levels in soils in the vicinity of Building 40, and subsurface kerosene free product at certain locations around Building 40. Fifty-one soil boring samples were collected from Area B. As shown on Table 7-2, kerosene was detected in 14 of the thirty samples collected, as well as substituted benzenes and naphthalene, which are typically associated with refined petroleum products. Aroclor 1242 was detected in 24 of 51 soil samples at a maximum concentration of 36 mg/kg.

Data was available from 35 on-site ground water monitoring wells in Area B. As shown on Table 7-2, chlorinated VOCs, substituted benzenes, and Aroclors 1242 and 1254 were detected in on-site ground water at Area B.

Remedial Investigation, General Electric Company
Fort Edward, New York
Table 7-1: Analytes Detected in Area A

Constituent	No. of Analyses	No. of Detects	Detection Limit Range	Minimum Detected Concentration	Maximum Detected Concentration	Risk Based Screening Value (RBC)	COPC?	Basis
Soils (ug/kg)								
Aroclor-1242	7	4	1100-1100	290	1,300	41,000	No	< RBC
Aroclor-1254	7	3	1100-1100	160	1,600	41,000	No	< RBC

*-Risk Based Screening Values are health based screening values for industrial soils or residential tap water from USEPA Region III Risk Based Concentration Table.

**-COPC = Chemical of Potential Concern

Remedial Investigation, General Electric Company
Fort Edward, New York
Table 7-2: Analytes Detected in Area B

Constituent	No. of Analyses	No. of Detects	Detection Limit Range	Minimum Detected Concentration	Maximum Detected Concentration	Risk Based Screening Value (RBC)	COPC?	Basis
Soil (ug/kg)								
1,2,3-Trichlorobenzene	51	2	5-1,500	1,200	15,000	2.00e + 07	No	<RBC
1,2,4-Trichlorobenzene	51	1	5-1,500	47,000	47,000	2.00e + 07	No	<RBC
1,2,4-Trimethylbenzene	51	7	5-1,500	150	40,000	1.00e + 08	No	<RBC
1,3,5-Trimethylbenzene	51	7	5-1,500	89	5,300	1.00e + 08	No	<RBC
Acetone	51	4	10-3,000	13	48	2.00e + 08	No	<RBC
Aroclor-1242	51	24	1,000-2,600	78	36,000	4.10e + 04	No	<RBC
Aroclor-1254	51	14	1,000-11,0000	27	1,100	4.10e + 04	No	<RBC
Isopropylbenzene	51	13	5-1,400	7	2,400	2.00e + 07	No	<RBC
Kerosene (mg/kg)	30	14	10-71	8	61,000	NA		
Naphthalene	51	24	5-1,400	19	67,000	8.20e + 07	No	<RBC
Toluene	51	5	5-1,500	2	350	4.10e + 08	No	<RBC
1,1,1-Trichloroethane	51	1	5-1,500	2,000	2,000	7.20E+08	No	<RBC
Trichloroethene	51	1	5-1,500	25	25	5.20e + 05	No	<RBC
Ethylbenzene	51	8	5-1,400	290	3,100	2.00E+08	No	<RBC
Total Xylenes	51	3	5-1,500	44	4,300	1.00e + 09	No	<RBC
n-Butylbenzene	51	14	5-1,400	3	15,000	2.00E+07	No	<RBC
n-Propylbenzene	51	17	5-1,400	64	5,200	1.00e + 08	No	<RBC
p-Cymene	51	19	5-1,400	3	8,300	8.20e + 07	No	<RBC
Sec-Butylbenzene	51	19	5-1,400	3	6,500	1.00e + 08	No	<RBC
On-Site Ground Water (ug/L)								
Aroclor-1242	52	34	0.065-0.065	0.041	310	0.73	Yes	>RBC
Aroclor-1254	52	10	0.065-3.3	0.064	5.1	0.73	Yes	>RBC
Bromodichloromethane	50	1	5-50	3	3	0.17	Yes	>RBC
Chloroethane	50	1	10-100	200	200	8600	No	<RBC
Chloroform	50	2	5-50	1	29	0.15	Yes	>RBC
p-Cymene	44	6	5-50	2	38	1,500	No	<RBC
sec-Butylbenzene	44	1	5-50	1	1	61	No	<RBC
n-Butylbenzene	44	5	5-25	3	250	1,300	No	<RBC
1,1-Dichloroethane	50	4	5-50	16	940	810	No	Low Freq
cis-1,2-Dichloroethene	50	2	5-50	2	91	61	No	Low Freq
1,3-Dichlorobenzene	50	1	10-100	13	13	540	No	<RBC

Remedial Investigation, General Electric Company
Fort Edward, New York
Table 7-2: Analytes Detected in Area B

Constituent	No. of Analyses	No. of Detects	Detection Limit Range	Minimum Detected Concentration	Maximum Detected Concentration	Risk Based Screening Value (RBC)	COPC?	Basis
On-Site Ground Water (ug/L)								
1,4-Dichlorobenzene	50	1	10-100	26	26	0.44	Yes	>RBC
Ethylbenzene	50	1	5-50	4	4	1300	No	<RBC
Isopropylbenzene	44	5	5-50	1	12	1300	No	<RBC
Methylene Chloride	50	1	5-50	11	11	4.1	Yes	>RBC
Naphthalene	55	20	5-25	1	1,000	1,500	No	<RBC
n-Propylbenzene	44	5	5-50	3	25	1300	No	<RBC
Toluene	50	2	5-50	17	39	750	No	<RBC
1,1,1-Trichloroethane	50	4	5-50	5	1,100	790	Yes	>RBC
1,3,5-Trimethylbenzene	44	6	5-50	2	30	300	No	<RBC
1,2,4-Trimethylbenzene	44	6	5-50	1	72	300	No	<RBC
Total Xylenes	50	5	5-50	9	66	520	No	<RBC
2-Methylnaphthalene	5	2	10-10	65	83	1500	No	<RBC

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*-Risk Based Screening Values are health based screening values for industrial soils or residential tap water from USEPA Region III Risk Based Concentration T

**-COPC = Chemical of Potential Concern, Low Freq = detected at low freq at concentration slightly greater than RBC.

Area C (shallow ground water)

Area C represents shallow and transition zone ground water in the southern portion of the site. Historical releases of PCB oil and chlorinated solvents in the southern portion of the plant have resulted in dissolved chlorinated VOCs and PCBs in ground water which have migrated to off-site locations to the south of the site. In addition, chlorinated VOCs have been detected in the down gradient surface springs to which the shallow ground water discharges, as well as in certain residential wells located down gradient of the site.

As part of the RI and previous site investigations, a total of 32 shallow unconsolidated unit and transition zone monitoring wells have been installed in Area C. Additionally, 22 off-site down-gradient wells and four springs were sampled in Area C. To minimize off-site migration of dissolved ground water constituents, a series of recovery wells were installed at the perimeter of the site in 1991. As discussed in the Five Year Review of Off-Site Remedial Program report (O'Brien & Gere 1995), the concentrations of VOCs in downgradient monitoring wells have shown a statistically significant decrease following activation of the recovery well system. Therefore, for the purposes of this risk assessment, the analytical data from the two most recent rounds of data was utilized as being representative of the current extent of PCBs and VOC's in off-site ground water.

A summary of the chemical substances detected in Area C and down gradient locations is presented on Table 7-3. As shown on Table 7-3, chlorinated VOCs and PCBs were detected in on-site and off-site ground water, and chlorinated VOCs were detected in spring water.

Area D (DNAPL)

Area D represents a DNAPL layer located in the southern portion of the facility. Historical releases of PCB oil in the plant have resulted in a PCB and chlorinated VOC DNAPL located approximately 25 ft. below land surface. A DNAPL recovery well system is currently in operation in the southeastern portion of the plant. The DNAPL is located on the top of the low permeability unit at a depth of approximately 25 ft. bgs, and is restricted to the identified on-site areas due to the site geology.

Remedial Investigation, General Electric Company
Fort Edward, New York
Table 7-3: Analytes Detected in Area C

Constituent	No. of Analyses	No. of Detects	Detection Limit Range	Minimum Detected Concentration	Maximum Detected Concentration	Risk Based Screening Value (RBC)	COPC?	Basis
Off-Site Ground Water (ug/L)								
Aroclor-1242	37	12	0.065-0.065	0.04	1.9	0.73	Yes	>RBC
Aroclor-1254	37	2	0.065-0.056	0.016	0.165	0.73	No	<RBC
Bromodichloromethane	38	1	5.0-100	3	3	0.17	Yes	>RBC
Chloroform	38	2	5.0-100	14	25	0.15	Yes	>RBC
Trichloroethene	38	14	5.0-5.0	8	3,800	1.6	Yes	>RBC
cis-1,2-Dichloroethene	38	7	5.0-50	2	120	61	Yes	>RBC
On-Site Ground Water (ug/L)								
Aroclor-1242	68	45	0.065-0.065	0.021	77	0.73	Yes	>RBC
Aroclor-1254	68	15	0.065-3.25	0.030	4.5	0.73	Yes	>RBC
Benzene	67	2	5-250	5	6	0.36	Yes	>RBC
Chlorobenzene	67	1	5-250	48	48	3.9	Yes	>RBC
Chloroform	68	2	5-250	1	5	0.15	Yes	>RBC
1,1-Dichloroethane	67	2	5-250	6	9	810	No	<RBC
cis-1,2-Dichloroethene	68	14	5-250	2	650	61	Yes	>RBC
1,2-Dichlorobenzene	66	1	10-500	7	7	270	No	<RBC
1,3-Dichlorobenzene	66	1	10-500	38	38	540	No	<RBC
1,4-Dichlorobenzene	66	1	10-500	46	46	0.44	Yes	>RBC
Methylene Chloride	67	1	5-250	6	6	4.1	Yes	>RBC
1,1,1-Trichloroethane	67	2	5-250	12	19	790	No	<RBC
Trichloroethene	67	30	5-5	3	10,000	1.6	Yes	>RBC
Tetrachloroethene	67	2	5-250	10	10	1.1	Yes	>RBC
Vinyl Chloride	67	1	10-500	67	67	0.019	Yes	>RBC
Spring Water (ug/L)								
Trichloroethene	8	6	5-5	0.9	1,000	1.6	Yes	>RBC
cis-1,2-Dichloroethene	8	2	5-5	1	180	61	Yes	>RBC

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*-Risk Based Screening Values are health based screening values for industrial soils or residential tap water from USEPA Region III Risk Based Concentration

**-COPC = Chemical of Potential Concern

Area E (bedrock ground water)

Area E represents bedrock ground water at the site. Thirty monitoring wells were sampled in Area E. A summary of the chemical substances detected in Area E is presented on Table 7-4. As shown on Table 7-4, chlorinated VOCs and PCBs were detected in on-site bedrock ground water.

Area F (leachfield)

Area F represents the leach field located in the southwestern portion of the site. Waste water from the facility was discharged to the leachfield prior to construction of the plant site wastewater treatment facility in 1976. Four sub-surface soil samples were collected, and one on-site monitoring well was installed at Area F. A summary of the chemical substances detected at Area F is presented on Table 7-5. PCBs were detected in sub-surface soil at Area F at a maximum concentration of 203 mg/kg, and in shallow ground water at a maximum estimated concentration of 0.059 ug/l.

Area G (inactive sewers)

Area G represents the active and inactive storm sewers at the facility. The active sewers discharge to the equalization basin in the south western portion of the facility. The integrity of the equalization basin and its potential to act as a source to ground water will be investigated in accordance with Order on Consent Index #A5-0316-94-06.

A summary of the chemical substance detected at Area G is presented on Table 7-6. Chlorinated VOCs, non-chlorinated VOCs and PCBs were detected in water collected from the inactive sewers. The water in the inactive sewers results from infiltration of shallow ground water to the sewer. Therefore, the chemical substances detected in the inactive sewers will be considered to be representative of shallow ground water at the site, and will be evaluated as such.

Current and future land use

Land use at the facility is industrial and is expected to remain as such. On site ground water is not used as a potable water supply or for industrial activities. On-site soil excavation activities are likely to be limited to shallow excavations related to the installation and maintenance of utilities.

Remedial Investigation, General Electric Company
Fort Edward, New York
Table 7- 4: Analytes Detected in Area E

Constituent	No. of Analyses	No. of Detects	Detection Limit Range	Minimum Detected Concentration	Maximum Detected Concentration	Risk Based Screening Value (RBC)	COPC?	Basis
On-Site Ground Water (ug/L)								
Aroclor-1242	50	13	0.065-0.065	0.037	76	0.73	Yes	>RBC
Benzene	52	2	5-5	6	11	0.36	Yes	>RBC
Chloroform	52	5	5-5	1	7	0.15	Yes	>RBC
cis-1,2-Dichloroethene	52	3	5-5	1	7	61	No	<RBC
Trichloroethene	52	1	5-5	4	4	1.6	Yes	>RBC
Vinyl Chloride	52	2	10-10	10	14	0.019	Yes	>RBC

Area E represents all of the on-site bedrock wells.

*-Risk Based Screening Values are health based screening values for industrial soils or residential tap water from USEPA Region III Risk Based Concentration Table.

**-COPC = Chemical of Potential Concern

Remedial Investigation, General Electric Company
Fort Edward, New York
Table 7- 5: Analytes Detected in Area F

Constituent	No. of Analyses	No. of Detects	Detection Limit Range	Minimum Detected Concentration	Maximum Detected Concentration	Risk Based Screening Value (RBC)	COPC?	Basis
Soil (ug/kg)								
Aroclor-1242	4	2	1100-1100	370	63,000	41,000	Yes	>RBC
Aroclor-1254	4	3	1100-1100	43	140,000	41,000	Yes	>RBC
On-Site Ground Water (ug/L)								
Aroclor-1242	1	1	0.065-0.065	0.059	0.059	0.73	No	<RBC

Area F represents leachfield soils/ground water.

*-Risk Based Screening Values are health based screening values for industrial soils or residential tap water from USEPA Region III Risk Based Concentration Table.

**-COPC = Chemical of Potential Concern

Remedial Investigation, General Electric Company
Fort Edward, New York
Table 7- 6: Analytes Detected in Area G

Constituent	No. of Analyses	No. of Detects	Detection Limit Range	Minimum Detected Concentration	Maximum Detected Concentration	Risk Based Screening Value (RBC)	COPC?	Basis
On-Site Ground Water (ug/L)								
(Inactive Sewers)								
Aroclor-1242	4	4	0.065-6.5	7.3	1,200	0.73	Yes	>RBC
Aroclor-1254	4	1	0.065-6.5	2.4	2.4	0.73	Yes	>RBC
Benzene	4	1	5-5	4	4	0.36	Yes	>RBC
Chlorobenzene	4	2	5-5	150	200	3.9	Yes	>RBC
cis-1,2-Dichloroethene	4	1	5-5	5	5	61	No	<RBC
1,2-Dichlorobenzene	4	2	10-10	35	61	270	No	<RBC
1,3-Dichlorobenzene	4	2	10-10	130	160	540	No	<RBC
1,4-Dichlorobenzene	4	2	10-10	190	270	0.44	Yes	>RBC
Trichloroethene	4	1	5-5	5	5	1.6	Yes	>RBC
Toluene	4	1	5-5	4	4	750	No	<RBC
sec-Butylbenzene	4	1	5-6	9	9	61	No	<RBC
n-Butylbenzene	4	1	5-6	18	18	1,300	No	<RBC
Naphthalene	4	1	5-6	49	49	1,500	No	<RBC
Total Xylenes	4	1	5-6	10	10			
1,2,3-Trichlorobenzene	4	1	5-5	25	25	300	No	<RBC
1,2,4-Trichlorobenzene	4	1	5-5	7	7	300	No	<RBC
On-Site Surface Water (ug/L)								
(Active Sewers)								
Aroclor-1242	9	9	0.065-1.3	1.3	53	0.73	Yes	>RBC
Aroclor-1254	9	8	0.065-1.3	1.1	24	0.73	Yes	>RBC
Bromodichloromethane	9	1	5-5	3	3	0.17	Yes	>RBC
Chlorobenzene	9	1	5-5	14	14	3.9	Yes	>RBC
Chloroform	9	2	5-12	13	16	0.15	Yes	>RBC
1,3-Dichlrobenzene	9	1	10-10	2	2	540	No	<RBC
1,4-Dichlorobenzene	9	1	10-10	7	7	0.44	Yes	>RBC

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*-Risk Based Screening Values are health based screening values for industrial soils or residential tap water from USEPA Region III Risk Based Concentration Table.

**-COPC = Chemical of Potential Concern

Land use to the south and east of the site is residential/commercial. Residences/businesses in the vicinity of the site may utilize private ground water supply wells for potable water. As discussed in the RI/FS Work Plan (OBG 1995), in June 1994 GE initiated a residential well sampling and analysis program, with the objective of connecting homes with potentially impacted water supply wells to available public water. A total of 48 residences/businesses within the vicinity of the site were identified as utilizing ground water as their drinking water source. Of the 48 residences, 46 wells were sampled and analyzed for PCBs and VOCs. As part of the program GE connected homes with wells in which PCBs or VOCs were detected to the public water supply. Currently, 31 of the 48 homes have been connected to public water, and an additional 6 homes had existing public water connections. Currently, all homes in the vicinity of the site at which VOCs or PCBs have been detected in ground water wells have been connected to public water supplies. A summary of the 1995 and 1996 residential well sampling program is included as Appendix L.

Potential receptor populations

Based on the site characterization, the following current potential receptor populations were identified:

> *On-site.* GE or non-GE employees engaged in soil excavation activities workers may be exposed to chemical substances in sub-surface soils or shallow overburden ground water during maintenance activities such as installing or repairing utility lines if excavation is required in or through areas of contamination. Workers are unlikely to be exposed to DNAPL since the DNAPL is located approximately 25 ft. bls.
>
> *Off-site.* It was assumed that residents may be exposed to VOCs in the off-site springs during recreational activities in the woods. In addition, some residents may utilize ground water for non-potable purposes such as watering the lawn, or washing the car.

7.3. Selection of chemicals of potential concern

In order to focus the risk calculations, analytes which are detected at less than background concentrations, at low concentrations and frequency, or are highly unlikely to result in significant human health risk are eliminated from further consideration in the risk assessment. Analytes which are not eliminated via this step are identified as Chemicals of Potential Concern (COPCs) and are carried through the quantitative risk assessment process. In order to identify COPCs, the maximum detected concentrations in soils and ground water were compared with USEPA Region III Risk Based concentrations (RBCs) (USEPA 1996). RBCs are derived soil and water concentrations below which it would be highly unlikely that the detected concentrations would result in significant human health risks. If the maximum detected concentration of an analyte was less than the corresponding RBC concentration, it was eliminated from further consideration as a COPC in the risk assessment.

Area A (north of Foil Mill) (Table 7-1)

Aroclor 1242 was detected in soils in four of seven samples collected at a maximum concentration of 1.3 mg/kg, and Aroclor 1254 was detected in Three of seven samples at a maximum concentration of 1.6 mg/kg. The maximum detected concentration are less than the identified Region III screening health based screening values. No VOCs, other than methylene chloride, a common laboratory contaminant were detected in Area A soils. As such, no COPCs were identified for Area A.

Area B (Foil Mill) (Table 7-2)

VOCs detected in soils at Area B included chlorobenzenes, alkyl substituted benzenes, and chlorinated aliphatics. In addition, naphthalene was detected in 24 of 51 samples at a maximum concentration of 67 mg/kg, Aroclor 1242 was detected in 24 of 51 samples at a maximum concentration of 36 mg/kg, and Aroclor 1254 was detected in 14 of 51 samples at a maximum concentration of 1.1 mg/kg. As shown on Table 7-2, none of the chemical substances detected in soils at Area B exceeded identified Region III risk based screening values. As such, no COPCs were identified in soils in Area B.

In ground water, Aroclor 1242 was detected in 34 of 52 samples analyzed at a maximum concentration of 310 ug/l, Aroclor 1254 was detected in 10 of 52 samples at a maximum concentration of 5.1 ug/l, and naphthalene was detected in 20 of 55 samples at a maximum concentration of 1,000 ug/l. In addition, alkyl substituted benzenes, chlorinated benzenes, chlorinated aliphatics, and methylnaphthalene were also detected in shallow ground water. Based on a comparison with the identified Region III RBCs, as well as consideration of the frequency and magnitude of the detected concentrations, Aroclor 1242, Aroclor 1254, bromodichloromethane, chloroform, 1,4-dichlorobenzene, methylene chloride and 1,1,1-trichloroethane were identified as COPCs in on-site ground water at Area B.

Area C (Shallow Ground Water) (Table 7-3)

VOCs detected in on-site shallow overburden and transition zone ground water include chlorinated aliphatics, chlorobenzenes, and benzene. Aroclor 1242 was detected in 45 of 68 samples collected at a maximum concentration of 77 ug/l, Aroclor 1254 was detected in 15 of 68 samples at a maximum concentration of 4.5 ug/l. Based on a comparison with the identified Region III RBCs, Aroclor 1242, Aroclor 1254, benzene, 1,4-dichlorobenzene, chlorobenzene, cis-1,2-dichloroethene, chloroform, chlorobenzene, methylene chloride, trichloroethene, tetrachloroethene, and vinyl chloride were identified as COPCs in on-site shallow overburden and transition zone ground water.

VOCs detected in off-site ground water were chlorinated aliphatics and bromodichloromethane. In addition, Aroclor 1242 was detected in 12 of 37 samples and Aroclor 1254 was detected in 2 of 37 samples. Aroclor 1242, bromodichlormethane, chloroform, trichlorethene, and cis-1,2-dichloroethene were identified as COPCs in off-site ground water.

Area D (DNAPL)

Area D is identified as sub-surface DNAPL. The DNAPL consists of chlorinated aliphatics and PCBs, principally Aroclor 1242. As such, chlorinated aliphatics and Aroclor 1242 are identified as COPCs for Area D.

Area E (Bedrock Ground Water) (Table 7-4)

VOCs detected in on-site shallow bedrock ground water include chlorinated aliphatics and benzene. Aroclor 1242 was detected in 13 of 50 samples analyzed at a maximum concentration of 76 ug/l. Aroclor 1242, benzene, chloroform, trichloroethene, and vinyl chloride were identified as COPCs in on-site shallow bedrock ground water.

Area F (Leachfield)(Table 7-5)

Aroclor 1242 was detected in two of four soil samples at a maximum concentration of 63 mg/kg, and Aroclor 1254 was detected in three of four samples at a maximum concentration of 140 mg/kg. Aroclor 1242 and 1254 were identified as COPCs in soils. Aroclor 1242 was detected in the ground water sample collected from this area at a maximum concentration of 0.059 ug/l, which is less than the identified Region III RBC. Therefore, no COPCs were identified in ground water at this area.

Area G (Inactive Sewers) (Table 7-6)

VOCs detected in water samples collected from the inactive sewers include chlorinated aliphatics, chlorobenzenes, alkyl substituted benzene, and benzene. Aroclor 1242 was detected in four of four samples at a maximum concentration of 1,200 ug/l and Aroclor 1254 was detected in one of four samples at a maximum concentration of 2.4 ug/l. Based on a comparison with Region III RBCs, Aroclor 1242, Aroclor 1254, benzene, chlorobenzene, trichloroethene, and 1,4-dichlorobenzene were identified as COPCs in Area G.

Table 7-7 presents a summary of the COPCs carried through the risk assessment.

7.4. Exposure assessment

In the exposure assessment, the mechanisms by which receptors may be exposed to the COPCs present at or migrating from the site are identified, and the concentrations of the chemicals to which receptors may be exposed are estimated. The exposure assessment is conducted in the following sections:

- Exposure Pathway Analysis
- Quantification of Exposure
    - Estimation of Exposure Point Concentrations
    - Identification of Exposure Scenarios
    - Calculation of Chemical Intakes by Receptors

7.4.1. Exposure pathway analysis

An exposure pathway describes the course a chemical takes from the source to the potentially exposed individual. A complete exposure pathway consists of four elements:

- a source and mechanism by which a chemical substance may be released to the environment;
- a retention or transport medium;

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Table 7-7
Summary of Chemicals of Potential Concern for the Human Health Risk Assessment

Source Area	Soils	On-Site Shallow Overburden Ground Water	On-Site Shallow Bedrock Ground Water	Off-Site Ground Water	Off-Site Spring Water
A	None	None	NA		
B	None	Aroclor 1242, Aroclor 1254, BCM, chloroform, 1,4-DCB, methylene chloride, 1,1,1-TCA			
C	NA	Aroclor 1242, Aroclor 1254, benzene, chlorobenzene, chloroform, cis-1,2-DCE, methylene chloride, TCE, PCE, VC, 1,4-DCB		Aroclor 1242, BCM, chloroform, trichloroethene, cis-1,2-DCE	TCE, cis-1,2-DCE
E	NA	NA	Aroclor 1242 benzene, chloroform, TCE, VC		
F	Aroclor 1242 Aroclor 1254	None	NA		
G		Aroclor 1242 Aroclor 1254 benzene, chlorobenzene, TCE, 1,4-DCB			

BCM= Bromodichloromethane, 1,4,-DCB=1,4,-Dichlorobenzene, 1,1,1-TCA=1,1,1-Trichloroethane, TCE=Trichloroethylene, cis-1,2,-DCE=cis-1,2-Dichloroethylene, PCE=Tetrachloroethylene, VC=Vinyl Chloride

- a point of potential human contact with the contaminated medium (referred to as the exposure point); and,
- an exposure route (e.g., ingestion) at the contact point.

A pathway is considered to be complete if the conditions listed above exist for that pathway. If one or more of these conditions are not met, there is no physical means by which a receptor may be exposed to the compounds of potential concern, and the pathway is classified as incomplete. Incomplete pathways are not considered further in the RA.

The results of the exposure pathway analysis are summarized on Figures 7-1 thru 7-6 for Areas A, B, C, D, E, and F respectively. To facilitate the assessment, the exposure pathway analysis is organized according to the areas previously discussed.

Area A (Fig 7-1)

No COPCs were identified in soils or ground water at Area A. As such, no complete pathways were identified at Area A.

Area B (Fig 7-2)

Area B represents soils and shallow ground water at and around the Foil Mill. No COPCs were identified in soils at Area B. Therefore, potential soil exposures were not considered further in the risk assessment. COPCs were identified in shallow on-site ground water at Area B. As such, the direct contact with ground water pathway is complete at Area B. Workers may be exposed to COPCs in shallow ground water if they excavate soils in Area B. Workers may be exposed via incidental ingestion, dermal contact, and inhalation.

Area C (Fig 7-3)

Area C represents shallow and transition zone ground water in the southern portion of the site. Workers may be exposed to COPCs in on-site shallow ground water at Area C if they excavate soils in the area. As such , the direct contact with ground water pathway is complete at Area C. Workers may be exposed via incidental ingestion, dermal contact, and inhalation.

In addition COPCs in ground water at Area C have migrated to off-site locations. As previously discussed, downgradient residences at which

PCBs or VOCs have been detected in ground water wells have been connected to municipal water. However, some residences may utilize ground water for non potable purposes such as car washing. Therefore, the off-site ground water usage pathway for non-potable uses was classified as complete.

There is a theoretical possibility that VOC COPCs in ground water beneath off-site residences may migrate to indoor air of homes via soil gas infiltration. This pathway has been quantitatively evaluated as part of a previous investigation (LMS 1989). The report concluded that there were no significant health risks associated with the potential migration of soil gas to indoor air. The concentration of VOCs in off-site ground water have dropped significantly since the mid to late 1980s. Therefore, the indoor air migration pathway will not be evaluated as part of this risk assessment.

VOCs have also been detected in surface springs to the south of the site. For the purposes of this assessment, it was assumed that an adolescent recreator may be exposed to COPCs detected in the down gradient springs. Therefore, the recreational exposure to spring water pathway was classified as complete.

Area D (Fig 7-4)

Area D represents DNAPL which is located 25 ft. bls. It is highly unlikely that workers would come into contact with DNAPL except during implementation of the final remedial option. Therefore, the direct contact with DNAPL exposure pathway is incomplete. DNAPL acts as a source of dissolved chemical substances to ground water. The dissolved residues will be quantified as part of the Area C evaluation. As such, while the dissolution to ground water pathway is complete for Area D, it will not be quantified as part of the Area D evaluation.

Area E (Fig 7-5)

Area E represents bedrock ground water at the site. Workers are not expected to contact ground water in the shallow bedrock unit. Therefore, the direct contact with shallow bedrock ground water exposure pathway is incomplete. COPCs in Area E may migrate to off-site locations via ground water transport. The detected COPCs in ground water at off-site areas will be evaluated as part of the Area C evaluation. Therefore, while the off-site ground water transport pathway is complete for Area E, it will not be quantified as part of the Area E evaluation.

Area F (Fig 7-6)

Area F represents the leachfield located in the south west portion of the site. COPCs were identified in sub-surface soils at Area F. Workers engaged in soil excavation activities in this area may contact COPCs in sub-surface soils. Therefore, the direct contact with sub-surface soils pathway is classified as complete for Area F. PCBs were detected in ground water at concentrations which are lower than risk based concentrations. As such, the direct contact with ground water pathway was classified as incomplete.

Area G

Area G represents the active and inactive sewer system. The active sewer system discharges to the equalization basin in the southwest portion of the site. The results of the sewer inspection indicates that the active sewers lines are tight. The integrity of the equalization basin and its potential to act as a source to ground water will be investigated in accordance with Order on Consent Index #A5-0316-94-06.

COPCs were detected in water collected from the inactive sewers. The water in the inactive sewers results from infiltration of shallow ground water to the sewer. Chemical residues in the sewers may dissolve in the ground water which may periodically leak to ground water depending on the ground water elevation. As such, the inactive sewers may act as a source of COPCs to ground water. Therefore, the COPCs detected in the inactive sewers will be considered to be representative of shallow ground water at the site, and the direct contact with ground water pathway for Area G is classified as complete.

7.4.2. Quantification of exposure

The next step in the exposure assessment was to quantify the magnitude, frequency, and duration of exposure for the complete exposure pathways. The quantification of exposure was performed in accordance with the following USEPA guidance for exposure assessment activities:

- *Guidelines for Exposure Assessment* (USEPA 1992)

- *Risk Assessment Guidance for Superfund* (USEPA 1989).

In keeping with USEPA guidance, the Reasonable Maximum Exposure estimates (RME), as defined by USEPA (1989), were calculated for the identified receptors. The RME estimates were derived by combining a series of average and upper bound exposure factor estimates in calculating the chemical specific chronic daily intakes, and are a conservative estimate of the potential exposures that may occur at the site.

The calculations were performed in the following steps :

- Estimation of exposure point concentrations
- Selection of intake equations and parameter estimates
- Calculation of chemical intakes by receptors.

Estimation of exposure point concentrations

According to USEPA guidance, the exposure point concentration should be a reasonably conservative estimate of the COPC concentration at the location where receptors may contact the COPC. Exposure point concentrations may be derived based on statistical evaluations of site analytical data, or based on the results of quantitative chemical fate and transport modeling. Since representative data for on-site soils and ground water were available at this site, the exposure point concentrations for these media were derived directly from the available data. Air exposure point concentrations were derived based on quantitative models. A summary of the derived exposure point concentrations is presented on Table 7-8. The approach for estimating the exposure point concentrations is further discussed below.

Contact with on-site ground water

The complete exposure pathway for on-site ground water are direct contact by workers during soil excavation activities. As such, the RME point concentrations for the shallow ground water contact pathway are represented as the upper bound estimate on the spatial and temporal average concentrations across the area being evaluated. Consistent with USEPA guidance, the RME estimate on the average was taken to be the upper 95% confidence limit on the mean concentration, if it could be reasonably derived, or the maximum detected concentration. The UCL may be reasonably derived if there are a sufficient number of samples to estimate the underlying statistical distribution of the data (normal, log-normal etc.), and if there is a high enough frequency of detected samples compared with non detects (>= 30%)(otherwise the calculated UCL

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Table 7- 8
Summary of RME Point Concentrations for the Human Health Risk Assessment

Source Area	Soils			On-Site Shallow Overburden Ground Water			Off-Site Ground Water			Off-Site Spring Water		
	COPC	mg/kg	Basis	COPC	ug/l	Basis	COPC	ug/l	Basis	COPC	ug/l	Basis
B	None			Aroclor 1242	21.4	UCL						
				Aroclor 1254	5.1	Max						
				BCM	3	Max						
				chloroform	29	Max						
				1,4-DCB	26	Max						
				methylene chloride	11	Max						
				1,1,1-TCA	1100 *(13)	Max						
C	NA			Aroclor 1242	8	UCL	Aroclor 1242	1.9	Max			
				Aroclor 1254	4.5	Max	BCM	3	Max			
				benzene	6	Max						
				chlorobenzene	48	Max						
				chloroform	5	Max	chloroform	25	Max			
				cis-1,2-DCE	650 *(9.1)	Max	cis-1,2-DCE	120	Max	cis-1,2-DCE	61	Max
				methylene chloride	6	Max						
				TCE	4717 *(55)	UCL	TCE	3,800 *(77)	Max	TCE	1,000 *(44)	Max
				PCE	10	Max						
				VC	67	Max						

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Table 7- 8
Summary of RME Point Concentrations for the Human Health Risk Assessment

Source Area	Soils			On-Site Shallow Overburden Ground Water			Off-Site Ground Water			Off-Site Spring Water		
	COPC	mg/kg	Basis	COPC	ug/l	Basis	COPC	ug/l	Basis	COPC	ug/l	Basis
F	Aroclor 1242	63	Max	None								
	Aroclor 1254	140	Max									
G				Aroclor 1242	1200	Max						
				Aroclor 1254	2.4	Max						
				benzene,	4	Max						
				chlorobenzene	200	Max						
				TCE	5	Max						

BCM= Bromodichloromethane, 1,4,-DCB=1,4,-Dichorobenzene, 1,1,1-TCA=1,1,1-Trichloroethane, TCE=Trichloroethylene, cis-1,2,-DCE=cis-1,2-Dichloroethylene, PCE=Tetrachloroethylene, VC=Vinyl Chloride

*(9.1) - Derived air exposure point concentration - ug/m3

UCL=Upper 95% Confidence Limit on the Mean represents an estimate of the detection limit rather than the detected concentrations). For the available data, the data was sufficient to derive UCLs for Aroclor 1242 in Areas B and C, and trichloroethene in Area C. For all other COPCs, the exposure point concentration was taken to be the maximum detected concentration. While this approach may be lead to a conservative evaluation, it does not significantly affect the results and conclusions of the risk assessment, since Aroclor 1242 and trichloroethene are the predominant contributors to the total calculated risk estimates for contact with on-site ground water at each source Area. This is discussed in greater detail in the risk characterization section and uncertainty assessment section of the RA.

Contact with on-site soils

COPCs were identified in soils at Area F. Based on the number of samples collected from Area F, the exposure point concentration was taken to be the maximum concentration detected at that Area.

Contact with off-site ground water

For off-site ground water, exposure may occur as a result of water being drawn from a well. Since a well only access a fixed location in the aquifer, it is inappropriate to derive exposure point concentrations for off-site ground water based on a spatial average of the detected concentrations in the plume. However, since COPC concentrations in a well may vary with time it is appropriate to consider temporal averages or temporal trends in deriving the exposure point concentrations. As previously discussed, the concentrations of COPCs in down gradient monitoring wells have shown a statistically significant decrease following activation of the on-site and off-site ground water recovery well system. Therefore, for the purposes of this risk assessment, the analytical data from 1995 and 1996 was utilized as being representative of the current extent of COPCs in off-site ground water. The off-site ground water exposure point concentrations were taken to be the maximum detected concentrations of COPCs in off-site wells in those rounds.

Contact with spring water

Based on the information discussed above, the maximum detected concentrations of COPCs in spring water from the two most recent rounds of sampling were taken to be the exposure point concentration for spring water.

Air

Airborne concentrations of VOC COPCs may occur as a result of volatilization from the water matrices. Air exposure point concentrations were derived for cis-1,2-dichoroethylene and trichoroethylene in Area C on-site ground water, trichloroethylene in off-site ground water and spring water, and 1,1,1-trichloroethane at Area B. These COPCs were selected for calculation of airborne concentrations since they were detected at relatively high concentrations compared with other detected volatile COPCs. A detailed description of the methodology and assumptions used to derive air exposure point concentrations is presented on Table 7-9.

Calculation of chemical intakes by receptors

Based on the identified exposure scenarios and intake parameters, chemical specific chronic daily intake (CDI) estimates were developed for the identified receptors according to the equations presented on Table 7-10 and parameters presented on Tables 7-11 thru 7-14 respectively.

Identification of exposure scenarios

Once the chemical concentrations at the exposure points were estimated, the potential activity patterns of receptors at the exposure points were evaluated. This included identifying how often and for how long the receptor may be present at the exposure point, and other specific variables that influence the amount of COPCs potentially taken up by the receptor. A summary of the exposure scenarios and parameters for the identified receptors (on-site workers, off-site adult resident, off-site child resident, and off-site adolescent recreator) are presented on 7-11 through 7-14 respectively, and briefly summarized below.

On-site workers. On-site workers may contact COPCs if soil excavation activities occur at certain areas. Workers may contact COPCs in shallow overburden ground water at Areas B and Area C, and sub-surface soils at Area F. For the purposes of this assessment, a reasonably conservative assumption was made that an on-site worker may contact sub-surface COPCs at any given source area for a period of 60 days over one year. Intake of the COPCs may occur via incidental ingestion and dermal contact with sub-surface soils or ground water, as well as inhalation of vapors from ground water. Details of the parameter values utilized to quantify these pathways are summarized on Table 7-11.

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Table 7-9 : Estimation of Outdoor Air Concentrations

EQUATIONS USED TO MODEL OUTDOOR AIR CONCENTRATIONS:

$E_i = k_o * A * C_i$[a] where:
E_i = Emission rate of volatile constituent (g/s)
k_o = overall mass transfer coefficient (m/s)
C_i = concentration in ground water (g/m^3)
A = area of horizontal section (base) of box model (m^2)

$C_{air} = E_i / Q$ where:
C_{air} = Steady state air concentration at all points in volume of model box (μg/m^3)
Q = volumetric flow rate of air through vertical section of model box

$Q = U_{avg} * a$ where:
U_{avg} = average outdoor wind velocity (m/s)[b]. Based on geographic location U_{avg} = 4m/s
a = area of vertical section of box model (m^2)

CONSTITUENT	PARAMETERS		BOX DIMENSIONS		MODELED AIR CONCENTRATION
AREA B:					
1,1,1, trichloroethane	Henry's Law Constant (atm-m^3/mol) :	1.44 E-02	length (m)	3	
	Molecular weight (g/mol) :	133	width (m) :	5	13 μg/m^3
	overall mass transfer coefficient (m/s) :	3.1 E-05	height (m)	2	
	Concentration in groundwater (source conc - m	1100			
AREA C - on-site groundwater:					
trichloroethene	Henry's Law Constant (atm-m^3/mol) :	9.1 E-03	length (m)	3	
	Molecular weight (g/mol) :	131	width (m) :	5	55 μg/m^3
	overall mass transfer coefficient (m/s) :	3.13 E-05	height (m)	2	
	Concentration in groundwater (source conc - m	4717			
cis-1,2 dichloroethene	Henry's Law Constant (atm-m^3/mol) :	7.58 E-03	length (m)	3	
	Molecular weight (g/mol) :	97	width (m) :	5	9.1 μg/m^3
	overall mass transfer coefficient (m/s) :	3.73 E-05	height (m)	2	
	Concentration in groundwater (source conc - m	650			
AREA C - off-site groundwater:					
trichloroethene	Henry's Law Constant (atm-m^3/mol) :	9.1 E-03	length (m)	5	
	Molecular weight (g/mol) :	131	width (m) :	3	77 μg/m^3
	overall mass transfer coefficient (m/s) :	3.13 E-05	height (m)	2	
	Concentration in groundwater (source conc - m	3800			
AREA C - springwater:					
trichloroethene	Henry's Law Constant (atm-m^3/mol) :	9.1 E-03	length (m)	5	
	Molecular weight (g/mol) :	131	width (m) :	1	44 μg/m^3
	overall mass transfer coefficient (m/s) :	3.13 E-05	height (m)	1	
	Concentration in groundwater (source conc - m	1000			

[A] - Baseline air emissions at superfund sites, Air/Superfund National Technical Guidance Study Series, Radian Corporation

[B] - Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites, EPA/600/8-85/002

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Table 7- 10
Human Health Risk Assessment
Equations for Calculation of Chronic Daily Intakes (CDIs)

Pathway	Equation* to Calculate Chronic Daily Intake (CDI)
Incidental Ingestion of Soil	$CDI = \frac{C_{soil} * IR * EF * ED * 1E{-6}\ kg/mg}{BW * AT}$
Dermal Contact with Soil	$CDI = \frac{C_{soil} * SA * ABS * AF * ED * 1E{-6}\ kg/mg}{BW * AT}$
Incidental Ingestion of Water	$CDI = \frac{C_{sw} * IR * ET * EF * ED}{BW * AT}$
Dermal Contact with Water	$CDI = \frac{C_{sw} * SA * PC * ET * EF * ED * 0.001\ l/ml}{BW * AT}$
Inhalation of Vapor	$CDI = \frac{C_{air} * IR * ET * EF * ED}{BW * AT}$

* - The acronyms for the chronic daily intake parameters are defined in Tables 7-11 through 7-14

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Table 7- 11
Human Health Risk Assessment
Parameters for Calculation of Chronic Daily Intakes (CDIs)
On-Site Worker

Pathway	Parameter	Description	RME Estimate	Justification	Reference
General	EF	Exposure Frequency (days/year)	60	Judgement for estimated duration of soil excavation activities at any given area	
	ED	Exposure Duration (years)	1	It was assumed that soil excavation activities would occur during one summer.	
	BW	Body Weight (kg)	70	USEPA recommended value for adults	a
	AT	Averaging time (non-cancer) (days)	365		a
	AT	Averaging Time (cancer) (days)	25,550	USEPA recommended value	a
Incidental Ingestion of, and Dermal Contact with Soils	C_{soil}	Concentration in Soil (mg/kg)	Chem. Spec.	Based on analytical data	Chem. Spec.
	IR_{soil}	Soil Ingestion Rate (mg/day)	480	USEPA recommended value for activities involving high levels of soil contact.	b
	SA	Skin Surface Area Available (cm^2/day)	5800	As per USEPA guidance the average value represents 25 % of the estimated median total skin surface area for adults in the United States, whereas the upper bound value reflects 25 % of the upper 95th percentile.	c
	AF	Soil to Skin Adherence Factor (mg/cm^2)	1.0	USEPA recommended RME value for assessing soil exposures	c
	ABS	Absorption Constant (no units)	Chem. Spec.	Value obtained from literature review	Chem. Spec.

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Table 7- 11
Human Health Risk Assessment
Parameters for Calculation of Chronic Daily Intakes (CDIs)
On-Site Worker

Pathway	Parameter	Description	RME Estimate	Justification	Reference
Incidental Ingestion of, and Dermal Contact with Shallow Ground Water	C_{gw}	Concentration in Ground Water (mg/l)	Chem. Spec.	Based on analytical data	Chem. Spec.
	IR_{gw}	Ground Water Ingestion Rate (ml/hour)	0.01	USEPA recommended value is 50 ml/hour for swimming. Contact with groundwater during soil excavation activities would result in lower incidental ingestion rates relative to swimming. Thus, as a conservative judgment, 10 ml/hour was used.	a
	ET	Exposure Time (hours/day)	2	Conservative estimates of possible contact time with groundwater during soil excavation activities.	
	SA	Skin Surface Area Available (cm^2)	3100	As a conservative estimate, it was assumed that the hands, forearms, and 60 % of the upper arms may be in continuous contact with shallow ground water for 2 hours/day during soil excavation activities.	b
	PC	Permeability Constant (cm/hour)	Chem. Spec.	Value obtained from USEPA guidance document	c
Inhalation of Outdoor Air	C_{air}	Concentration in air (mg/m^3)	Chem./Site Specific	The air concentrations for VOCs were derived as described on Table 7-9	
	IR_{dust}	Inhalation Rate (m^3/hour)	4.8	Recommended inhalation rate by USEPA for adult males at heavy activity levels (i.e. vigourous physical exercise)	b
	ET	Exposure Time (hours/day)	8	As a conservative estimate, it was assumed that, during the work day , the worker would be in the vicinity of the excavated area for 8 hours/day.	

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a) U.S. EPA 1989, Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) Interim Final, EPA/540/1089/002

b) U.S. EPA 1989, Exposure Factors Handbook, EPA/600/8-89/043

c) U.S. EPA, 1992, Dermal Exposure Assessment: Principles and Applications EPA/600/8-91/011B

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Table 7- 12
Human Health Risk Assessment
Parameters for Calculation of Chronic Daily Intakes (CDIs)
Off-site Adult Resident

Pathway	Parameter	Description	Upper Bound	Justification	Reference
General	EF	Exposure Frequency (days/year)	56	As a conservative estimate, it was assumed that an adult resident may use ground water for non-potable applications 2 times/week for 28 weeks/year.	
	ED	Exposure Duration (years)	24	Upper 95 percentile for time spent at a given residence for the United States population	b
	BW	Body Weight (kg)	70	USEPA recommended value for adults	a
	AT	Averaging time (non-cancer) (days)	8760	USEPA recommended value	a
	AT	Averaging Time (cancer) (days)	25,550	USEPA recommended value	a
	ET	Exposure time (hours)	1	It was estimated that an adult resident would spend one hour per day, 56 days per year using ground water for non-potable purposes.	
Incidental Ingestion and Dermal Contact with Ground Water - Non potable uses	C_w	Concentration in ground water (mg/l)	Chem./Site Specific		
	IR	Incidental ingestion rate (l/hour)	0.01	USEPA recommended value is 50 ml/hour for swimming. The incidental ingestion rate of water during non-potable household uses is likely to result in less incidental ingestion relative to swimming. Thus, 10 ml/hour was used.	a
	SA	Skin Surface Area ($cm^{2)}$	3100	As a conservative estimate, it was assumed that the hands, forearms, and 60 % of the upper arms may be in continuous contact with shallow ground water for 2 hours/day during soil excavation activities	c
	PC	Permeability Constant (cm/hour)	Chem. Spec.		c

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Table 7- 12
Human Health Risk Assessment
Parameters for Calculation of Chronic Daily Intakes (CDIs)
Off-site Adult Resident

Pathway	Parameter	Description	Upper Bound	Justification	Reference
Inhalation of Outdoor Air	C_{air}	Concentration in air (mg/m^3)	Chem./Site Specific	The air concentrations for VOCs were derived as described on Table 7-9	
	IR_{air}	Inhalation rate (m^3/hour)	2.6	The average and upper bound rates reflect USEPAs recommended inhalation rates for outdoor activities at a moderate activity level (e.g. heavy cleaning, major repairs, climbing stairs)	b

a) U.S. EPA 1989, Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) Interim Final, EPA/540/1089/002

b) U.S. EPA 1989, Exposure Factors Handbook, EPA/600/8-89/043

c) U.S. EPA, 1992, Dermal Exposure Assessment: Principles and Applications EPA/600/8-91/011B

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Table 7- 13
Human Health Risk Assessment
Equations for Calculation of Chronic Daily Intakes (CDIs)
Off-Site Child Resident

Pathway	Parameter	Description	Upper Bound	Justification	Reference
General	EF	Exposure Frequency (days/year)	56	As a conservative estimate, it was assumed that a child resident may be exposed to ground water during non-potable applications 2 times/week for 28 weeks/year.	
	ED	Exposure Duration (years)	6	Default ED for child	a
	BW	Body Weight (kg)	16	Default body weight for child	a
	AT	Averaging time (non-cancer) (days)	2190	USEPA recommended value	a
	ET	Exposure Time (hours/day)	1	It was estimated that an child resident would spend one hour per day, 56 days per year using ground water for non-potable purposes.	
	AT	Averaging Time (cancer) (days)	25,550	USEPA recommended value	a
Incidental Ingestion and Dermal Contact with Ground Water - Non potable uses	C_w	Concentration in ground water (mg/l)	Chem Specific		
	IR	Incidental ingestion rate (l/hour)	0.01	USEPA recommended value is 50 ml/hour for swimming. The incidental ingestion rate of water during non-potable household uses is likely to result in less incidental ingestion relative to swimming. Thus, 10 ml/hour was used	a
	SA	Skin Surface Area ($cm^{2)}$	2000	The average value represents 25 % of the estimated median total skin surface area for children aged 6 years or under in the United States. This includes the head, hands, arms, and lower legs.	c
	PC	Permeability Constant (cm/hour)	Chem. Spec.		c
Inhalation of Outdoor Air	C_{air}	Concentration in air (mg/m^3)	Chem./Site Specific	The air concentrations for VOCs were derived as described on Table 7-9	
	IR_{air}	Inhalation rate (m^3/hour)	1	The estimated inhalation rate rates reflect USEPAs recommended value for children engaged in light - moderate levels of physical activity.	b

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a) U.S. EPA 1989, Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) Interim Final, EPA/540/1089/002

b) U.S. EPA 1989, Exposure Factors Handbook, EPA/600/8-89/04

c) U.S. EPA, 1992, Dermal Exposure Assessment: Principles and Applications EPA/600/8-91/011B

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Table 7- 14
Human Health Risk Assessment
Parameters for Calculation Chronic Daily Intakes (CDIs)
Off-site Adolescent Recreator

Pathway	Parameter	Description	Upper Bound	Justification	Reference
General	EF	Exposure Frequency (days/year)	56	As a conservative estimate, it was assumed that an adolescent (age 6-16) resident may be active at the spring area 2 days/week for 28 weeks/year.	
	ED	Exposure Duration (years)	10	It was assumed that a child/adolescent between the ages of 6-16 may play/be active in the area around the springs.	
	BW	Body Weight (kg)	36	Average body weight for males aged 6-16.	b
	AT	Averaging time (non-cancer) (days)	3650	USEPA recommended value	a
	ET	Exposure Time (hours/day)	0.5	For the purposes of this assessment it was assumed that an individual may play in the immediate vicinity of the spring water for approximately 0.5 hours/day.	
	AT	Averaging Time (cancer) (days)	25,550	USEPA recommended value	b
Incidental Ingestion of, and Dermal Contact with Surface Water	C_{water}	Chemical Concentration in Water (mg/L)	Chem. Spec.	Based on analytical data	Chem. Spec
	IR_{water}	Water Ingestion Rate (L/hour)	0.010	USEPA recommended value is 50 ml/hour for swimming. The incidental ingestion rate of water during activities at the spring is likely to result in significantly less incidental ingestion relative to swimming. Thus, 10 ml/hour was used	b
	SA	Skin Surface Area Available for Contact (cm^2)	2000		d
	PC	Chemical Specific Permeability Constant (cm/hr)	Chem. Spec.	USEPA estimates	c

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Table 7- 14
Human Health Risk Assessment
Parameters for Calculation Chronic Daily Intakes (CDIs)
Off-site Adolescent Recreator

Pathway	Parameter	Description	Upper Bound	Justification	Reference
Inhalation of Outdoor Air	C_{air}	Concentration in air (mg/m^3)	Chem./Site Specific	The air concentrations for VOCs were derived as described on Table 7-9	e
	IR_{air}	Inhalation rate (m^3/hour)	1	The estimated inhalation rate rates reflect USEPAs recommended value for children engaged in light - moderate physical activity.	a

a) U.S. EPA 1989, Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) Interim Final, EPA/540/1089/002

b) U.S. EPA 1989, Exposure Factors Handbook, EPA/600/8-89/043

c) U.S. EPA, 1992, Dermal Exposure Assessment: Principles and Applications EPA/600/8-91/011B

Off-site adult residents. As previously discussed, site related COPCs have been detected at off site locations in shallow overburden and transition zone ground water, as well as shallow bedrock ground water. Homes at which COPCs have been detected in residential supply well water have been connected to municipal water. However, some homes may use ground water for non-potable purposes such as washing the car or watering the lawn. For the purposes of this assessment, a reasonably conservative assumption was made that a 70 kg adult resident may use ground water from the supply well 2 days/week for 28 weeks of the year for one hour each day. Further, consistent with USEPA recommended default guidance, it was assumed that an individual would live in a downgradient home for a period of 24 years as an adult. This is a conservative estimate of potential duration of residence of an individual in any given home in the United States, and represents the upper 90th percentile for length of residence as an adult at a given home by home owners in the United States (USEPA 1989). Intake of the COPCs from the well water may occur via incidental ingestion and dermal contact with ground water, as well as inhalation of vapors during usage of the water for non-potable purposes. Details of the parameter values utilized to quantify these pathways are presented on Table 7-12.

Off-site child residents. For the purposes of this assessment, a reasonably conservative assumption was made that a 1-6 year old 16 kg child resident may contact well water 2 days/week for 28 weeks of the year for one hour each day. Intake of the COPCs from the well water may occur via incidental ingestion and dermal contact with ground water, as well as inhalation of vapors during usage of the water for non-potable purposes. Details of the parameter values utilized to quantify these pathways are presented on Table 7-13.

Off-Site adolescent re-creator. COPCs have been detected in springs which surface in a wooded area down gradient of the site. Homeowners may be exposed to COPCs in the springs if they utilize the wooded area for recreational purposes. For the purposes of this assessment, it was assumed that an adolescent resident may frequent the wooded area over a 10 year period (age 6 - 16), 2 days/week for 28 weeks of the year. While in the woods, it was assumed that direct exposure to the spring water may occur over a 30 minute period. Intake of the COPCs from the spring water may occur via incidental ingestion and dermal contact with spring water, as well as inhalation of vapors while the individual is in the vicinity of the spring. Further details of the parameter values utilized to quantify these exposures are presented on Table 7-14.

7.5. Toxicity assessment

In the toxicity assessment, available toxicological data summaries for site related compounds are reviewed and the relationship between the extent of exposure to a specific COPC and the potential for adverse health effects are estimated. The potential toxicologic effects induced by a given dose of a chemical are classified according to two types of effects: carcinogenic effects, and non-carcinogenic effects.

7.5.1. Non-carcinogenic effects

A non-cancer health effect occurs as a result of damage to cells in one or more human organ, which causes the organ(s) to function less efficiently. Due to the body's ability to cope with small doses of a chemical, a non-cancer health effect will not occur if intake of a chemical is less than a certain critical dose. This is referred to as a No Observed Adverse Effect Level (NOAEL) for a chemical. If the calculated intake of a chemical is less than the NOAEL for that chemical in a given species, then no adverse non-cancer health effects are expected as a result of that exposure.

The specific non-carcinogenic toxic effects that may be elicited depend on the exposure concentration and the duration of exposure. If an individual is exposed to very high concentrations of a chemical, toxic effects can occur in a short period of time. This is termed an acute toxic effect. If an individual is exposed to lower levels of a chemical regularly for a long period of time, smaller amounts of repeated damage to the organ can accumulate and ultimately cause the toxic effects. These are termed sub-chronic and chronic toxic effects (depending on the exposure duration).

In order to evaluate potential non-carcinogenic effects following exposure of human populations to chemicals, USEPA derives chemical specific "reference doses" (RfDs). If the calculated intake of a chemical is less than the published RfD, then no adverse non-carcinogenic effects are expected in the exposed population. A brief discussion of the methods by which RfDs are derived is presented below.

For some chemicals, RfDs are derived directly from data on human exposures. Such data includes data relating to occupational exposures that are known to have no adverse effects, normal dietary levels of certain chemicals (e.g. magnesium), therapeutic doses of certain chemicals (e.g. silver), epidemiologic data relating to populations with background exposures (e.g.. selenium). For most chemicals USEPA derives RfDs based on laboratory studies in which experimental animals were exposed to different concentrations of a chemical, and a NOAEL is estimated. If data from several animal studies are available, USEPA seeks to identify the species that is most comparable to humans based on a knowledge of specific biologic properties. However, if adequate comparative data is not available, USEPA selects the study on the most sensitive animal species as the critical study for the basis of the NOAEL. The NOAEL is then used to derive a RfD for evaluating potential adverse effects in human populations.

RfD Uncertainty Factors

In most cases, there is considerable uncertainty regarding the extension of toxicologic data from animal studies to humans. This uncertainty arises because there may be differences between the animal and human species regarding factors such as the metabolism of the chemical, the distribution and clearance rate of the chemical from the body, and the sensitivity of specific organ systems to the chemical. Therefore, the USEPA derives RfDs that are designed to be protective of the public at large, *including sensitive sub-populations*. The USEPA applies a series of "uncertainty" factors to calculate the final RfD values. Depending on the data, the NOAEL may be divided by an uncertainty factor ranging from 0 - 10,000. For human data, in most cases, the uncertainty factor of 10 is utilized to account for the application of data from the public at large to sensitive sub-populations. For animal data a minimum uncertainty factor of 100 (10 for sensitive sub-population, and 10 for animal-human extrapolation) is applied for deriving the human RfD.

7.5.2. Carcinogenic effects

The other health effect of concern in the exposure of humans to chemicals in the environment is the induction of cancer.

Weight of evidence

USEPA classifies chemicals according to their potential to induce cancer in humans. In general, USEPA reviews and evaluates available data regarding the potential carcinogenic effects of a chemical, and assigns a "carcinogenicity" classification according to a weight of evidence classification scheme (USEPA 1984, 49 CFR 462394). A chemical may be classified into one of five groups with respect to the weight of evidence for human carcinogenicity. The categories are:

- Group A - Known Human Carcinogen. A chemical is classified in group A if there is sufficient[1] evidence from human observations (epidemiological studies) to support an association between exposure to a chemical agent and cancer in humans.
- Group B - Probable Human Carcinogen. A chemical may be classified as a B1 or a B2 carcinogen. An agent is classified as a B1 carcinogen if there is sufficient evidence for carcinogenicity based on animal studies, and limited (suggestive but not conclusive) evidence based on human observations. A B2 carcinogen is an agent for which there is sufficient evidence for carcinogenicity in animals, and inadequate evidence for carcinogenicity in humans.
- Group C - Possible Human Carcinogen. An agent is classified as a group C carcinogen if there is limited evidence for carcinogenicity in animals and inadequate evidence for carcinogenicity in humans.
- Group D - An agent is classified as a group D agent if there is insufficient data available with which to evaluate the carcinogenicity of the chemical.
- Group E - An agent is classified as a group E agent if there is no evidence for carcinogenic effects based on at least two technically adequate animal studies.

The above method for cancer classification is currently being re-evaluated by USEPA (USEPA 1996). The proposed approach replaces the letter classifications with descriptive narratives qualitatively describing the available data for a given chemical, and discussing the limitations and strengths of the available data. However, as of date, the revised cancer classification system has not been issued as final policy, and for most chemical substances, USEPA risk assessment methods utilize the system described above.

Slope factors

For group A, B, or C chemicals, USEPA derives chemical specific cancer slope factors. A cancer slope factor is a number which, when multiplied by the estimated chemical specific CDI, provides an estimate of the "excess cancer risk" associated with that exposure. Theoretically, the excess cancer

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[1] The definition of the terms "sufficient", “limited”, and “adequate” are given in USEPA 1986, Guidelines for Carcinogen Risk Assessment, (51 FR 33992).

risk represents the lifetime probability (greater than background) that a carcinogenic event would occur in an individual as a result of a given exposure or pattern of exposures. However, it is important to note that for many chemicals, the excess cancer risk as calculated by USEPA's procedure may result in a highly conservative estimate of the potential cancer risk. Indeed, as acknowledged by USEPA (51 FR 3398), the procedure "does not necessarily give a realistic prediction of the risk. The true value of the risk is unknown, and may be as low as zero".

7.5.3. Toxicity summaries

For each chemical of concern, a brief synopsis of the human toxicological effects, including acute effects, and chronic RfDs and cancer slope factors published by USEPA was compiled from the following hierarchy of sources:

- USEPA's Integrated Risk Information System (IRIS) database (USEPA 1996),
- Health Effects Summary Tables (HEAST),
- Environmental Criteria Office (ECAO), and
- Agency for Toxic Substances and Disease Registry (ATSDR).

This information is summarized on Tables 7-15 and 7-16. Since Aroclor 1242 is the most prevalent COPC detected at the site and since USEPA has recently revised the guidance for assessing the carcinogenic risks associated with PCBs, a more detailed discussion of the potential toxicity of PCBs is presented below.

Evaluation of Aroclor toxicity

To date, there is limited evidence that PCB exposures are associated with increased cancer rates in exposed human populations. However, according to recent USEPA data, oral exposure to Aroclor mixtures, including Aroclor 1242, have been associated with a carcinogenic response in rats and mice. Aroclor mixtures with low concentrations of congeners with less than 4 chlorines (e.g. Aroclor 1016) are observed to be less potent than those with higher levels of 4 or more chlorine congeners (USEPA 1996).

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Table 7-15
Toxicity values: Potential Noncarcinogenic Effects

Chemical	Chronic RfD[a] (mg/kg-day)	Confidence Level[b] S/DB/RfD_o	Critical Effect	RfD Basis/ RfD Source	Uncertainty and Modifying Factors
Oral Route					
Chloroform	0.01	Medium/ Medium/ Medium	Fatty cyst formation in the liver	Water[c]/ IRIS	UF = 1000 MF = 1
Bromodichloromethane	0.02	Medium/ Medium/ Medium	Renal Cytomegaly	Water[c]/ IRIS	UF = 1000 MF = 1
Chlorobenzene	0.02	Medium/ Medium/ Medium	Histopathologic changes in liver	Water[c]/ IRIS	UF = 1000 MF = 1
Methylene Chloride	0.06	High/ Medium/ Medium	Liver Toxicity	Water[c]/ IRIS	UF = 100 MF = 1
Tetrachloroethene	0.02*			Water[c]/ ECAO	
Trichloroethene	0.006*			Water[c]/ ECAO	

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Table 7-15
Toxicity values: Potential Noncarcinogenic Effects

Chemical	Chronic RfD[a] (mg/kg-day)	Confidence Level[b] S/DB/RfD$_o$	Critical Effect	RfD Basis/ RfD Source	Uncertainty and Modifying Factors
Inhalation Route					
1,4 Dichlorobenzene	0.8	Medium/ Medium/ Medium	Increased Liver Weights	Air/ IRIS	UF = 100 MF = 1
Benzene	8.3E-6*		Tumor Type Leukemia		

* Data from USEPA Region III Risk Based Concentration Table

[b] Confidence level from IRIS, either high, medium, or low.

[c] RfD expressed as administered dose in drinking water, with assumed absorption fraction of 1.0.

S - Study

DB - Database

UF - Uncertianty factor

MF - Modifying factor

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Table 7-16
Toxicity values: Potential Carcinogenic Effects

Chemical	Slope Factor (SF) (mg/kg-day)$^{-1}$	Weight of Evidence Classification	Type of Cancer[a]	SF Basis/ SF Source
Oral Route				
Aroclor 1242/ 1254 - Water	0.4			USEPA 1996
Aroclor 1242/ 1254 - Soil	1			USEPA 1996
Chloroform	0.0061*	B2		Water[b]/
Bromodichloromethane	0.06	B2		Water[b]/ IRIS
Benzene	0.029	A	Tumor Type: Leukemia	Water[b]/ IRIS
1,4 Dichlorobenzene	0.024*			Water[b]/ HEAST
Tetrachloroethene	0.052*			Water[b]/ ECAO
Trichloroethene	0.011*	D		Water[b]/
Inilation Route				
Chloroform	0.0805*	B2		Air/
Benzene	0.029*	A	Tumor Type: Leukemia	Air/
Tetrachloroethene	0.002*			Air/ ECAO
Trichloroethene	0.006*	D		Air/ EPA

* From USEPA Region III Risk Based Concentration Table

USEPA 1996 - PCBs: cancer Dose Response Assessment and Application to Environmental Mixtures, Final-September 1996

[a] Identity type(s) of Cancer in this table for class A carcinogens only.

[b] Slope factor based on administered dose in drinking water, with assumed absorption fraction of 1.0.

The methods for assessing the potential carcinogenicity of Aroclor mixtures was recently updated by USEPA (USEPA 1996 - *PCBs: cancer Dose-Response Assessment and Application to Environmental Mixtures* Final, September 1996)). The updated guidance provides a process by which information on toxicity, disposition, and environmental processes may be integrated to evaluate potential carcinogenic health risks associated with exposures to PCB mixtures in the environment. Briefly, the guidance recognizes that the potential carcinogenic potency of an Aroclor mixture in the environment is related to :

a) the presence of congeners with greater than four chlorines - Aroclor with little or no congener content exceeding four chlorines (e.g. Aroclor 1016) have lower observed cancer potency in animal bio-assays ,

b) the biological persistence of the congeners - congeners that are persistent in the body (i.e. are slowly metabolized by the body) tend to have a higher potency.

The environmental fate of an Aroclor mixture also influences the potential toxicity since the congener content of the mixture will be modulated by environmental processes. According to USEPA, "evaporated or dissolved congeners tend to be lower in chlorine content than the original mixture; they also tend to be more inclined to metabolism and elimination and lower in persistence and toxicity. Congeners adsorbed to sediment or soil tend to be higher in chlorine content and persistence, and bioaccumulated congeners ingested through the food chain tend to be the highest of all" (USEPA 1996). As such, the guidance directs risk assessors to select appropriate slope factors based on a tiered approach, which uses the exposure pathway to choose appropriate potency values. The highest observed potency (range from 1 to 2 $(mg/kg\text{-}day)^{-1}$) is appropriate for food chain exposures, sediment or soil ingestion, , and dust or aerosol inhalation. Lower potencies (range from 0.3 to 0.4 $(mg/kg\text{-}day)^{-1}$ are appropriate for ingestion of water soluble congeners or inhalation of evaporated congeners. The lowest potencies (range from 0.04 to 0.07 $(mg/kg\text{-}day)^{-1}$) are appropriate for Aroclor mixtures in which it can be demonstrated that there is < ½ % of more than 4 chlorine congeners.

Based on this guidance, the following cancer slope factors were selected for evaluating potential exposures to PCBs at the site :

water exposures : 0.4 (mg/kg-day)-1
soil exposures : 1 (mg/kg-day)-1

7.6. Risk characterization

In this section of the RA, the toxicity and exposure assessments are summarized and integrated into numerical values which may be used to evaluate the likelihood of adverse health effects in populations potentially exposed to site related chemicals. RME estimates of potential health risks were developed for each potentially exposed receptor at the site.

Chronic non-cancer health effects were evaluated by comparing the chemical specific CDIs with the respective chronic RfD as given below.

1. For each receptor identified during the exposure assessment, and each individual exposure pathway, the chemical specific hazard quotients (HQs) were calculated where HQ is given by:
   Hazard Quotient = CDI/RfD

2. For each exposure pathway, the chemical specific hazard quotients were summed to calculate the Hazard Index (HI) for that pathway. For each receptor, the pathway specific hazard indexes were summed to obtain the Total HI for that receptor. A total HI of less than one indicates that it is highly unlikely that chronic non-cancer toxic effects would occur for the given receptor.

To evaluate carcinogenic effects, the incremental cancer risk associated with exposure to chemicals of concern was calculated using chemical specific slope factors as described below.

1. For each receptor identified during the exposure assessment and each exposure pathway, the chemical specific risk is given by:
   Cancer risk = CDI * slope factor.

2. For each receptor the total incremental excess cancer risk was calculated by summing the pathway specific cancer risk. For the purposes of formulating risk management strategies, the calculated risk estimate may be compared with the target risk range identified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, *Federal Register*, March 8 1990, 40 CFR 300). The NCP states that the "acceptable risk range for Superfund cleanups [is] 10^{-4} to 10^{-6}". According to the NCP, "10^{-6} [is] a point of departure, but may be revised to a different risk level based on consideration of ... exposure factors, uncertainty factors, and technical factors. Technical factors may include ... technical limits to remediation". In other words a risk level below 10^{-6} is a starting target level, but risk levels up to 10^{-4} may be acceptable, depending on site specific circumstances.

A summary of the chemical specific, pathway specific and total HIs associated with the identified areas and receptors is presented on Table 7-17. A summary of the chemical specific, pathway specific and total cancer risk associated with the identified source and receptors are presented on Table 7-18. Details of the HI and cancer risk calculations are presented in Appendix M. The results are discussed below according to area and receptor.

Area B

Receptor : On-site soil excavation worker

The calculated RME HI for the on-site worker is 0.019, and the calculated RME cancer risk is 2.0E-06. The primary contributor to the calculated cancer risk estimate is Aroclor 1242 in shallow ground water. Since the RME HI is less than 1, and the cancer risk is within the USEPA's acceptable range of 1.0E-04 to 1.0E-06 set forth in the National Contingency Plan, it is concluded that chemical substances detected at Area B do not represent significant chronic health risk to workers at the site.

Area C

Receptor - On site soil excavation worker

The calculated RME HI for the on-site soil excavation worker is 2.8 and the calculated RME cancer risk is 4.2E-06. The primary contributor to the calculated HI is trichloroethylene in shallow ground water (HQ=2.6). Since the calculated HI for Area C exceeds 1, risk management strategies to minimize worker exposures at Area C may be appropriate. Such strategies may include utilization of personal protective equipment and a health and safety plan if soil excavation workers may contact shallow ground water at Area C in the future.

Receptor - Off-site adult resident

The calculated RME HI for off-site resident exposed to ground water via non-potable uses is 0.85 and the calculated RME cancer risk is 3.0E-06. The primary contributor to the calculated cancer risk exposure to Aroclor 1242 (cancer risk = 1.2E-06) and trichloroethylene (cancer risk=1.5E-06).

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Table 7-17
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Summary of Hazard Indices

Area	Receptor	Exposure Pathway	COPC	HQ	Pathway HI	Total Receptor HI
B	On-Site Worker	Incidental Ingestion of Shallow Ground Water during Soil Excavation	Bromodichloromethane	7.0E-06		
			Chloroform	1.4E-04		
			Methylene Chloride	8.6E-06		
			1,1,1-Trichloroethane	1.5E-03	1.6E-03	
		Dermal Contact with Ground Water during Soil Excavation	Bromodichloromethane	1.3E-05		
			Chloroform	5.5E-03		
			Methylene Chloride	1.2E-05		
			1,1,1-Trichloroethane	7.8E-03	1.3E-02	
		Inhalation of Air During Soil Excavation	1,1,1-Trichloroethane	4.1E-03	4.1E-03	1.9E-02
C	On-Site Worker	Incidental Ingestion of Shallow Ground Water during Soil Excavation	Chlorobenzene	1.1E-04		
			Chloroform	2.3E-05		
			Cis-1,2-Dichloroethylene	3.1E-03		
			Methylene Chloride	4.7E-06		
			Trichloroethylene	3.7E-02		
			Tetrachloroethylene	4.7E-05	4.0E-02	
		Dermal Contact with Shallow Ground Water during Soil Excavation	Chlorobenzene	1.4E-03		
			Chloroform	9.5E-04		
			Cis-1,2-Dichloroethylene	1.5E-02		
			Methylene Chloride	6.6E-06		
			Trichloroethylene	2.6		
			Tetrachloroethylene	5.4E-03	2.7	
		Inhalation of Air During Soil Excavation	Cis-1,2-Dichloroethylene	8.2E-02	8.2E-02	2.8

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Table 7-17
Human Health Risk Assessment
Summary of Hazard Indices

Area	Receptor	Exposure Pathway	COPC	HQ	Pathway HI	Total Receptor HI
G	On-Site Worker	Incidental Ingestion of Shallow Ground water during Soil Excvation	Chlorobenzene	4.7E-04		
			Trichloroethylene	3.9E-05	4.7E-04	
		Dermal Contact with Shallow Ground Water during Soil Excavation	Chlorobenzene	5.8E-03		
			Trichloroethylene	1.7E-04	5.8E-03	6.3E-03
C	Off-Site Adult Resident	Incidental Ingestion of Shallow Ground Water - Non Potable Uses	Bromodichloromethane	3.3E-06		
			Chloroform	5.5E-05		
			cis 1,2- dichloroethylene	2.6E-04		
			Trichloroethylene	1.4E-02	1.4E-02	
		Dermal Contact with Shallow Ground Water - Non Potable Uses	Bromodichloromethane	5.8E-06		
			Chloroform	2.0E-04		
			cis 1,2- dichloroethylene	1.3E-03		
			Trichloroethylene	7.0E-02	7.1E-02	8.5E-01
C	Off-Site Child Resident	Incidental Ingestion of Shallow Ground Water - Non Potable Uses	Bromodichloromethane	1.4E-05		
			Chloroform	2.4E-04		
			cis 1,2- dichloroethylene	1.2E-03		
			Trichloroethene	6.1E-02	6.2E-02	
		Dermal Contact with Shallow Ground Water - Non Potable Uses	Bromodichloromethane	1.9E-05		
			Chloroform	7.2E-04		
			cis 1,2- dichloroethylene	4.2E-03		
			Trichloroethene	2.2E-01	2.3E-01	2.9E-01
C	Off-Site (spring) - Child recreator	Incidental Ingestion of surface water	cis 1,2- dichloroethylene	1.3E-04		
			Trichloroethylene	3.3E-03	3.3E-03	
		Dermal contact with surface water	cis 1,2- dichloroethylene	4.2E-04		
			Trichloroethylene	1.0E-02	1.1E-02	1.1E-02

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Table 7-18
Human Health Risk Assessment
Summary of Cancer Risk

Area	Receptor	Exposure Pathway	COPC	Cancer Risk	Pathway Cancer Risk	Total Cancer Risk
B	On-Site Worker	Incidental Ingestion of Shallow Ground Water during Soil Excavation	Aroclor 1242	5.7E-09		
			Aroclor 1254	1.4E-09		
			Bromodichloromethane	1.2E-10		
			Chloroform	1.2E-10		
			1,4-Dichlorobenzene	4.2E-10		
			Methylene Chloride	5.5E-11	7.8E-09	
		Dermal Contact with Ground Water during Soil Excavation	Aroclor 1242	1.6E-06		
			Aroclor 1254	3.7E-07		
			Bromodichloromethane	2.2E-10		
			Chloroform	4.8E-09		
			1,4-Dichlorobenzene	8.0E-09		
			Methylene Chloride	7.7E-11	1.9E-06	2.0E-06
C	On-Site Worker	Incidental Ingestion of Shallow Ground Water during Soil Excavation	Aroclor 1242	2.1E-09		
			Vinyl Chloride	8.5E-08		
			Aroclor 1254	1.2E-09		
			Benzene	1.2E-10		
			Chloroform	2.0E-11		
			Methylene Chloride	3.0E-11		
			1,4-Dichlorobenzene	7.4E-10		
			Trichloroethylene	3.5E-08		
			Tetrachloroethylene	3.5E-10	1.2E-07	
		Dermal Contact with Shallow Ground Water during Soil Excavation	Aroclor 1242	5.8E-07		
			Vinyl Chloride	2.0E-07		
			Aroclor 1254	3.3E-07		
			Benzene	4.0E-09		
			Chloroform	8.2E-10		
			1,4-Dichlorobenzene	1.4E-08		
			Methylene Chloride	4.2E-11		
			Trichloroethylene	2.5E-06		
		Inhalation of air during Soil Excavation	Tetrachloroethylene	4.0E-08	3.6E-06	
			Trichloroethylene	4.3E-07	4.3E-07	4.2E-06

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Fort Edward, New York
Table 7-18
Human Health Risk Assessment
Summary of Cancer Risk

Area	Receptor	Exposure Pathway	COPC	Cancer Risk	Pathway Cancer Risk	Total Cancer Risk
F	On-Site Worker	Incidental Ingestion of Subsurface soil during Excavation	Aroclor 1242	1.0E-06		
			Aroclor 1254	2.3E-06	3.3E-06	
		Dermal Contact with Subsurface soil Excavation	Aroclor 1242	9.2E-07		
			Aroclor 1254	2.0E-06	3.0E-06	6.2E-06
G	On-Site Worker	Incidental Ingestion of Shallow Ground Water - Non Potable Uses	Aroclor 1242	3.2E-07		
			Aroclor 1254	6.4E-10		
			Benzene	7.8E-11		
			1,4-Dichlorobenzene	4.4E-09		
			Trichloroethylene	3.7E-11	3.2E-07	
		Dermal Contact with Shallow Ground Water - Non Potable Uses	Aroclor 1242	8.9E-05		
			Aroclor 1254	1.7E-07		
			Benzene	4.8E-10		
			1,4-Dichlorobenzene	5.0E-08		
			Trichloroethylene	1.8E-10	8.9E-05	8.9E-05
C	Off-Site Adult Resident	Incidental Ingestion of Shallow Ground Water - Non Potable Uses	Aroclor 1242	5.7E-09		
			Bromodichloromethane	1.4E-09		
			Chloroform	1.1E-09		
			Trichloroethylene	3.1E-09	3.2E-07	
		Dermal Contact with Shallow Ground Water - Non Potable Uses	Aroclor 1242	1.2E-06		
			Bromodichloromethane	2.4E-09		
			Chloroform	4.6E-09		
			Trichloroethylene	1.5E-06	1.7E-06	
		Inhalation of Ambient Air	Trichloroethylene	9.0E-07	9.0E-07	3.0E-06

Remedial Investigation, General Electric Company
Fort Edward, New York
Table 7-18
Human Health Risk Assessment
Summary of Cancer Risk

Area	Receptor	Exposure Pathway	COPC	Cancer Risk	Pathway Cancer Risk	Total Cancer Risk
C	Off-Site Child Resident	Incidental Ingestion of Shallow Ground Water - Non Potable Uses	Aroclor 1242	6.2E-09		
			Bromodichloromethane	1.2E-09		
			Chloroform	1.3E-09		
			Trichloroethylene	3.4E-07	3.5E-07	
		Dermal Contact with Shallow Ground Water - Non Potable Uses	Aroclor 1242	1.3E-06		
			Bromodichloromethane	2.0E-09		
			Chloroform	3.7E-09		
			Trichloroethylene	1.3E-06	2.5E-06	
		Inhalation of Ambient Air	Trichloroethylene	3.8E-07	3.8E-07	3.3E-06
C	Off-Site (spring) adolescent recreator	Incidental Ingestion of surface water	Trichloroethylene	3.3E-08	3.3E-08	
		Dermal Contact with surface water	Trichloroethylene	1.1E-07	1.1E-07	
		Inhalation of Ambient Air	Trichloroethylene	1.6E-07	1.6E-07	3.0E-07

It is important to note, however, that consistent with USEPA methodology, exposures to off-site residents were derived based on the maximum detected COPC concentrations in off-site wells (well SW-3). The concentrations of chemical substances detected in homeowner wells are significantly lower than the levels detected in SW-3. Therefore, while the calculated cancer risks suggest that remedial strategies may be appropriate for off-site ground water, there is no significant health risk to residents based on current ground water usage patterns.

Receptor - Off-site child resident

The calculated RME HI for off-site child resident exposed to ground water via non-potable uses is 0.29 and the calculated RME cancer risk is 3.3E-06. The primary contributor to the calculated cancer risk is exposure to Aroclor 1242 (cancer risk = 1.3E-06) and trichloroethylene (cancer risk=1.3E-06). It is important to note, however, that consistent with USEPA methodology, exposures to off-site residents were derived based on the maximum detected COPC concentrations in off-site wells (well SW-3). The concentrations of chemical substances detected in homeowner wells are significantly lower than the levels detected in SW-3. Therefore, while the calculated cancer risks suggest that remedial strategies may be appropriate for off-site ground water, there is no significant health risk to residents based on current ground water usage patterns.

Receptor - Off site adolescent exposed to spring water

The calculated RME HI for the adolescent exposed to off-site spring water is 0.03, and the calculated RME cancer risk is 3.0E-07. Since the RME HI is less than 1, and the cancer risk is less than 1E-06, it is concluded that chemical substances detected in off-site springs do not represent significant chronic health risk to recreators who may be active in the vicinity of the springs.

Area F

Receptor - On site soil excavation worker

The calculated RME cancer risk for the on-site worker is 6.0E-06. The primary contributor to the calculated cancer risk estimate is Aroclor 1254. Since the cancer risk is within the USEPA's acceptable range of 1.0E-04 to 1.0E-06 set forth in the National Contingency Plan, it is concluded that chemical substances detected at Area F do not represent significant chronic health risk to workers at the site.

Area G

Receptor - On site soil excavation worker

The calculated RME HI for the on-site worker is 0.006, and the cancer risk for the on-site worker is 8.9E-05. The primary contributor to the calculated cancer risk estimate is Aroclor 1242 (cancer risk 8.9E-05). Since the HI is less than 1 and the cancer risk is within the USEPA's acceptable range of 1.0E-04 to 1.0E-06 set forth in the National Contingency Plan, it is concluded that chemical substances detected at Area G do not represent significant chronic health risk to workers at the site.

7.7. Uncertainty analysis

The risk estimates derived in this assessments are an estimate of potential health risks to exposed populations based on conservative estimates of exposure patterns and toxicity. However, the actual health risks to exposed individuals may vary from the derived estimates if the specific exposures are different from the scenarios assumed in this assessment, or if the toxicity of the chemical substances differ from the values utilized. The purpose of this section is to identify the major sources of uncertainty in the derived risk estimates, and discuss the implications of the uncertainties on the results and conclusions of the risk assessment.

The main sources of uncertainty in the RA are related to : a) estimation of exposure point concentrations b) calculation of CDIs c) application of toxicity information. Uncertainties related to these sources are further discussed below.

Calculation of exposure point concentrations

For on-site shallow ground water, the exposure point concentration was derived as the UCL for the spatially averaged concentrations at each area. This approach assumes that a soil excavation worker is equally likely to be exposed to any part of the area during future soil excavation activities. However, it is recognized that the concentration of COPC at the areas are higher at certain locations as compared with others. The potential exposures of a worker may be higher than the calculated value if a worker were to spend the entire exposure time in areas of relatively high concentrations.

For off-site ground water, exposure was assumed to occur as a result of water being drawn from a well. Since a well only accesses a fixed location in the aquifer, it was inappropriate to derive exposure point concentrations for off-site ground water based on a spatial average of the detected concentrations in the plume. Therefore, consistent with USEPA guidance, the maximum detected off-site concentrations were utilized as exposure point concentrations. These concentrations were detected in a monitoring well (SW-3) and not a homeowner well. The concentrations of chemical substances detected in homeowner wells are significantly lower than the levels detected in SW-3. Therefore, while the calculated cancer risks suggest that remedial strategies may be appropriate for off-site ground water, there is no significant health risk to residents based on current ground water usage patterns.

Additionally, as previously discussed, the concentrations of COPCs in downgradient monitoring wells have shown a statistically significant decrease following activation of an on-site recovery well system in 1989. The risk assessment was based on the data collected during sampling conducted in 1995 and 1996. If the off-site COPC concentrations continue to decline, the calculated future health risks would be lower than the risk estimates calculated in this assessment.

Calculation of chronic daily intakes

Most of the input parameters applied in estimating the RME CDIs were conservative estimates, consistent with USEPA's RME methodology. In particular, the dermal contact calculations for exposure to water are particularly conservative, since the methods assume that hands, forearms, and upper arms would be in continuous contact with the water over a period of 1 hour per day exposed. While this scenario is possible, it is likely that the water contact rates would be significantly less than this on many occasions. As such, the actual CDIs are likely to be lower than the calculated RME estimates.

Toxicity values

The RfDs and slope factors published by USEPA are designed to be conservative values for the protection of public health including that of sensitive sub-populations. As such, as shown on Table 7-14, most of the RfDs are 100 to 1000 times lower than the NOAEL levels observed in animal bio-assays. Therefore, the derived chemical specific HQs are likely overestimates of the potential for chronic non-cancer health risks.

Since the purpose of the human health risk assessment is to evaluate long term risk management strategies, the assessment typically considers chronic and sub-chronic health effect end points and dose response relationships. However, it is important to recognize that a worker exposed to localized high concentrations of chemical substances may experience acute health effects during the exposure event. Such effects may include dermal and ocular irritation and/or respiratory effects. This is particularly relevant at Area B, since pockets of sub-surface kerosene have been reported in Area B. Direct exposure to kerosene by an unprotected worker may result in acute effects.

Additional uncertainty arises from the USEPA's assumption of a linear dose response function for carcinogenicity evaluation of low dose exposure to PCBs. The model assumes that at low doses, there is a linear relationship between the dose of a chemical substance and the excess cancer risk. In addition, the model assumes that there is no threshold dose for the induction of cancer. However, there are many instances in which this assumption may not hold true for the carcinogenic process. Examples of such effects are chemicals that cause an increased high dose cancer incidence due to stimulated cell proliferation rates, chemicals for which metabolic parameters limit the delivered dose to the target organ, promoters, or in instances where DNA repair mechanisms may be dose dependant. In these instances, linearized relationships for low-dose exposures may provide a "plausible upper limit" of potential cancer risk (51 FR 3398). However, as acknowledged by USEPA (51 FR 3398), "such an estimate does not necessarily give a realistic prediction of the risk. The true value of the risk is unknown, and may be as low as zero".

7.8. Conclusions

The results of the RA calculations suggest that the exposure to COPCs in Area B, F, and G, would not represent a significant health risk to unprotected soil excavation workers.

At Area C, the chronic HI associated with exposure to trichloroethylene in shallow ground water exceeds 1. As such, risk management strategies to minimize worker exposure to on-site shallow ground water in Area C may be appropriate.

Exposures at the off-site springs do not represent a significant health risks to recreators who may be active in the vicinity of the springs.

Based on current ground water usage patterns, there is no significant health risk to residents who utilize ground water for non-potable uses. However, since the calculated cancer risk associated with the maximum detected off-site ground water concentrations exceeds 1E-06, remedial strategies to reduce off-site ground water concentrations may be appropriate.

8. Conclusions

The Fort Edward remedial investigation was successful in meeting the project objectives of evaluating impacts, if any, of chemicals that may have previously migrated off-site on human health and the environment; determining if contamination continues to migrate off-site; implementing interim remedial measures (IRMs) as necessary; gathering engineering data required to perform a feasibility study; and to satisfy any corrective action obligations pursuant to the Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act and the Hazardous and Solid Waste Amendments and the New York ECL Article 27, Title 9.

Geology

The GE Fort Edward Plant is located in the Hudson-Champlain lowland physiographic province of New York. This lowland is a broad depression formed by erosion of soft shales and limestones of early paleozoic age, by the preglacial and interglacial Hudson River and by glacial scour during the Pleistocene. The region is characterized by open, sparsely wooded, flatlands with relatively low relief.

With the exception of fill, unconsolidated deposits of glacial origin unconformably overlie the bedrock throughout much of the Fort Edward Plant area. The glacial deposits are associated with the Hudson-Champlain Lobe of the late Wisconsin Laurentide ice sheet. Five types of unconsolidated sediments have been identified at the site. These include glacial till, glacio-lacustrine silt and clay, a transitional zone, glacio-deltaic sand and gravel and artificial fill. The unconsolidated deposits are underlain by the Snake Hill Formation.

Glacial till is observed directly overlying bedrock at the site and is composed of a poorly sorted mixture of sand, gravel, and sometimes cobbles in a matrix of fine sand and silt with occasional clay seams. The glacial till unit is absent in the area around the equalization basin, located in the southwestern portion of the site, where it appears to have been removed during the excavation activities associated with the construction of the basin.

Glacio-lacustrine silt and clay deposits are generally observed overlying the glacial till unit. The glacio-lacustrine silt and clay unit ranges in thickness from 44.9 feet in the northeast corner of the site adjacent to Upper Broadway and thins out to zero feet in the vicinity of the Foil Mill, the area of the former leachfield and the equalization basin where little to no glacio-lacustrine silt and clay unit is observed.

The glacio-lacustrine silt and clay unit can best be described as dark grey silt and clay, with frequent clayey silt seams and occasional fine sand partings. Descriptions range from a dark grey to brown varved silty clay to grey clayey silt, with frequent silt and clay seams and fine sand partings. Generally this unit is brown to red at the top and gradually changes to grey over the top 1 to 2 feet of the unit.

Overlying the glacio-lacustrine silt and clay unit in the eastern and southeastern portions of the site is a sequence of light gray sand and silt interbedded with frequent seams and partings of clay and silt which become more frequent with depth. This zone has been designated the transition zone and represents a change in depositional environment from a deep water , low energy glacial lake environment to a higher energy, near shore environment.

The uppermost unconsolidated unit at the Fort Edward plant is a glacio-deltaic sand and gravel unit and is ubiquitous throughout the site and is best described as brown coarse to fine sand with a little fine gravel. The glacio-deltaic sand and gravel unit is thinnest in the western portion of the site in the vicinity of the Foil Mill. This unit thickens considerably to the east and is observed at a thickness of 28.4 feet along the eastern property boundary of the site. The thickest accumulation of the sand and gravel unit is observed south of the plant site with an observed thickness of 42.9 feet at well location OBG-61, located near Griffin Avenue.

The bedrock immediately underlying the unconsolidated deposits in the vicinity of the Fort Edward plant are the shales of the Middle Ordovician Snake Hill Formation. The Snake Hill Formation is the highest and youngest formation encountered in the study area. Based on the results of the rock core from well OBG-26BD, the geophysical log from former production well PW-1 and investigations being performed in the Hudson Falls area, the Snake Hill Formation has been differentiated into three distinct units, these are the Upper, Middle and Lower Snake Hill Shale. The Upper Snake Hill Formation consists of approximately 200 feet of dark grey to black, fine grained, massive to moderately jointed shale. The Snake

Hill shale is underlain by the Glens Falls limestone and the Beekmantown Group.

Hydrogeology

A conceptualization of the hydrogeologic system at the Fort Edward facility has been developed based on information obtained during various investigations performed at the facility and includes four hydrogeologic units: the shallow unconsolidated unit, the transition zone unit, the low permeability confining unit and the shallow bedrock unit.

The shallow unconsolidated unit is composed of glacio-deltaic sand. The water table generally occurs in this unit under unconfined conditions and is free to rise and fall in response to ground water recharge and discharge. The transition zone hydrogeologic unit lies stratigraphically between the shallow unconsolidated unit and the shallow bedrock unit. The transition zone is limited in its extent across the site and is only found in the eastern portion of the site. This unit is less permeable than the overlying unconsolidated hydrogeologic unit. The mean horizontal hydraulic conductivity for the transition zone hydrogeologic unit is calculated to be 6.37E-04 cm/sec (1.81 ft/day).

The shallow unconsolidated unit and the transition zone is generally hydraulically separated from the shallow bedrock unit by a low permeability till and clay-rich aquitard which extends across the site. The results of the hydraulic conductivity tests performed in the till zone well OBG-26T indicate that the till unit has a hydraulic conductivity of 3.04E-06 cm/sec (.0086 ft/day).

The shallow bedrock hydrogeologic unit is composed of black, dense shale of the Snake Hill Formation. With the exception of well OBG-46BS, ground water in the shallow bedrock hydrogeologic unit is generally observed under confined conditions at the Fort Edward facility. At well location OBG-46, the confining layer is missing and the ground water in the bedrock is in direct contact vertically with the atmosphere through open pore spaces in the shallow unconsolidated unit and is best described as unconfined.

Ground water flow within the shallow bedrock hydrogeologic unit occurs principally through secondary porosity features such as fractures, joints and bedding planes. The mean hydraulic conductivity for the shallow bedrock hydrogeologic unit is 5.86E-05 cm/sec (0.17 ft/day).

Ground water flow within the shallow unconsolidated unit at the facility is controlled by a ground water table divide which trends northeast to southwest between monitoring well location OBG-54 and GM-5. Ground water flow in the northwest, western and southwestern portion of the facility is generally to the west towards the Hudson River. Flow in the central and southeastern portion of the facility is generally to the southeast toward Park Avenue.

As a result of pumping, ground water flow in the shallow unconsolidated unit has been altered in the southeastern portion of the facility. A trough of depression, has been formed in the vicinity of the shallow ground water recovery system. Water levels have been drawn down in the area between recovery well RW-3 and monitoring well GM-29 and indicate that ground water immediately south of Park Avenue is being pulled back (i.e., north) toward the shallow ground water recovery system. Ground water flow within the shallow unconsolidated unit in the area south of Park Avenue is generally to the south. Ground water flow in the central portion of the off-site ground water plume (i.e., areas west of Putnam Avenue and Ethan Allen) is generally to the south and shifts toward the southwest in the area west of Broadway, south of well OBG-60.

Ground water flow within the transition zone is principally horizontal through the fine sand and silt layers and seams within this unit. Based on ground water levels measured during pumping of the shallow unconsolidated unit ground water recovery system, ground water flow in the transition zone is from northeast to southwest toward the ground water recovery wells.

Ground water flow in the shallow bedrock is controlled by a hydrogeologic divide which trends north-northwest to the south-southeast in the vicinity of Lower Allen Street. Ground water flow in the area west of Lower Allen Street is generally to the west towards the Hudson River. In the area east of Lower Allen Street ground water in the shallow bedrock flows west to east across the facility. Ground water flow directions and hydraulic gradients do not appear to change appreciably from high to low recharge conditions within the shallow bedrock unit.

The effect of ground water pumping from recovery wells GM-8DR and GM-11D is observed in the southwestern portion of the facility. Water levels have been drawn down in the immediate vicinity of these two wells and indicates that ground water immediately east of pumping well GM-11D is being pulled back (i.e., west) toward the pumping well.

Ground water flow within the deep bedrock is controlled by a hydrogeologic divide which trends north to south between well OBG-15BD through the area of the Foil Mill towards well location OBG-26. Ground water flow in the western portion of the facility and west of Lower Allen Street is generally to the west towards the Hudson River. Ground water in the central and eastern portion of the facility flows west to east across the facility towards Upper Broadway. Ground water flow directions and hydraulic gradients do not change appreciably from high to low recharge conditions within the shallow bedrock unit.

Soil gas survey results

A total of 119 soil gas points were installed around Building 40, along the western property line, and surrounding monitoring well GM-10. The samples were screened for total VOCs using a portable PID and for chlorinated VOCs, specifically TCE and 1,1-DCA, and kerosene constituents (i.e., naphthalene and trimethylbenzenes) using a portable on-site gas chromotograph.

Three areas of elevated concentrations of kerosene constituents were observed; the southeastern portion of building 40, the area near well GM-2 and the area between the northern portion of building 40 and well cluster OBG-43.

Three areas of elevated chlorinated VOCs were observed; the northwest and southeast corners of Building 40 and the area immediately south of the Building 40 near the rail line.

Constituents in soils

Seven soil borings, designated SS-1 through SS-7, were installed in the soil disposal area located north of Building 40. Methylene chloride (0.006 mg/kg) was the only VOC detected in the soil samples collected from the soil disposal area designated as SWMU #16. Methylene chloride is not a characteristic constituent of the chlorinated VOCs or kerosene detected in the ground water in other areas of the facility and is most likely a laboratory artifact.

PCBs were detected in soil samples collected from two relatively recent soil piles (i.e., SS-1 and SS-2) and two piles created in the past (i.e., SS-3 and SS-5). The highest concentrations of total PCBs were detected at 2.17 mg/kg in soil boring SS-1 and 2.56 mg/kg in soil boring SS-2, both located in the soil piles created more recently.

The detected concentrations of Aroclor-1242 plus the Aroclor-1254 are well below USEPA's industrial risk-based value of 41 mg/kg for Aroclor-1254.

A total of 30 environmental soil samples were collected from 17 soil borings installed around Building 40 from depths ranging from approximately 2 to 12 feet below ground surface. The soil samples were submitted for VOC, kerosene and PCB analyses. VOCs were detected in 13 soil samples collected from 11 of the 17 soil borings. Kerosene was detected in 14 soil samples collected from 11 of the 17 soil borings.

The highest concentrations (i.e., greater than 10 mg/kg) of total VOCs characteristic of kerosene were detected between 14.1 and 66.0 mg/kg in the following four soil boring locations and depth intervals; SB-37 S-1 (3 to 5 feet), SB-43 S-4 (5 to 6 feet), OBG-50 S-3 (4 to 6 feet), and the field duplicate of OBG-55 S-3 (4 to 6 feet). These soil borings are located off the northwestern and southwestern corners of Building 40.

In general, the highest concentrations of kerosene and kerosene-related VOCs were detected 4 to 6 feet below ground surface, within the upper few feet of the ground water surface. Similarly, kerosene and characteristic kerosene VOCs were absent or detected at lower concentrations in the soil samples collected above the ground water table and/or 7 to 10 feet below the ground surface, below the upper few feet of the ground water surface.

A comparison of analytical results from soil samples collected in the vicinity of Building 40 indicates that the results for each VOC detected were below USEPA's available industrial risk-based concentrations.

Aroclor-1242 was identified in eight of the soil samples, the highest concentration reported is at 36.0 mg/kg in the soil sample collected from 8 to 9.4 feet below ground surface from soil boring location SB-49, located between Buildings 27 and 40.

Aroclor-1254 was detected at an estimated 0.30 mg/kg in the one soil sample collected from the 5 to 6 foot depth interval in boring SB-43, located along the southern wall of Building 40.

The comparison of analytical results from soil samples collected in the vicinity of Building 40 indicates that all concentrations of the Aroclor-1242 and Aroclor-1254 detected were well below USEPA's industrial risk-based concentration of 41.0 mg/kg for Aroclor-1254.

Three soil samples were collected from approximately 2 to 3 feet below ground surface in three soil borings (OBG-69, OBG-70, and OBG-71) and analyzed for PAHs. No PAHs were detected in the three soil samples.

Twelve (12) soil borings, designated FM-1 through FM-12, were completed under Building 40. Twenty-one (21) soil samples were collected from the 12 soil borings from depths ranging from 0.5 to 15 feet below ground surface.

In general, the highest concentrations of VOCs were detected in soil samples collected from 5 to 9 feet below ground surface, which coincides with the upper 1 to 3 feet of the ground water surface in the majority of the wells. Similarly, the lower concentrations of VOCs were reported in the soil samples collected from shallower depths (i.e., 0.5 to 4 feet below ground surface), which were collected from above the water table. The deepest sample collected, 13 to 15 feet below ground surface in boring FM-12, also did not contain detectable VOCs.

The comparison of analytical results from soil samples collected under Building 40 indicates that all results for each VOC detected were below USEPA's available industrial risk-based concentrations.

The comparison of analytical result from soil samples collected under Building 40 indicates that the total PCB concentrations for each sample were below USEPA's industrial risk-based concentration of 41 mg/kg for Aroclor-1254.

Four soil borings, designated LF-1 through LF-4, were drilled in the former leachfield area located south of Building 40 and west of the main manufacturing building. One sample was collected from each boring and analyzed for VOCs. No VOCs were detected in any of the four soil samples collected in the former leachfield area.

Soil samples collected from the four soil borings described above were also analyzed for PCBs. Concentrations of Aroclor-1242 and/or Aroclor-1254 were detected in three of the four soil samples collected from the former leachfield area at locations LF-1, LF-3, and LF-4. The soil sample collected from 6 to 7.9 feet below ground surface in soil boring LF-1 contained the highest PCB concentrations; Aroclor-1242 at 63 mg/kg and Aroclor-1254 at 140 mg/kg.

The total PCB concentrations detected in the three remaining soil samples collected were well below USEPA's industrial risk-based concentration of 41 mg/kg for Aroclor-1254.

Constituents in ground water

Ground water samples were collected from a total of 106 monitoring wells located on-site, and 22 monitoring wells and four springs located off-site.

Foil Mill

Concentrations of one or more VOCs characteristic of kerosene were detected above the NYSDEC Class GA ground water standards or guidance values in monitoring wells GM-5, OBG-50, OBG-52, OBG-55, and OBG-68 and ranged in total concentrations from 11 to 1,250 μg/L.

Concentrations of chlorinated VOCs, 1,1-dichloroethane and/or 1,1,1-trichloroethane, were detected at or above NYSDEC Class GA ground water standards (5 μg/L each) in monitoring wells OBG-55 and OBG-68 and ranged in total concentrations from 5 to an estimated 1,310 μg/L.

Concentrations of Aroclor-1242 and/or Aroclor-1254 were detected above NYSDEC Class GA ground water standard of 0.10 μg/L in monitoring wells F-2, F-3, GM-2, GM-5, OBG-44S (destroyed), OBG-48S (destroyed), OBG-50, OBG-51, OBG-52, OBG-53, OBG-1A(replaced GM-1), OBG-54 and OBG-68 and ranged in total concentrations of 0.12 to 60 μg/L.

Concentrations of one or more VOCs characteristic of kerosene were detected above NYSDEC Class GA ground water standards or guidance values in monitoring wells FM-1, FM-5, FM-7, FM-9, FM-10, FM-11, and FM-12 and ranged in total concentration from 63 to 251 μg/L.

Concentrations of chloroethane, 1,1-dichloroethane, cis-1,2-dichloroethene, and 1,1,1-trichloroethane were detected above NYSDEC Class GA ground water standards in monitoring wells FM-9 and FM-11 and ranged in total concentration from 216 to 1,521 μg/L.

Concentrations of Aroclor-1242 and/or Aroclor-1254 were detected above the NYSDEC Class GA ground water standard of 0.10 μg/L in each of the 10 wells and ranged in total concentration of 0.264 to 310 μg/L. Additionally, Aroclor-1242 was detected at concentrations of 4.4 and 220 mg/L in the LNAPL samples collected from monitoring wells FM-5 and FM-12, respectively.

Leachfield

One shallow unconsolidated unit monitoring well, OBG-83, was installed in the leachfield area as part of the Supplemental RI scope of work. VOCs were not detected in the ground water sample collected from this well during the supplemental RI sampling event. Aroclor-1242 was detected at an estimated concentration of 0.059 μg/L, below the Class GA ground water standard of 0.10 μg/L.

Eastern property boundary

No VOCs or PCBs were detected in monitoring well OBG-42S, located on the northeastern property boundary.

Transition zone

Trichloroethene was the most frequently detected VOC in the transition zone wells. The next most frequently detected VOCs included cis-1,2-dichloroethene, benzene, and chloroform. Concentrations of trichloroethene and/or cis-1,2-dichloroethene were detected above NYSDEC Class GA ground water standards (5 μg/L each) in on-site transition zone wells OBG-63, OBG-64, and OBG-82 and ranged in total concentrations from 8 to 4,300 μg/L. Trichloroethene was detected above the NYSDEC Class GA ground water standard of 5 μg/L at concentrations of 29 and 30 μg/L in one off-site transition zone well, OBG-76, located in the area of the off-site overburden plume south of the facility.

Aroclor-1242 and/or Aroclor-1254 were detected above the NYSDEC Class GA ground water standard of 0.10 μg/L in one off-site well, OBG-76, at 0.39μg/L and five on-site wells, OBG-63, OBG-64, OBG-65, OBG-66, and OBG-82, and ranged in total concentration from 2.0 to 28.1 μg/L. Aroclor-1242 was detected in off-site well OBG-79 at an estimated concentration of 0.055 μg/L, well below the ground water standard of 0.10 μg/L.

Southern portion of the facility

Twenty-five (25) shallow unconsolidated unit monitoring wells are located within the southern portion of the facility.

Trichloroethene and cis-1,2-dichloroethene were the most frequently detected VOCs in the shallow unconsolidated unit ground water collected from the southern portion of the facility. The other less frequently detected VOCs include tetrachloroethene, vinyl chloride, 1,1,1-trichloroethane, 1,1-

dichloroethane, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, chloroform, and methylene chloride.

Concentrations of one or more chlorinated VOCs were detected at or above NYSDEC Class GA ground water standards in shallow unconsolidated unit monitoring wells GM-8A, GM-12A, GM-12B, GM-12C, GM-21, GM-22, GM-23, GM-24, GM-25, GM-30, GM-32, GM-33, and GM-35 and ranged in total concentrations of 5 to 10,000 μg/L.

Concentrations of several chlorobenzenes were reported above NYSDEC Class GA ground water standards in shallow unconsolidated unit monitoring wells GM-8A, OBG-8B (formerly GM-8A), and GM-25 and ranged in total concentrations of 139 to 723 μg/L.

PCBs were detected in 19 of the 25 shallow unconsolidated unit monitoring wells located in the southern portion of the facility. Concentrations of Aroclor-1242 and/or Aroclor-1254 were detected at or above the NYSDEC Class GA ground water standard of 0.10 μg/L in GM-8A, OBG-8B (GM-8A replacement), GM-12A, GM-12B, GM-12C, GM-21, GM-22, GM-24, GM-25, GM-28, GM-30, GM-32, GM-33, GM-35, OBG-26T(till zone), and OBG-56 and ranged in concentration from 0.10 to 77 μg/L. It should be noted that PCBGs were not confirmed in OBG-56 in January or June 1996.

Concentrations of Aroclor-1242 and/or Aroclor-1254 were reported below the NYSDEC Class GA ground water standard in GM-11, GM-16, GM-29, and GM-31, ranging from an estimated 0.055 to 0.093 μg/L.

Off-site

Shallow unconsolidated unit ground water monitoring wells and springs located off-site include 18 wells and springs.

Trichloroethene and cis-1,2-dichloroethene were the most frequently detected VOCs in shallow unconsolidated unit ground water samples collected off-site. The other VOCs detected include chloroform and bromodichloromethane. Concentrations of trichloroethene and/or cis-1,2-dichloroethene were detected above NYSDEC Class GA ground water standards (5 μg/L each) in off-site monitoring locations SW-3, SW-4, SW-5, GFNB, Dobroski, Griffin Avenue spring, Hillview Avenue spring, OBG-59, and OBG-61 and ranged in total concentrations from 8 to 3,920 μg/L.

Chloroform was detected at estimated concentrations of 25 and 14 μg/L in the samples collected from off-site well OBG-59 in the October/November 1995 and June 1996, respectively. These concentrations of chloroform are above the NYSDEC Class GA ground water standard of 7 μg/L.

Aroclor-1242 and/or Aroclor-1254 were reported above NYSDEC Class GA ground water standard of 0.10 μg/L in monitoring wells SW-3, SW-4, GFNB, OBG-57, and Rencor #2, ranging from total concentrations of 0.14 to 1.9 μg/L. However, concentrations of PCBs in OBG-57 located on the Rencor property have shown a decrease since January 1995 and PCBs were not detected in Rencor #2 in June 1996.

Bedrock ground water

With the exception of ground water recovery wells GM-11D and GM-8DR, and monitoring well GM-9D, no bedrock wells exhibited confirmed detections of VOC or PCBs levels above NYSDEC Class GA ground water standards.

Sewer sample results

Sewer sample analytical results indicate that PCBs were detected in every sample of industrial wastewater collected; concentrations ranged from 1.3 μg/L to 1200 μg/L.

VOCs were detected in wastewater samples collected from manholes MH-5, MH-7, MH-8, MH-9, and MH-23. Total VOC concentrations in these samples ranged from 3 to 94 μg/L. Compounds detected in manholes MH-5, MH-7, MH-8, and MH-9 included bromodichloromethane, chlorobenzene, chloroform, and dichlorobenzene.

Risk assessment

The results of the RA calculations suggest that the exposure to COPCs in Area B, F, and G, would not represent a significant health risk to unprotected soil excavation workers.

At Area C, the chronic HI associated with exposure to trichloroethylene in shallow ground water exceeds 1. As such, risk management strategies to minimize worker exposure to on-site shallow ground water in Area C may be appropriate.

Exposures at the off-site springs do not represent a significant health risks to recreators who may be active in the vicinity of the springs.

Based on current ground water usage patterns, there is no significant health risk to residents who utilize ground water for non-potable uses. However, since the calculated cancer risk associated with the maximum detected off-site ground water concentrations exceeds 1E-06, remedial strategies to reduce off-site ground water concentrations may be appropriate.

9. Recommendations

Based on the results of the RI, it is recommended that a Feasibility Study be conducted. The feasibility study should be conducted to evaluate remedial alternatives which address contamination on a site wide basis, such that a cost-effective remedy can be proposed for the site which is protective of human health and the environment and meets pertinent regulatory requirements.

References

Bouwer, H. and Rice, R.C. 1976. A slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells. Water Resources Research. Vol. 12. No. 3.

Cadwell, D.H., et al. 1986. Surficial Geologic Map of New York, N.Y.S. Mus. Geological Survey, Map and Chart Series #40. Hudson-Mohawk Sheet (1987).

Cushman, R.V. 1953. The Ground Water Resources of Washington County, New York. Bulletin GW-33, Albany, New York 1953, 65 p.

Dames & Moore, Inc.. 1976(a). Geohydrologic Investigations Impounding Basins, Fort Edward and Hudson Falls, New York, May 1976.

Dames & Moore, Inc. 1976(b). Investigation of Geohydrologic Conditions Related to Possible Ground Water Contamination by PCBs at the Fort Edward and Hudson Falls Plants of General Electric, November 1976.

Dames & Moore. October 28, 1994. Outfall 004 Investigation Report.

DeSimone, David J., LaFleur, Robert G. 1985. Glacial Geology and History of the Northern Hudson Basin, New York and Vermont: in Lindemann, Richard H., ed., New York State Geological Association, 57th Annual Meeting, Guidebook, p. 82-116.

Dunn Geoscience Corporation. March 1990. Hydrogeologic Evaluation of Recovery Well RW-1/1A, GE Company Fort Edward Facility, Fort Edward, New York.

Fisher, D.W. 1984. Bedrock Geology of the Glens Falls - Whitehall Regions, New York: New York State Geology Survey Map and Chart Series, No. 35.

Geraghty & Miller. January 1983. Hydrogeology of the General Electric Company Capacitor Plant, Fort Edward, NY.

Hamon, W.R. 1961. Estimating Potential Evapotranspiration. Journal of the Hydraulics Division, Proc. of Amer. Society of Civil Engineers, v. 87, no H43, Part 1, p. 107-120.

Lawler, Matusky & Skelly Engineers. 1985. Revised Remedial Investigation Report, GE Capacitor Plant, Fort Edward, New York, December 1985.

Lawler, Matusky & Skelly Engineers. 1988a. Feasibility Study Off-Site, Shallow Aquifer, GE Capacitor Plant, Fort Edward, New York, January 1988.

Lawler, Matusky & Skelly Engineers. 988b. Supplemental Remedial Investigations On-Site, GE Capacitor Plant, Fort Edward, New York, February 1988.

Lawler, Matusky & Skelly Engineers. 1989. Revised On-Site Feasibility Study, GE Capacitor Plant, Fort Edward, New York, May 1989.

NYSDEC. 1993. Technical and Operational Guidance Series (1.1.1). Ambient Water Quality Standards and Guidance Values.

O'Brien & Gere Engineers, Inc. March 1994a. Foil Mill Trench and Tank Observations.

O'Brien & Gere Engineers, Inc. May 1994b. AOC Assessment Report.

O'Brien & Gere Engineers, Inc. March 1995a. Deep Bedrock Ground Water Evaluation Work Plan.

O'Brien & Gere Engineers, Inc. April 1995b. Remedial Investigation/Feasibility Study Final Work Plan.

O'Brien & Gere Engineers, Inc. July 1995c. Five-Year Review of Off-Site Remedial Program

O'Brien & Gere Engineers, Inc. August 1995d, as revised. Remedial Investigation/Feasibility Study Field Sampling Plan.

O'Brien & Gere Engineers, Inc. August 1995e, as revised. Remedial Investigation/Feasibility Study Quality Assurance Project Plan.

O'Brien & Gere Engineers, Inc. March 1996a. Supplemental Remedial Investigation Technical Scope of Work.

Piper, Anson S. 1985. Tri-Corn Geology, The Geology-History and Environmental Problems of the Upper Hudson Champlain Valley: in Lindemann, Richard H., ed., New York State Geological Association, 57th Annual Meeting, Guidebook, p. 224-268.

Rowley, D.B., and Kidd, W.S.F. 1981. Stratigraphic relationships and detrital composition of the medial Ordovician flysch of western New England: implications for the tectonic evolution of the Taconic orogenyc: Journal of Geology, v. 89, p. 199-218.

USEPA. 1992. Guidance on Risk Characterization for Risk Managers and Risk Assessors, February 26 1992, U.S.EPA Memorandum from Henry Habicht, Deputy Administrator, to Assisstant Administrators and Regional Administrators.

USEPA. 1992. Guidelines for Exposure Assessment - 57 FR 104, May 28, 1992.

USEPA. 1992c. Dermal Exposure Assessment: Principles and Applications EPA/600/8-91/011B

USEPA. 1996. Integrated Risk Information System (IRIS) online database-Polychlorinated Biphenyls

USEPA. 1996. PCBs: cancer Dose-Response Assessment and Application to Environmental Mixtures Final, September 1996

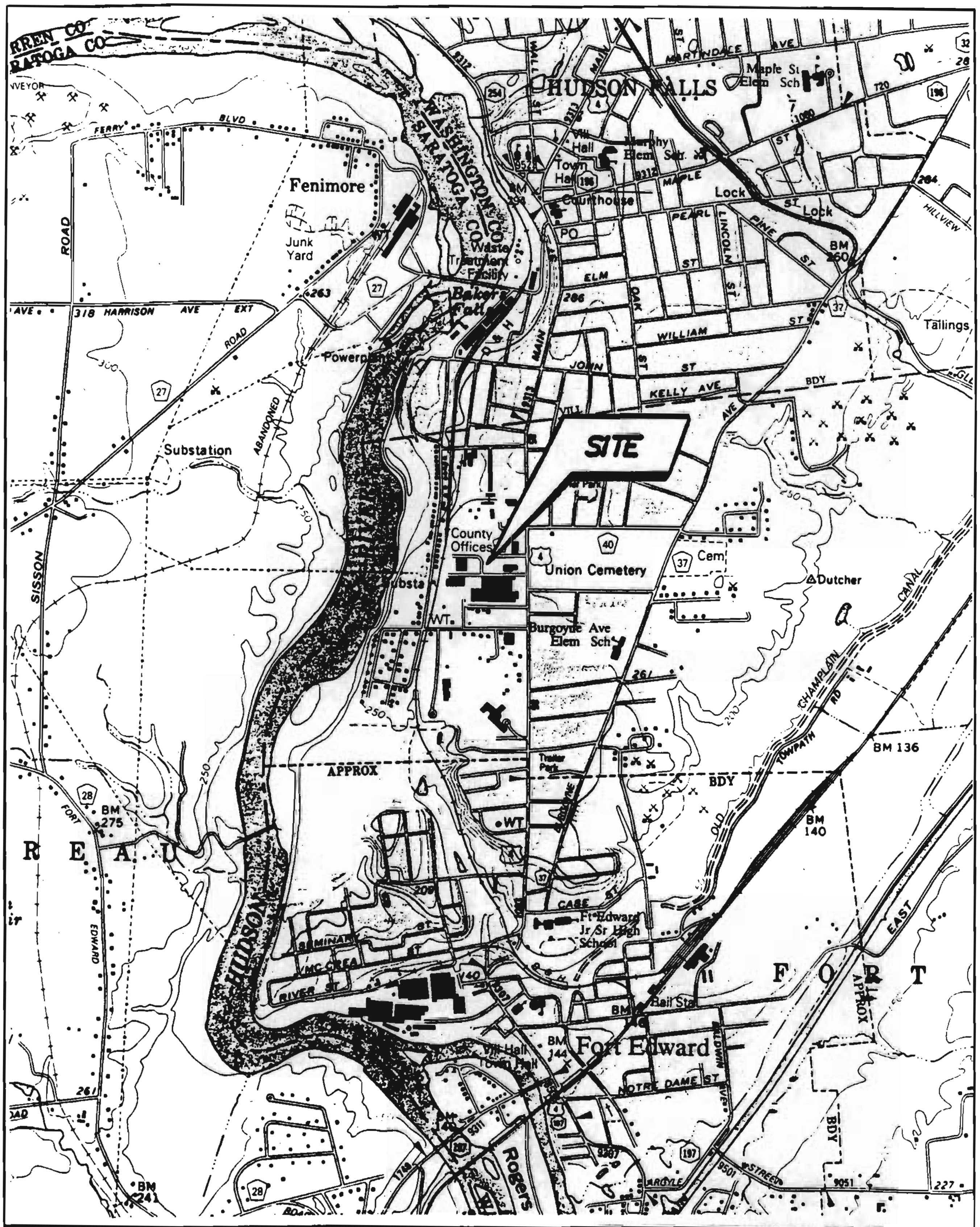
USEPA. 1996. Proposed Guidelines for Carcinogen Risk Assessment, (61 FR 17969; April 23 1996)

USEPA. 1986. Guidelines for Carcinogen Risk Assessment, (52 FR 33992; September 24 1986)

USEPA. 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, EPA-540/1-89-002

USEPA. 1989. Risk Assessment Guidance for Superfund, Volume I, Supplemental Guidance "Standard Default Exposure Factors".

USEPA. 1996. USEPA Region III Memorandum from Roy L. Smith regarding Risk-Based Concentration Table.



O'BRIEN & GERE ENGINEERS, INC.

SITE LOCATION MAP

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK

FILE NO.	5731.000
DATE.	APR 1995

FIGURE 1-1

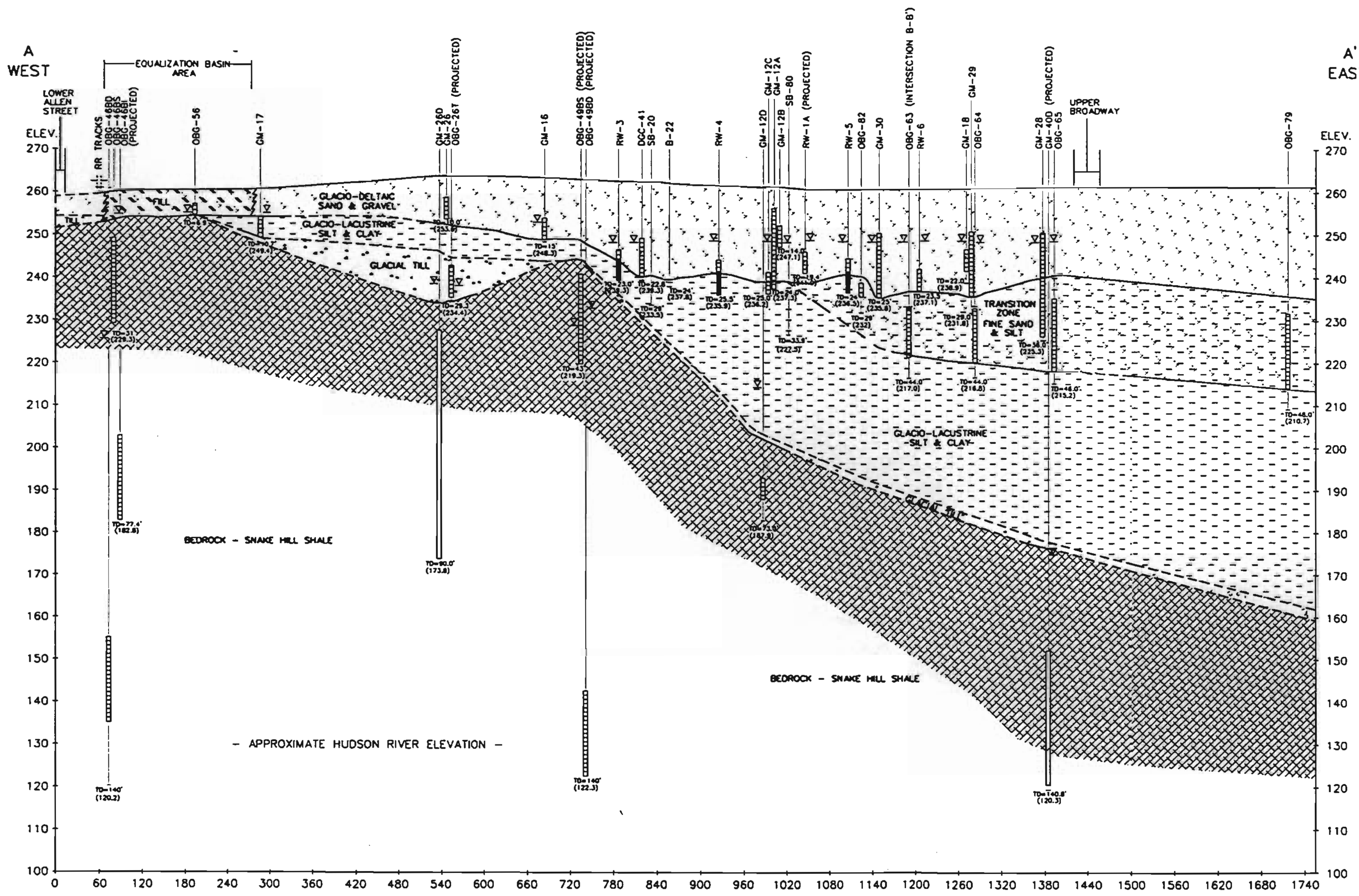
[illegible]

FIGURE 4-1
GENERALIZED STRATIGRAPHIC SECTION
FORT EDWARD, NEW YORK

AGE	FORMATION			THICKNESS (FEET)
	Overburden Soils			0 - 85
Middle Ordovician	Upper Snake Hill Formation			200-210
	Middle Snake Hill Formation			30 - 40
	Lower Snake Hill Formation			130-150
	Glens Falls Limestone			100-110
	Isle LaMotte Limestone			40-50
Lower Ordovician	Beekmantown Group	Fort Ann Formation		50-115
		Grt Meadows Formation	Fort Edward Dolostone	60-150
			Winchell Creek Siltstone	8-110
		Whitehall Formation		200 - 250
Cambrian		Ticonderoga Formation		150 - 240
		Potsdam Sandstone		85-225

Notes

1 Thickness of upper, middle, and lower Snake Hill Formations, Glens Falls Limestone, and Isle LaMotte Limestone are based on core log of OBG-26BD, and geophysical log of PW-1.



LEGEND

SB-13 — SOIL BORING DESIGNATION
BACKFILLED SECTION OF BORING
TD15' = TOTAL DEPTH OF BORING (feet below grade)
(243) = ELEVATION (TYP)

GM-17 — MONITORING WELL DESIGNATION
RISER PIPE
GROUND WATER ELEVATION (JUNE 17, 1996)
SCREENED SECTION
TD33' = TOTAL DEPTH OF BORING (feet below grade)
(232) = ELEVATION (TYP)

RW-4 — GROUND WATER RECOVERY WELL DESIGNATION
STEEL CASING
SCREENED SECTION
ZERO SLOT WELL SCREEN (SUMP)
TD=23.5' = TOTAL DEPTH OF WELL (feet below grade)
(235.9) = ELEVATION (feet above mean sea level)

GLACIO-DELTAIC SAND & GRAVEL: Coarse to Fine Sand and Fine Gravel.

GLACIO-LACUSTRINE SILT & CLAY: Interbedded Silt & Clay with Occasional Very Fine Sand Seams.

GLACIAL TILL: Medium to Fine Gravel and Coarse to Fine Sand in a Clayey Matrix.

SHALLOW BEDROCK-SNAKE HILL SHALE: Dark Grey to Black, Fine Grained, Massive to Moderately Jointed with Sub-Angular to Horizontal Bedding.

TRANSITION ZONE: Interbedded Fine Sand & Silt with Occasional Clay Seams

FILL: Widely Varying Materials Placed by Man.

FIGURE 4-2

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK

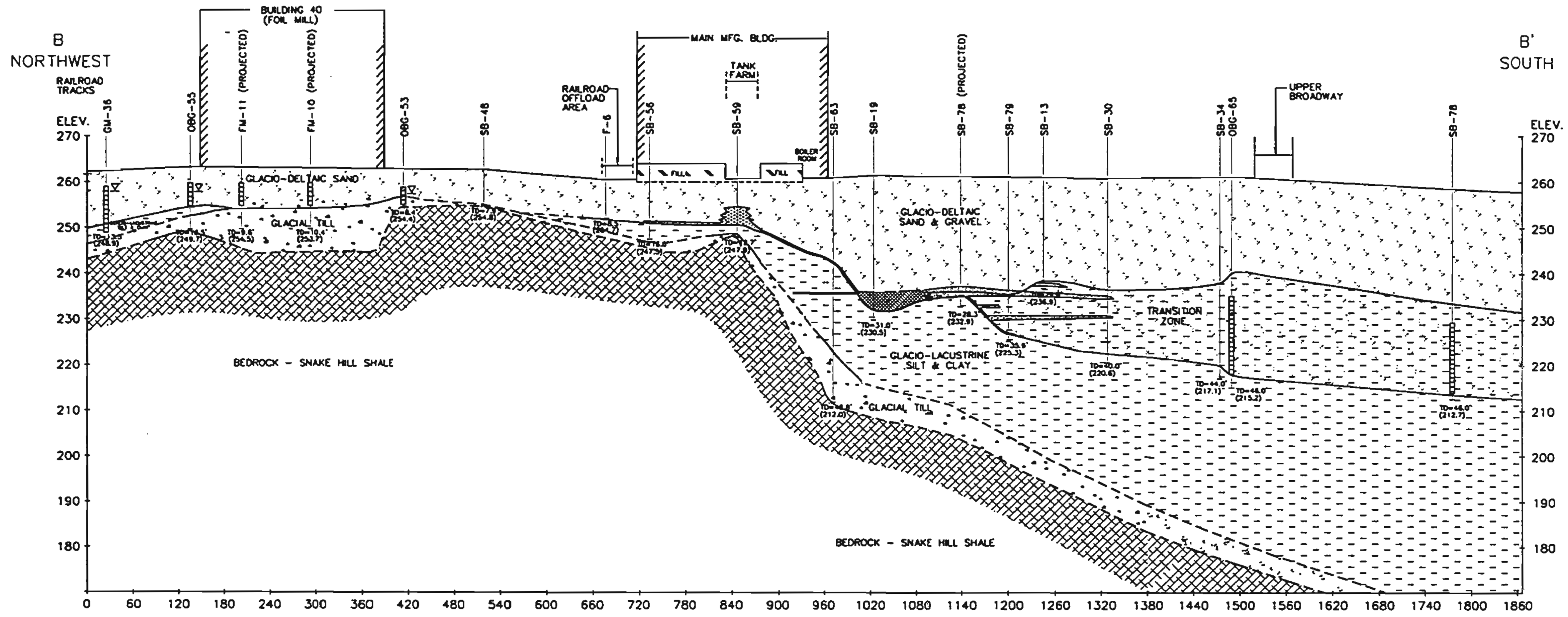
STRATIGRAPHIC CROSS SECTION A-A'

10 0 10 20
SCALE IN FEET (VERT)
60 0 60 120
SCALE IN FEET (HORZ)

FILE NO. 5731.046-01F

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 4-3



- APPROXIMATE HUDSON RIVER ELEVATION = 133'

LEGEND

SB-13 — SOIL BORING DESIGNATION

— BACKFILLED SECTION OF BORING

TD15' = TOTAL DEPTH OF BORING (feet below grade)
(245) = ELEVATION (TYP)

GM-17 — MONITORING WELL DESIGNATION

— RISER PIPE
▽ — GROUND WATER ELEVATION (OCT. 30, 1995)
— SCREENED SECTION

TD35' = TOTAL DEPTH OF BORING (feet below grade)
(232) = ELEVATION (TYP)

GLACIO-DELTAIC SAND & GRAVEL: Coarse to Fine Sand and Fine Gravel.

GLACIO-LACUSTRINE SILT & CLAY: Interbedded Silt & Clay with Occasional Very Fine Sand Seams.

GLACIAL TILL: Medium to Fine Gravel and Coarse to Fine Sand in a Clayey Matrix.

TRANSITION ZONE: Interbedded Fine Sand & Silt with Occasional Clay Seams.

BEDROCK-SNAKE HILL SHALE: Dark Grey to Black, Fine Grained, Massive to Moderately Jointed with Sub-Angular to Horizontal Bedding.

FILL: Widely Varying Material Placed By Man.

Area of Known or Suspected Residual PCB DNAPL's.

Area of Known or Suspected Recoverable PCB DNAPL's.

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK

STRATIGRAPHIC CROSS SECTION B–B'

10 0 10 20
SCALE IN FEET (VERT)
60 0 60 120
SCALE IN FEET (HORZ)

FILE NO. 5731.046-01F

O'BRIEN & GERE ENGINEERS, INC.

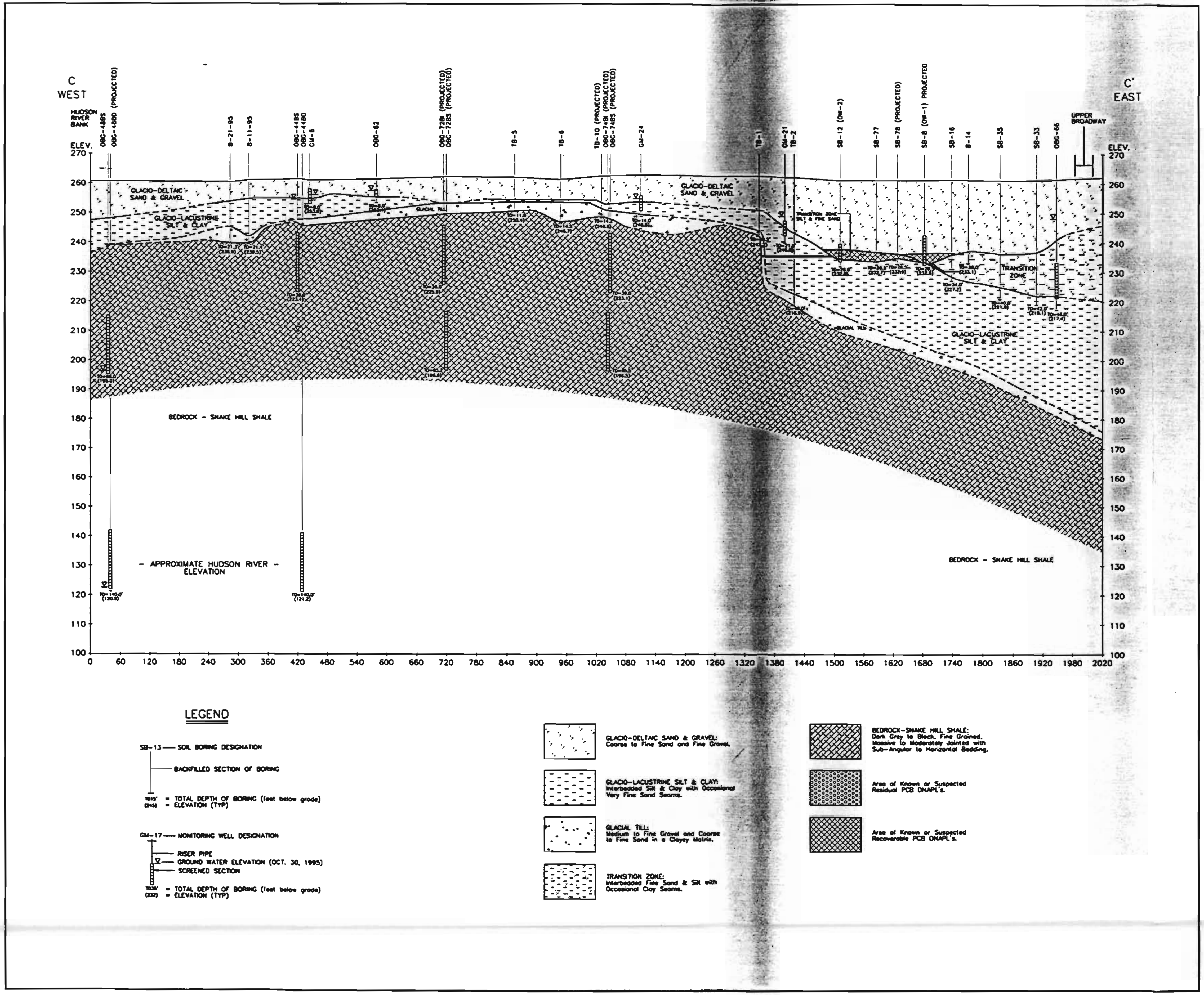


FIGURE 4-4

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK
REMEDIAL INVESTIGATION

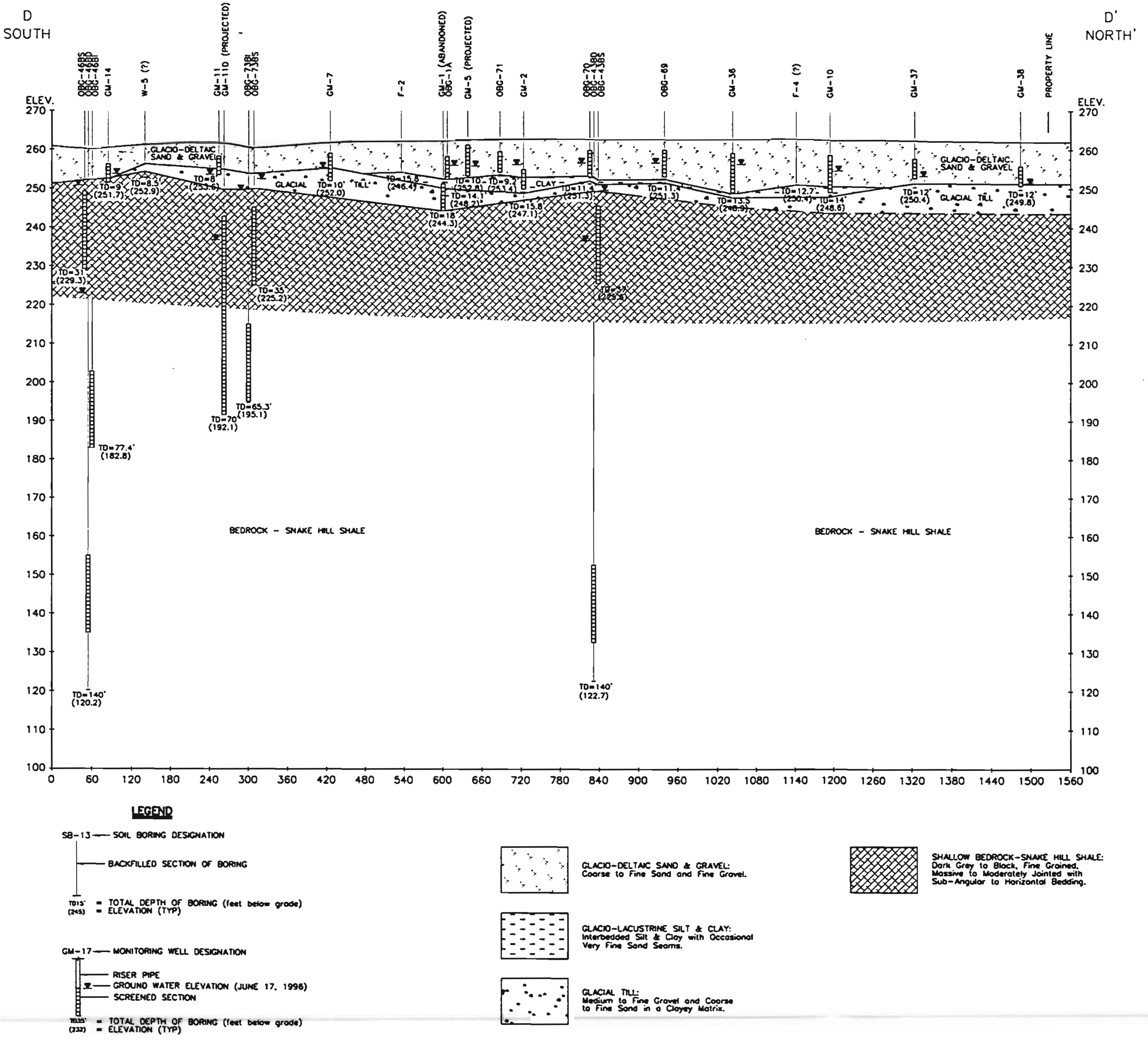
STRATIGRAPHIC
CROSS SECTION C-C'

10 0 10 20
SCALE IN FEET (VERT)
60 0 60 120
SCALE IN FEET (HORZ)

FILE NO. 5731.046-01F

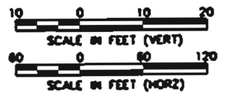
O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 4-5



GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK

STRATIGRAPHIC CROSS SECTION D–D'



FILE NO. 5731.046–01F

O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 4-6

LEGEND

⊘OBG-54	LOCATION OF SHALLOW UNCONSOLIDATED UNIT MONITORING WELL
⊕OBG-42BS	LOCATION OF BEDROCK MONITORING WELL
•SB-43	LOCATION OF SOIL BORING
○RW-2	LOCATION OF OIL RECOVERY WELL
⊖RW-5	LOCATION OF SHALLOW UNCONSOLIDATED UNIT GROUND WATER RECOVERY WELL
—248—	TOP OF LOW PERMEABILITY UNIT ELEVATION CONTOUR (dashed where inferred).
A A'	LINE OF GEOLOGIC CROSS-SECTION
▨	AREA OF KNOWN OR SUSPECTED RESIDUAL PCB DNAPL'S AT SAND-CLAY INTERFACE.
☐	AREA OF KNOWN OR SUSPECTED PCB DNAPL'S WITHIN TRANSITION ZONE.
☐	AREA OF KNOWN OR SUSPECTED PCB DNAPL'S WITHIN GLACIOLACUSTRINE SILT & CLAY UNIT AND/OR GLACIAL TILL UNIT.
▒	AREA OF KNOWN OR SUSPECTED RECOVERABLE PCB DNAPL'S AT SAND-CLAY INTERFACE.

NOTE:
ALL ELEVATIONS AND CONTOURS ARE IN FEET ABOVE MEAN SEA LEVEL

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK
REMEDIAL INVESTIGATION

TOP OF LOW PERMEABILITY UNIT ELEVATION CONTOUR MAP

200 0 200
SCALE IN FEET

FILE NO. 5731.046-01F

O'BRIEN & GERE ENGINEERS, INC.

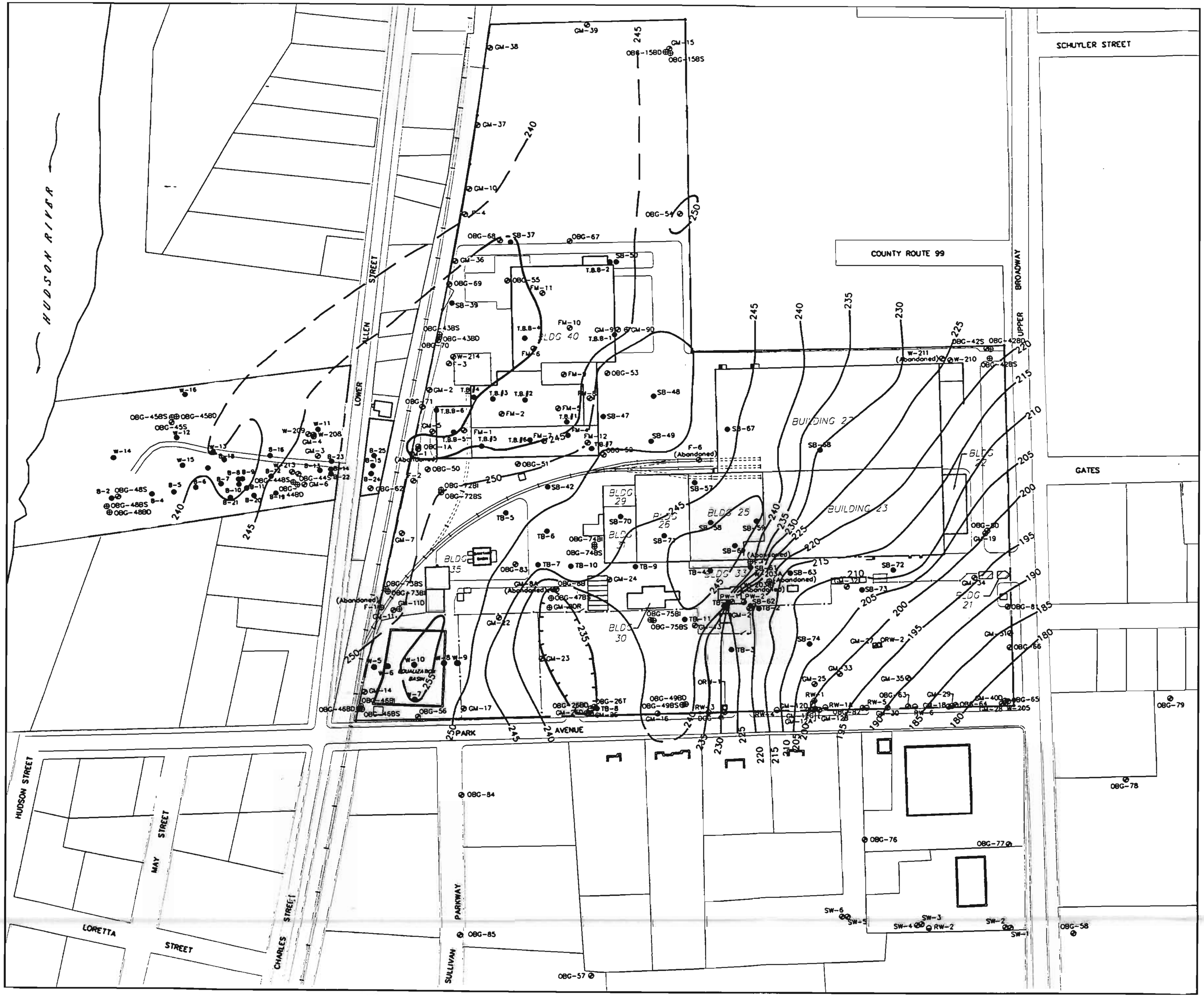


FIGURE 4-7

LEGEND

⊗OBG-54	LOCATION OF SHALLOW UNCONSOLIDATED UNIT MONITORING WELL
⊕OBG-42BS	LOCATION OF BEDROCK MONITORING WELL
●SB-43	LOCATION OF SOIL BORING
○ORW-2	LOCATION OF OIL RECOVERY WELL
⊖RW-5	LOCATION OF SHALLOW UNCONSOLIDATED UNIT GROUND WATER RECOVERY WELL
248	TOP OF BEDROCK ELEVATION CONTOUR (dashed where inferred).

NOTES: All elevations are in feet above mean sea level

Bedrock elevations are listed in Table 4-1

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK
REMEDIAL INVESTIGATION

TOP OF BEDROCK ELEVATION CONTOUR MAP

200 0 200
SCALE IN FEET

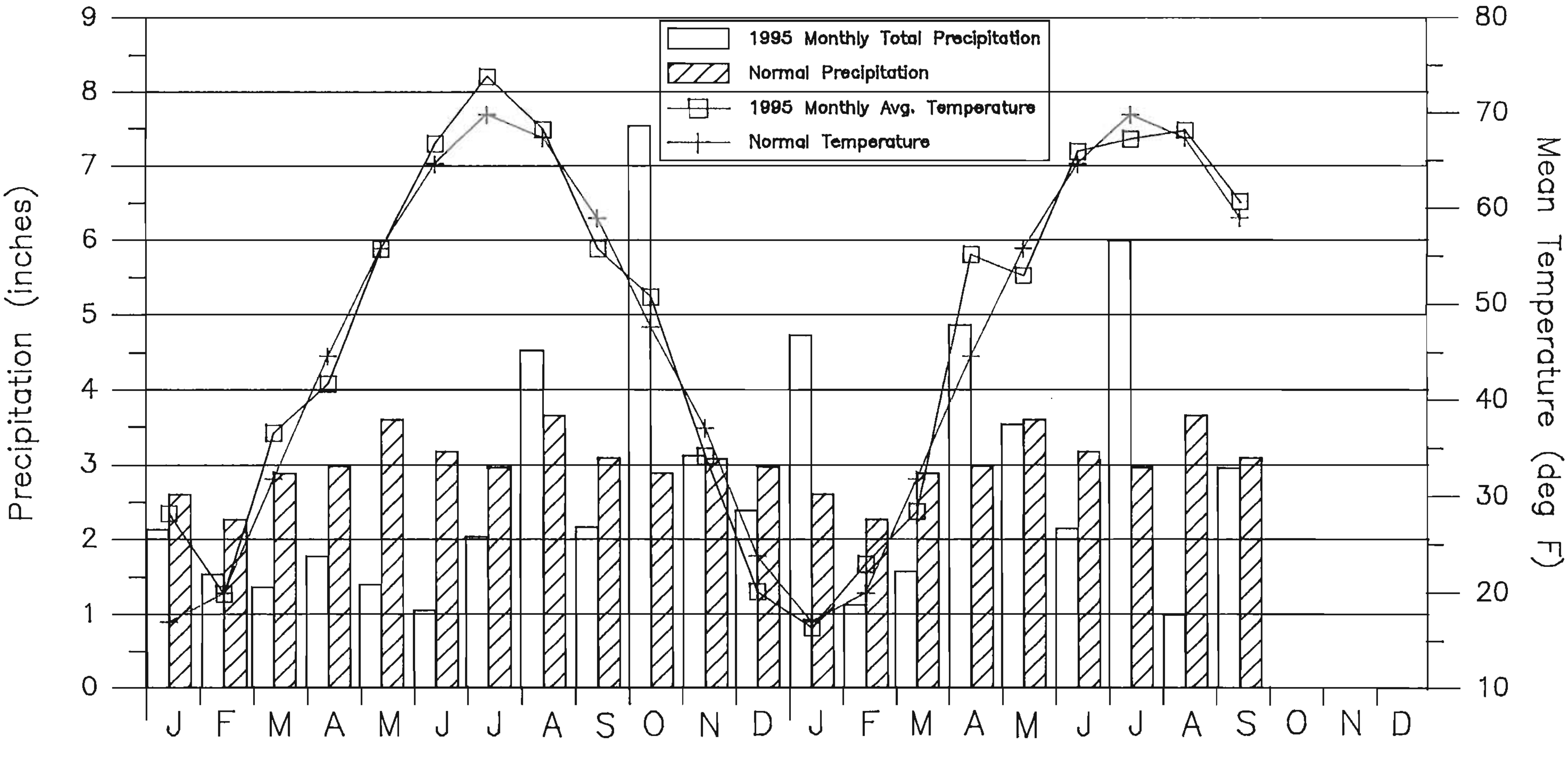
FILE NO. 5731.046-01F

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 5–1

MONTHLY PRECIPITATION and TEMPERATURE
January 1, 1995 – September 31, 1996

General Electric Company
Fort Edward, New York



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ENGINEERS, INC.

FIGURE 5-2
PRECIPITATION LESS POTENTIAL EVAPOTRANSPIRATION
January 1 – December 31, 1995

General Electric Facility
Fort Edward, New York

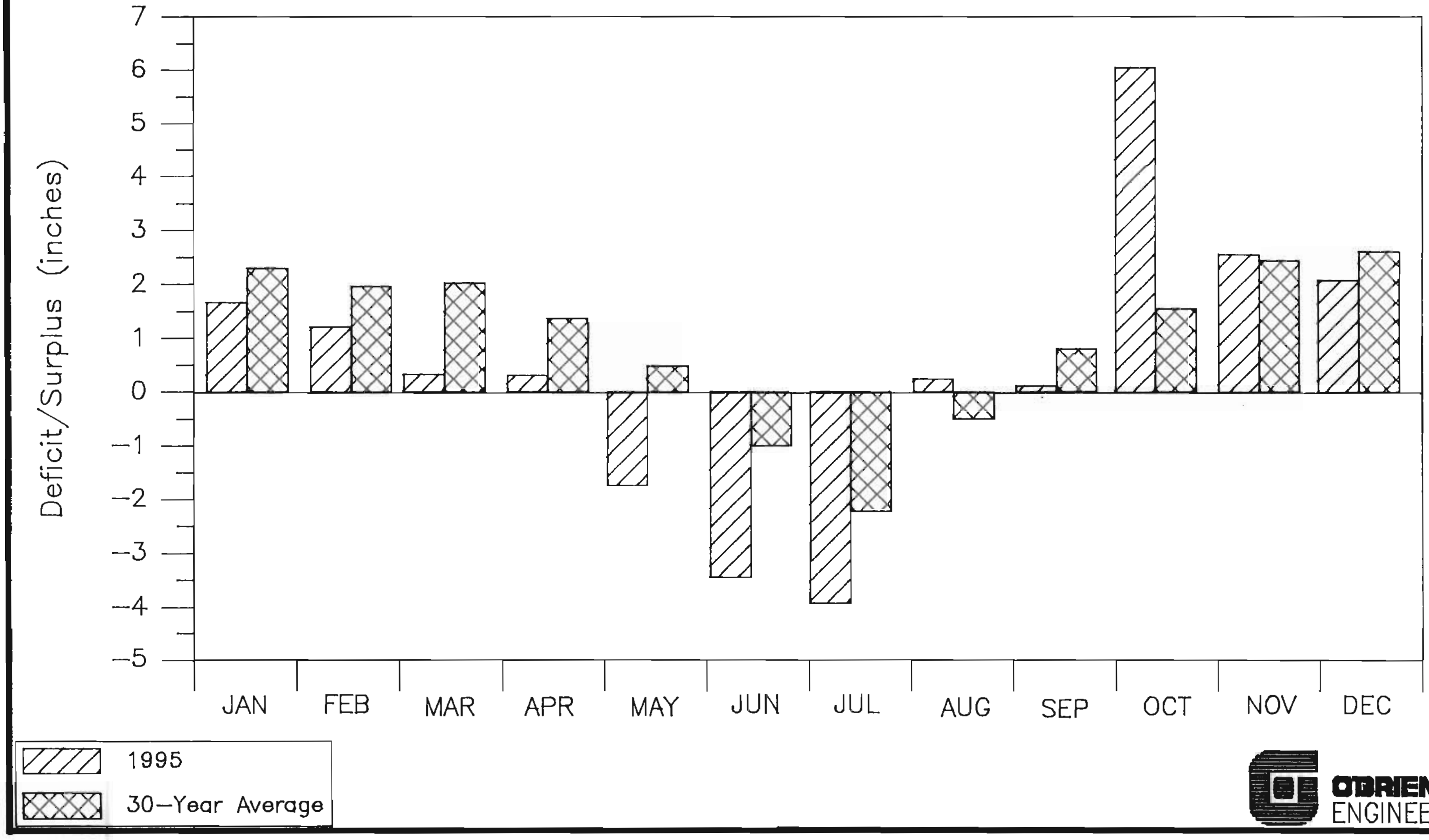

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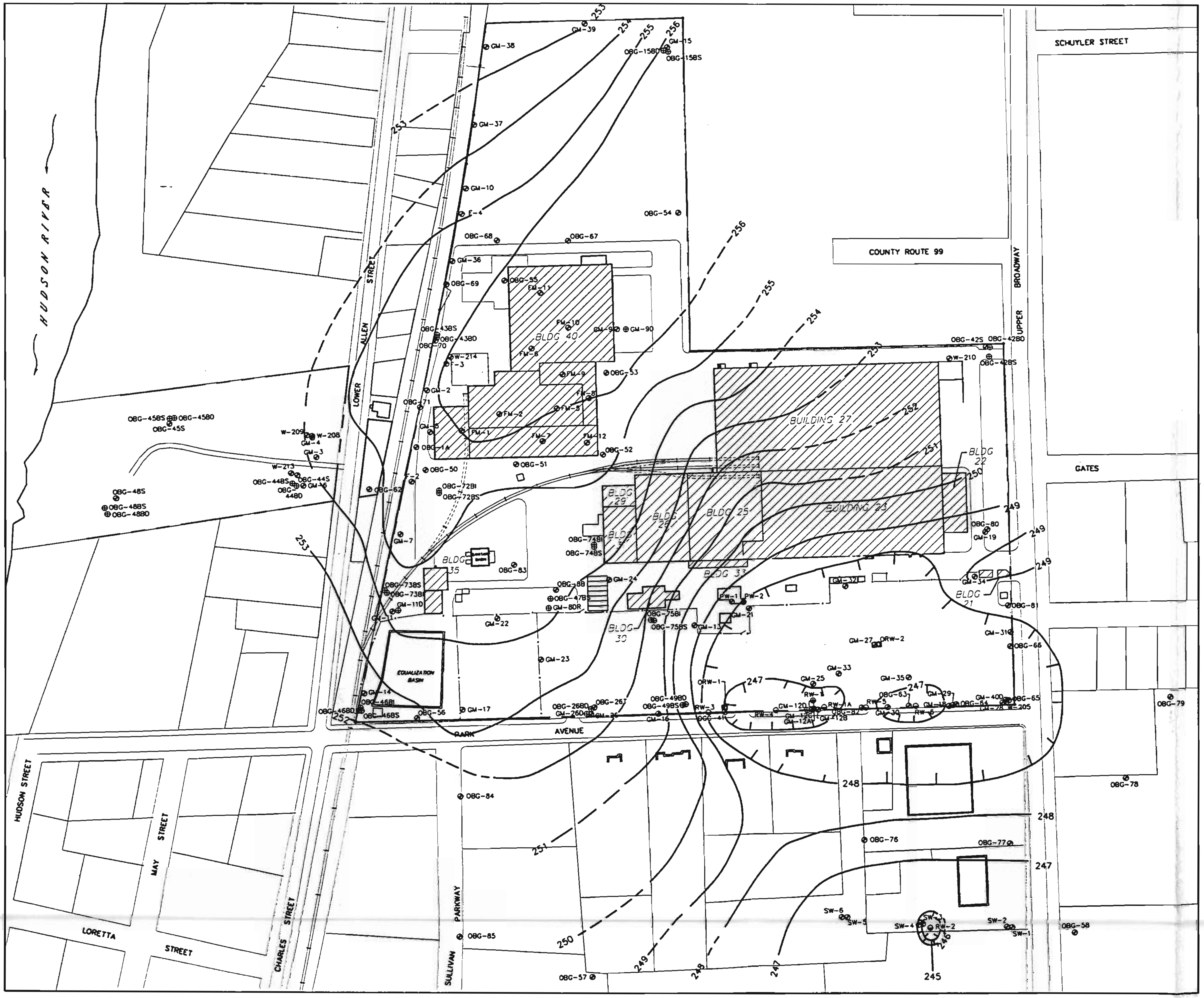
FIGURE 5-3



LEGEND

⊘OBG-54	LOCATION OF SHALLOW UNCONSOLIDATED UNIT MONITORING WELL
⊕OBG-42BS	LOCATION OF BEDROCK MONITORING WELL
○ORW-2	LOCATION OF OIL RECOVERY WELL
●RW-5	LOCATION OF SHALLOW UNCONSOLIDATED UNIT GROUND WATER RECOVERY WELL
249	SHALLOW UNCONSOLIDATED UNIT GROUND WATER CONTOUR (dashed where inferred)

NOTES: Water Elevation Contours in Feet Above Mean Sea Level

Ground Water Elevations are Presented In Appendix E

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK
REMEDIAL INVESTIGATION

UNCONSOLIDATED UNIT GROUND WATER TABLE CONTOUR MAP ON JULY 12,1995

200 0 200
SCALE IN FEET

FILE NO. 5731.046-01F

O'BRIEN & GERE ENGINEERS, INC.

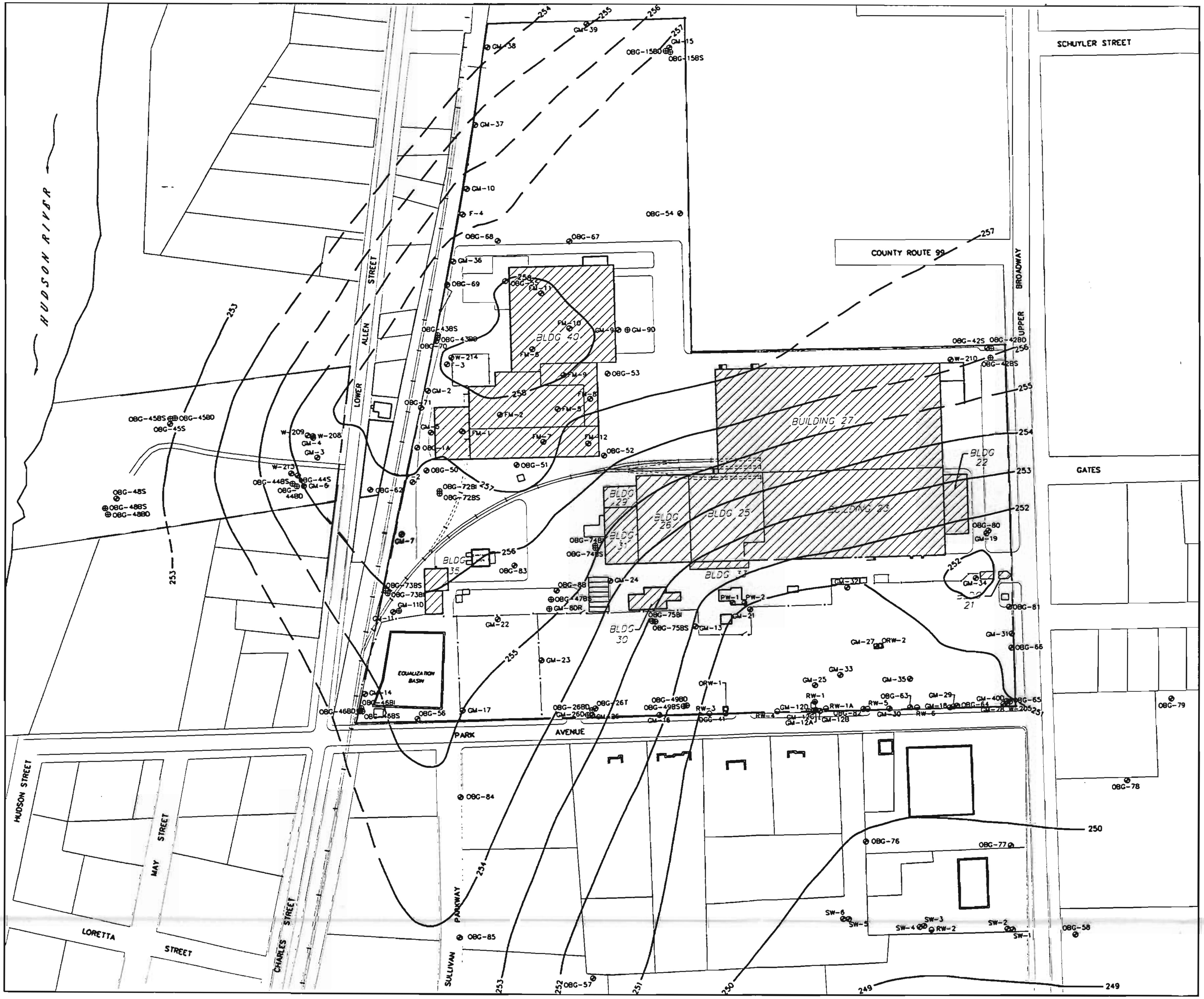


FIGURE 5-4

LEGEND

⊘OBG-54	LOCATION OF SHALLOW UNCONSOLIDATED UNIT MONITORING WELL
⊕OBG-42BS	LOCATION OF BEDROCK MONITORING WELL
○ORW-2	LOCATION OF OIL RECOVERY WELL
◓RW-5	LOCATION OF SHALLOW UNCONSOLIDATED UNIT GROUND WATER RECOVERY WELL
249	SHALLOW UNCONSOLIDATED UNIT GROUND WATER CONTOUR (dashed where inferred)

NOTES: Water Elevation Contours in Feet Above Mean Sea Level

Ground Water Elevations are Presented In Appendix E

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK
REMEDIAL INVESTIGATION

UNCONSOLIDATED UNIT GROUND WATER TABLE CONTOUR MAP ON JUNE 17, 1996

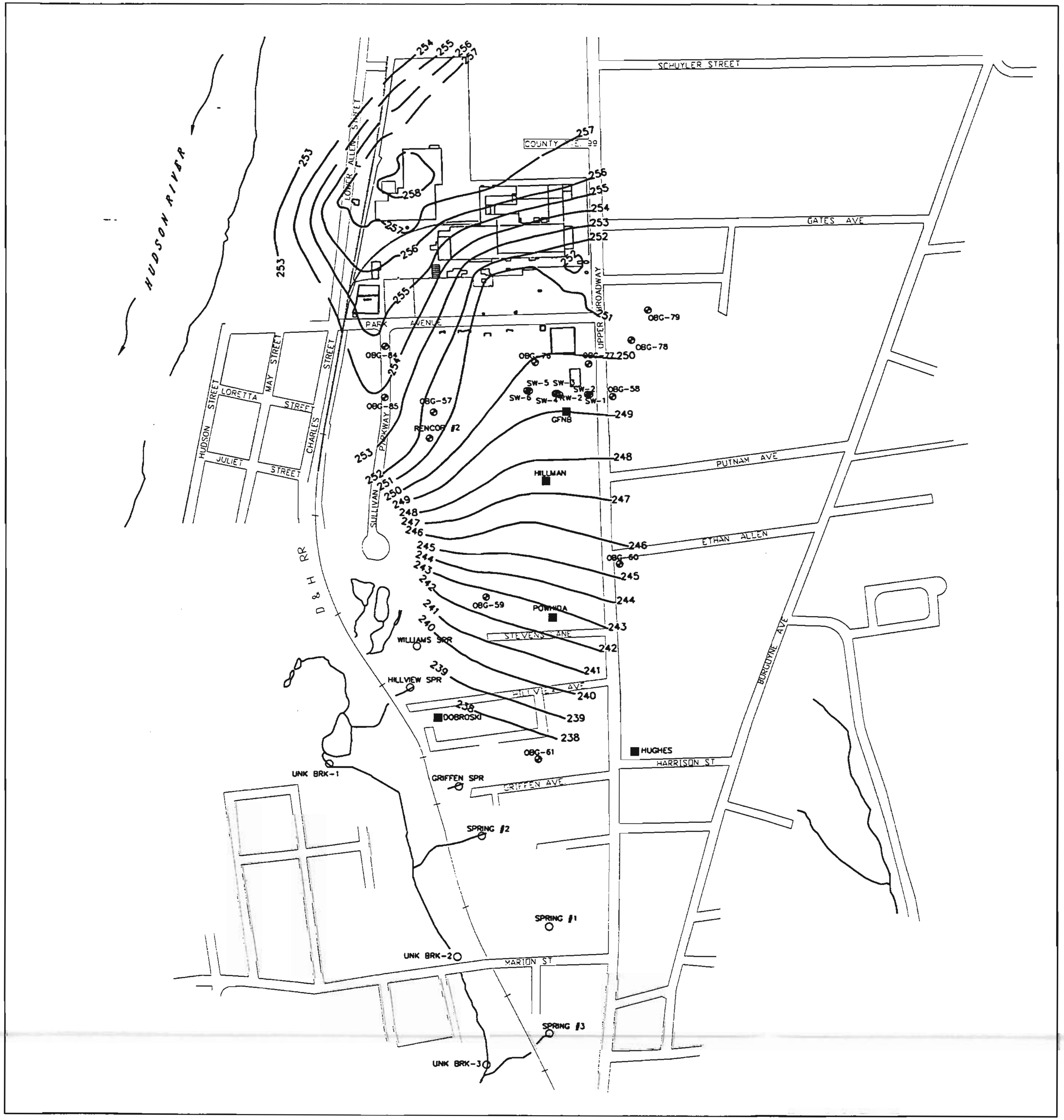
200 0 200
SCALE IN FEET

FILE NO. 5731.046-01F

O'BRIEN & GERE ENGINEERS, INC.

C:\FTED\5731046\DWG\FE-RI-OF.DWG

FIGURE 5-5



LEGEND

RW-1A Location of ground water recovery well

SPRING #3 ○ Location of surface water sample

HUGHES ■ Location of residential well sample

— — — GE Property line

SW-2 Location of NYS monitoring well pair

OBG-60 Location of unconsolidated unit monitoring well

—248— Shallow Unconsolidated Unit Ground Water Elevation Contour (dashed where inferred)

NOTES: Ground Water Elevations are Presented in Appendix E

Ground Water Elevations are in Feet Above Mean Sea Level

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK
REMEDIAL INVESTIGATION

OFF-SITE UNCONSOLIDATED UNIT GROUND WATER ELEVATION CONTOUR MAP ON JUNE 17, 1996

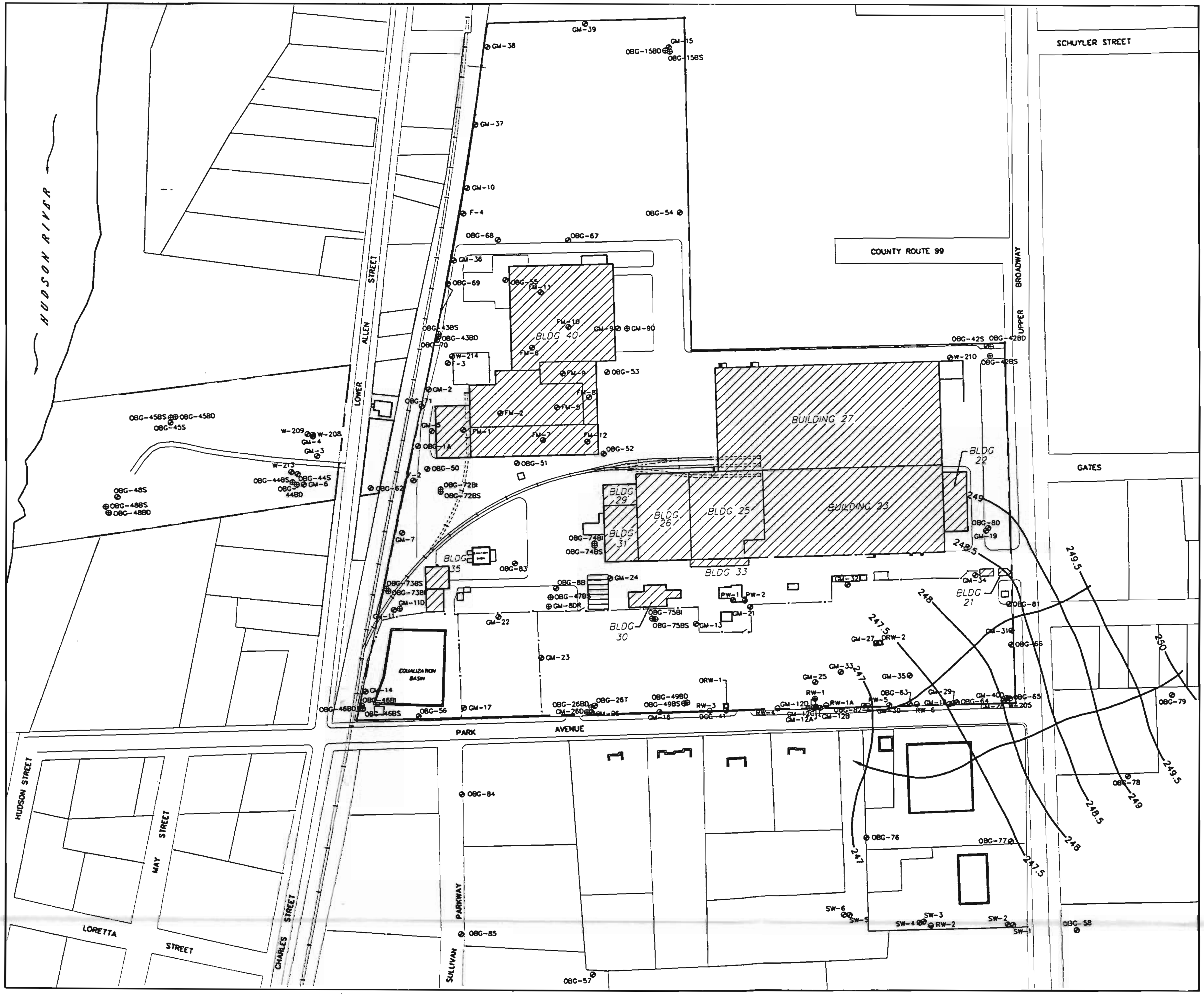
300 0 300 600
Scale in Feet

FILE 5731.046

O'BRIEN & GERE
ENGINEERS, INC.

1/9/97

FIGURE 5-6



LEGEND

⊘OBG-54	LOCATION OF SHALLOW UNCONSOLIDATED UNIT MONITORING WELL
⊕OBG-42BS	LOCATION OF BEDROCK MONITORING WELL
○ORW-2	LOCATION OF OIL RECOVERY WELL
●RW-5	LOCATION OF SHALLOW UNCONSOLIDATED UNIT GROUND WATER RECOVERY WELL
248	GROUND WATER POTENTIOMETRIC SURFACE ELEVATION CONTOUR (dashed where inferred).
⟶	DIRECTION OF GROUND WATER FLOW

NOTES: Water Elevation Contours in Feet Above Mean Sea Level

Ground Water Elevations are Presented In Appendix E

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK
REMEDIAL INVESTIGATION

POTENTIOMETRIC SURFACE MAP FOR THE TRANSITION ZONE ON NOVEMBER 22, 1996

200 0 200
SCALE IN FEET

FILE NO. 5731.046-01F

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 5–7

LEGEND

⊘OBG-54	LOCATION OF SHALLOW UNCONSOLIDATED UNIT MONITORING WELL
⊕OBG-42BS	LOCATION OF BEDROCK MONITORING WELL
○ORW-2	LOCATION OF OIL RECOVERY WELL
◒RW-5	LOCATION OF SHALLOW UNCONSOLIDATED UNIT GROUND WATER RECOVERY WELL
248	GROUND WATER POTENTIOMETRIC SURFACE ELEVATION CONTOUR (dashed where inferred).
←	DIRECTION OF GROUND WATER FLOW

NOTES: Water Elevation Contours in Feet Above Mean Sea Level

Ground Water Elevations are Presented In Appendix E

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK
REMEDIAL INVESTIGATION

POTENTIOMETRIC SURFACE MAP FOR THE SHALLOW BEDROCK GROUND WATER ON SEPTEMBER 23, 1996

200 0 200
SCALE IN FEET

FILE NO. 5731.046-01F

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 5-8

LEGEND

OBG-54	LOCATION OF SHALLOW UNCONSOLIDATED UNIT MONITORING WELL
OBG-42BS	LOCATION OF BEDROCK MONITORING WELL
ORW-2	LOCATION OF OIL RECOVERY WELL
RW-5	LOCATION OF SHALLOW UNCONSOLIDATED UNIT GROUND WATER RECOVERY WELL
248	GROUND WATER POTENTIOMETRIC SURFACE ELEVATION CONTOUR (dashed where inferred).
	DIRECTION OF GROUND WATER FLOW

NOTES: Water Elevation Contours in Feet Above Mean Sea Level

Ground Water Elevations are Presented In Appendix E

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK
REMEDIAL INVESTIGATION

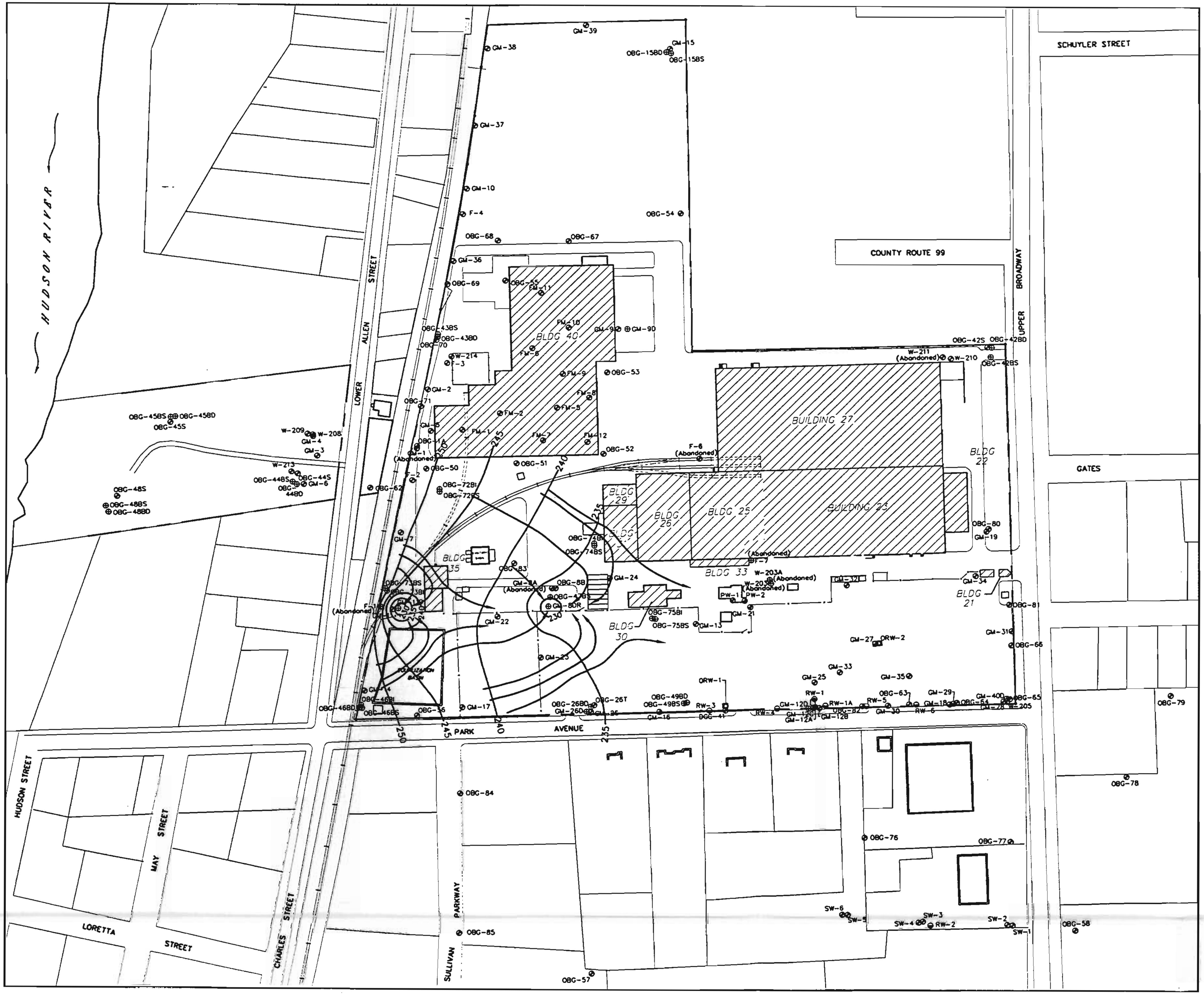
POTENTIOMETRIC SURFACE MAP FOR THE SHALLOW BEDROCK GROUND WATER ON OCTOBER 2, 1996

200 0 200
SCALE IN FEET

FILE NO. 5731.046-01F

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 5-9



LEGEND

⊘OBG-54	LOCATION OF SHALLOW UNCONSOLIDATED UNIT MONITORING WELL
⊕OBG-42BS	LOCATION OF BEDROCK MONITORING WELL
○ORW-2	LOCATION OF OIL RECOVERY WELL
⊖RW-5	LOCATION OF SHALLOW UNCONSOLIDATED UNIT GROUND WATER RECOVERY WELL
248	GROUND WATER POTENTIOMETRIC SURFACE ELEVATION CONTOUR
	DIRECTION OF GROUND WATER FLOW

NOTES: Water Elevation Contours are in Feet Above Mean Sea Level

Ground Water Elevations are Presented in Appendix E

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK
REMEDIAL INVESTIGATION

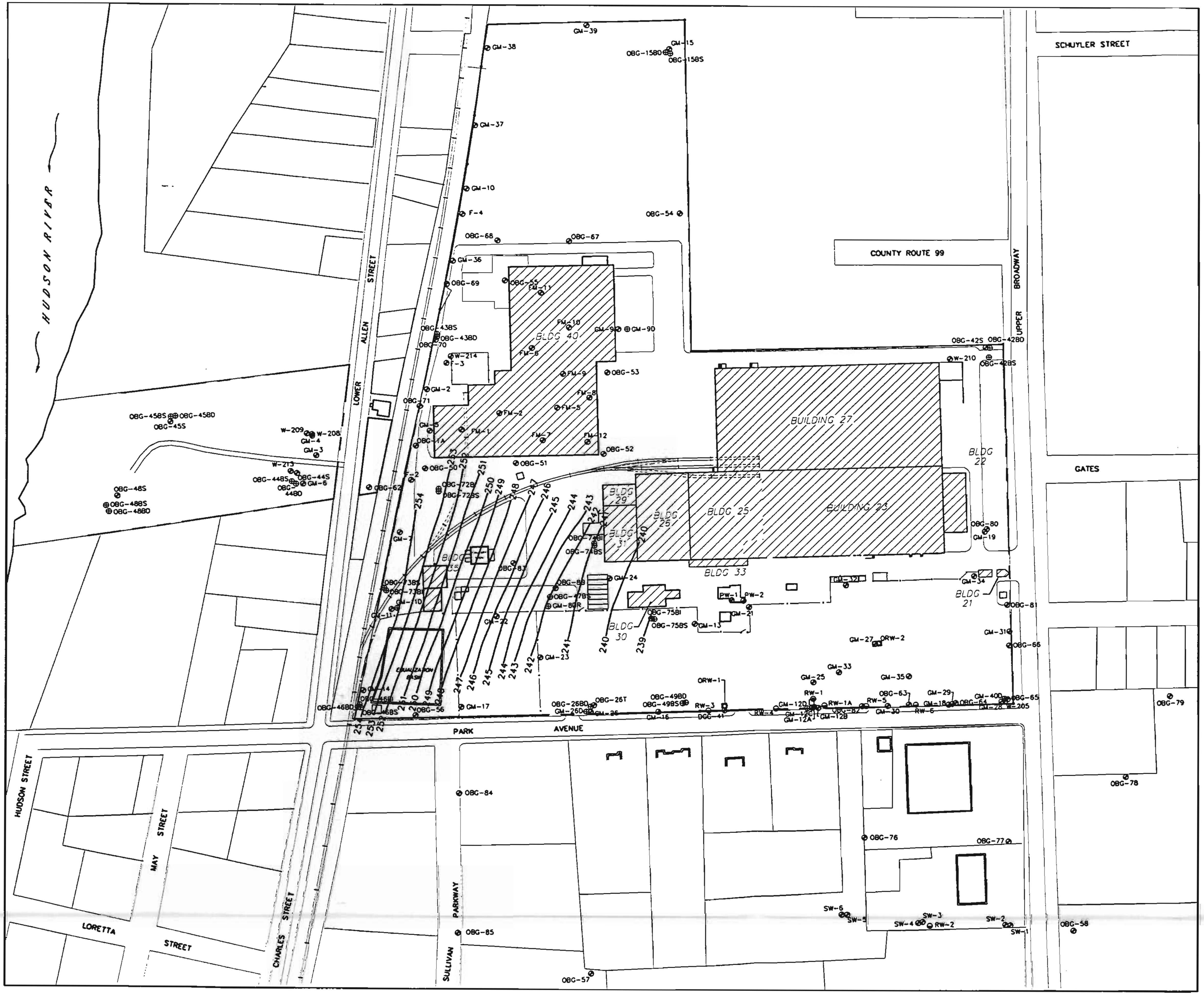
POTENTIOMETRIC SURFACE MAP FOR THE INTERMEDIATE BEDROCK GROUND WATER ON SEPTEMBER 23, 1996

200 0 200
SCALE IN FEET

FILE NO. 5731.046-01F

OBRIEN&GERE
ENGINEERS, INC.

FIGURE 5-10



LEGEND

OBG-54	LOCATION OF SHALLOW UNCONSOLIDATED UNIT MONITORING WELL
OBG-42BS	LOCATION OF BEDROCK MONITORING WELL
ORW-2	LOCATION OF OIL RECOVERY WELL
RW-5	LOCATION OF SHALLOW UNCONSOLIDATED UNIT GROUND WATER RECOVERY WELL
248	GROUND WATER POTENTIOMETRIC SURFACE ELEVATION CONTOUR (dashed where inferred).

NOTES: Ground Water Elevation Contours are in Feet Above Mean Sea Level

Ground Water Elevations are Presented In Appendix E

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK
REMEDIAL INVESTIGATION

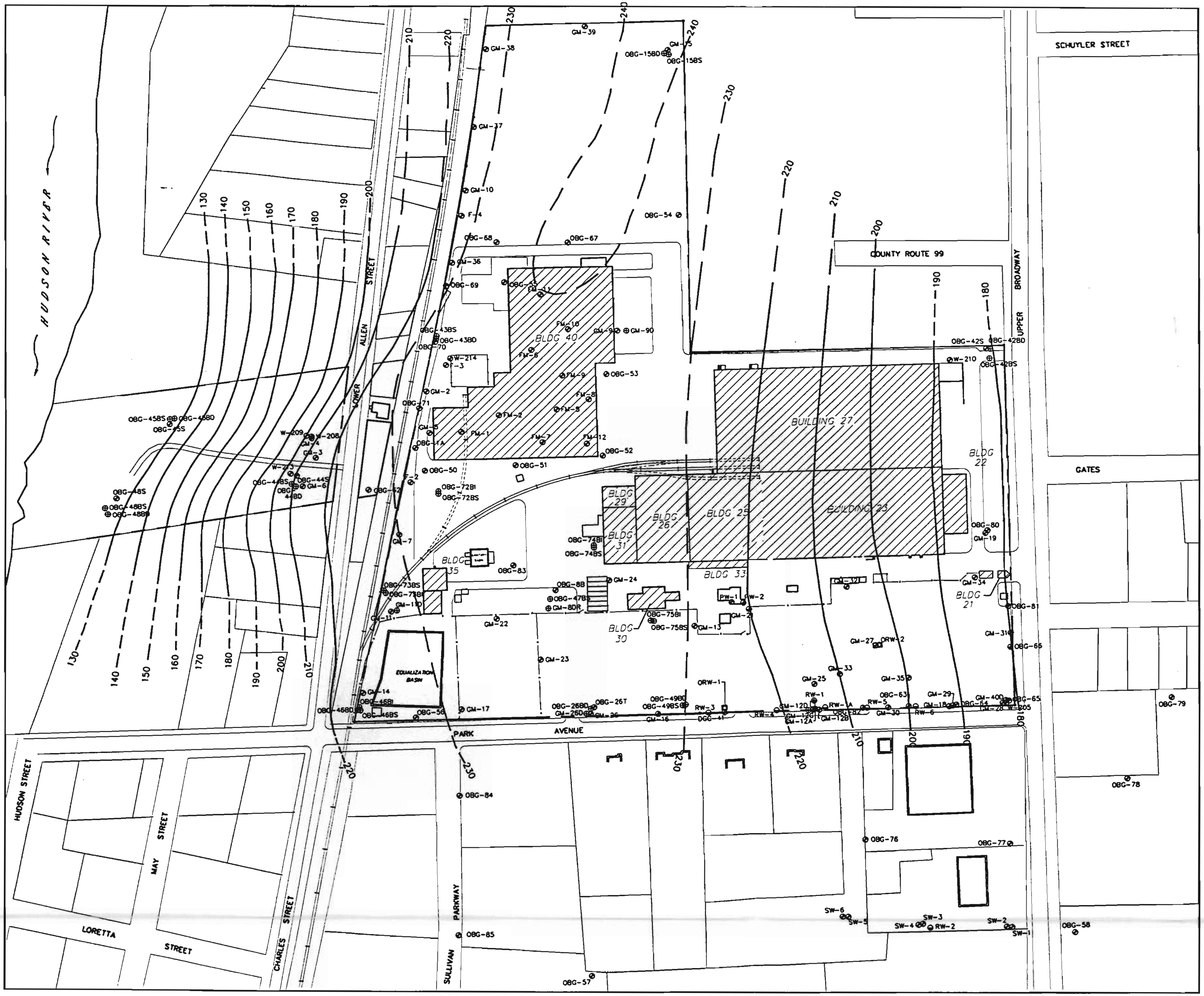
POTENTIOMETRIC SURFACE MAP FOR THE INTERMEDIATE BEDROCK GROUND WATER ON OCTOBER 2, 1996

200 0 200
SCALE IN FEET

FILE NO. 5731.046-01F

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 5-11



LEGEND

⊗OBG-54	LOCATION OF SHALLOW UNCONSOLIDATED UNIT MONITORING WELL
⊕OBG-42BS	LOCATION OF BEDROCK MONITORING WELL
○ORW-2	LOCATION OF OIL RECOVERY WELL
◒RW-5	LOCATION OF SHALLOW UNCONSOLIDATED UNIT GROUND WATER RECOVERY WELL
—248—	GROUND WATER POTENTIOMETRIC SURFACE ELEVATION CONTOUR

NOTES: Water Elevation Contours are in Feet Above Mean Sea Level

Ground Water Elevations are Presented in Appendix E

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK
REMEDIAL INVESTIGATION

POTENTIOMETRIC SURFACE MAP FOR DEEP BEDROCK GROUND WATER ON JUNE 17, 1996

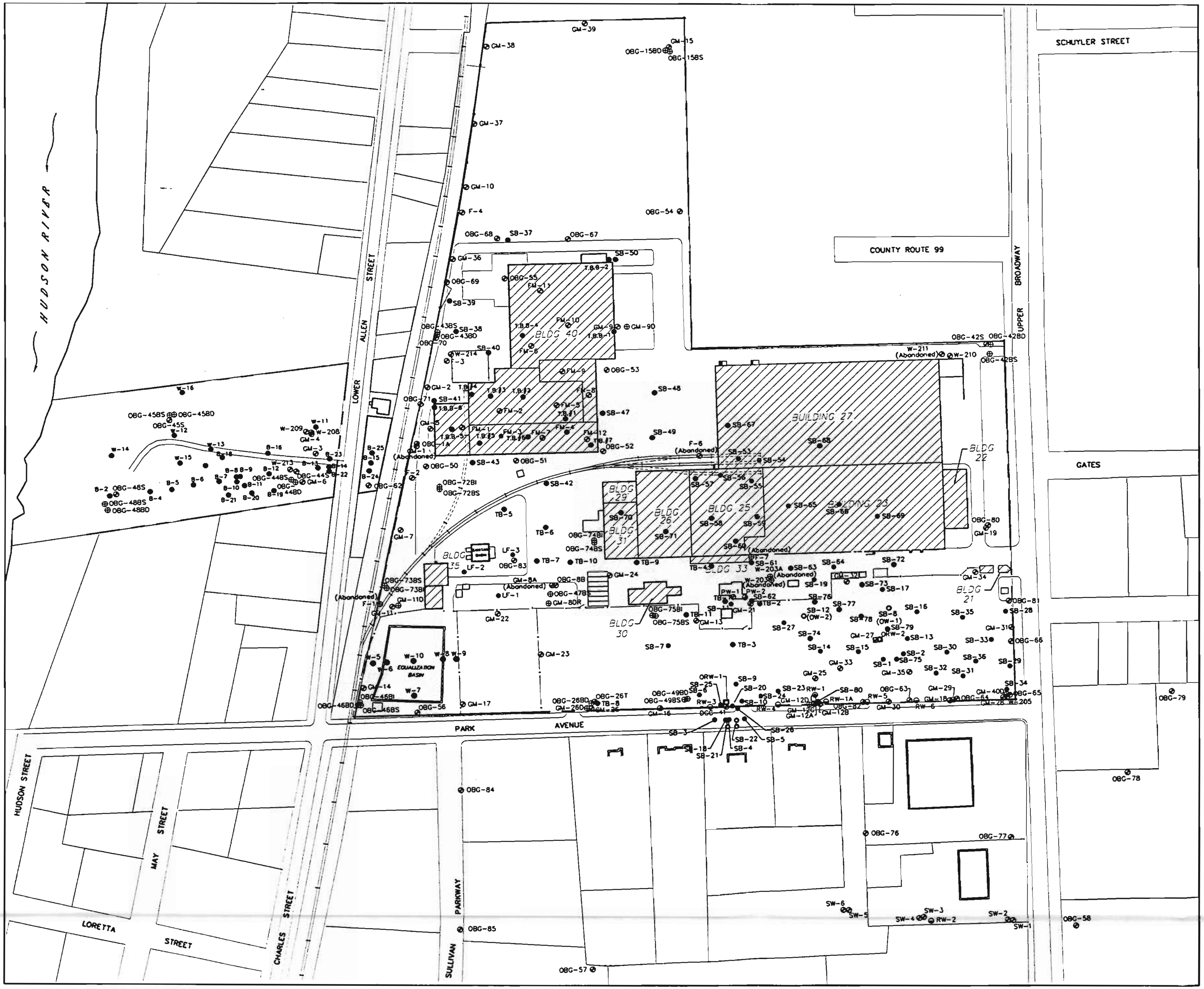
200 0 200

SCALE IN FEET

FILE NO. 5731.046-01F

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 1–2



LEGEND

⊘OBG-54	LOCATION OF SHALLOW UNCONSOLIDATED UNIT MONITORING WELL
⊕OBG-42BS	LOCATION OF BEDROCK MONITORING WELL
●SB-43	LOCATION OF SOIL BORING
○ORW-2	LOCATION OF OIL RECOVERY WELL
◓RW-5	LOCATION OF SHALLOW UNCONSOLIDATED UNIT GROUND WATER RECOVERY WELL

GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK
REMEDIAL INVESTIGATION

SITE MAP

200 0 200
SCALE IN FEET

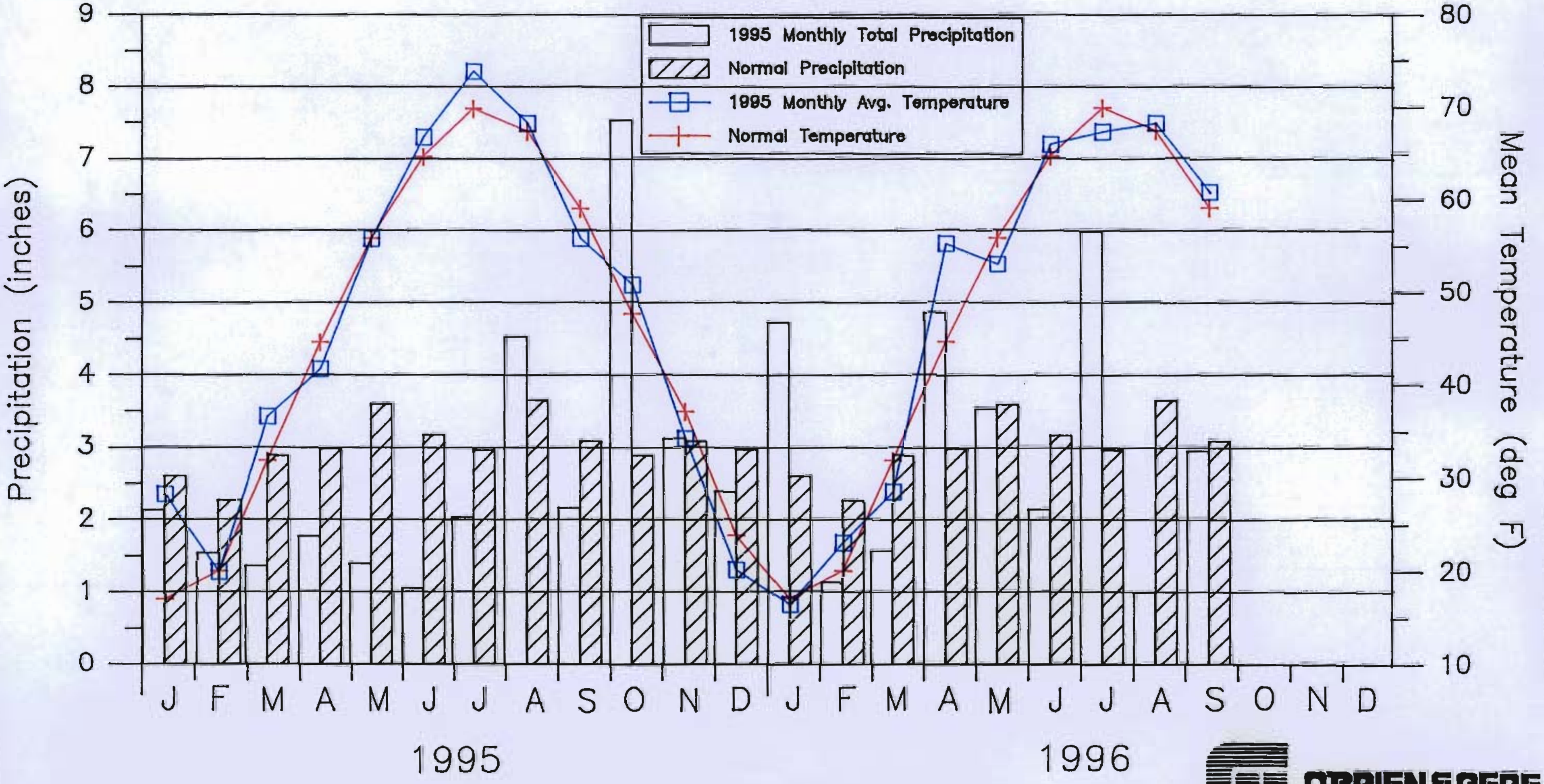
FILE NO. 5731.046-01F

OBRIEN & GERE
ENGINEERS, INC.

FIGURE 5-1

MONTHLY PRECIPITATION and TEMPERATURE
January 1, 1995 – September 31, 1996

General Electric Company
Fort Edward, New York

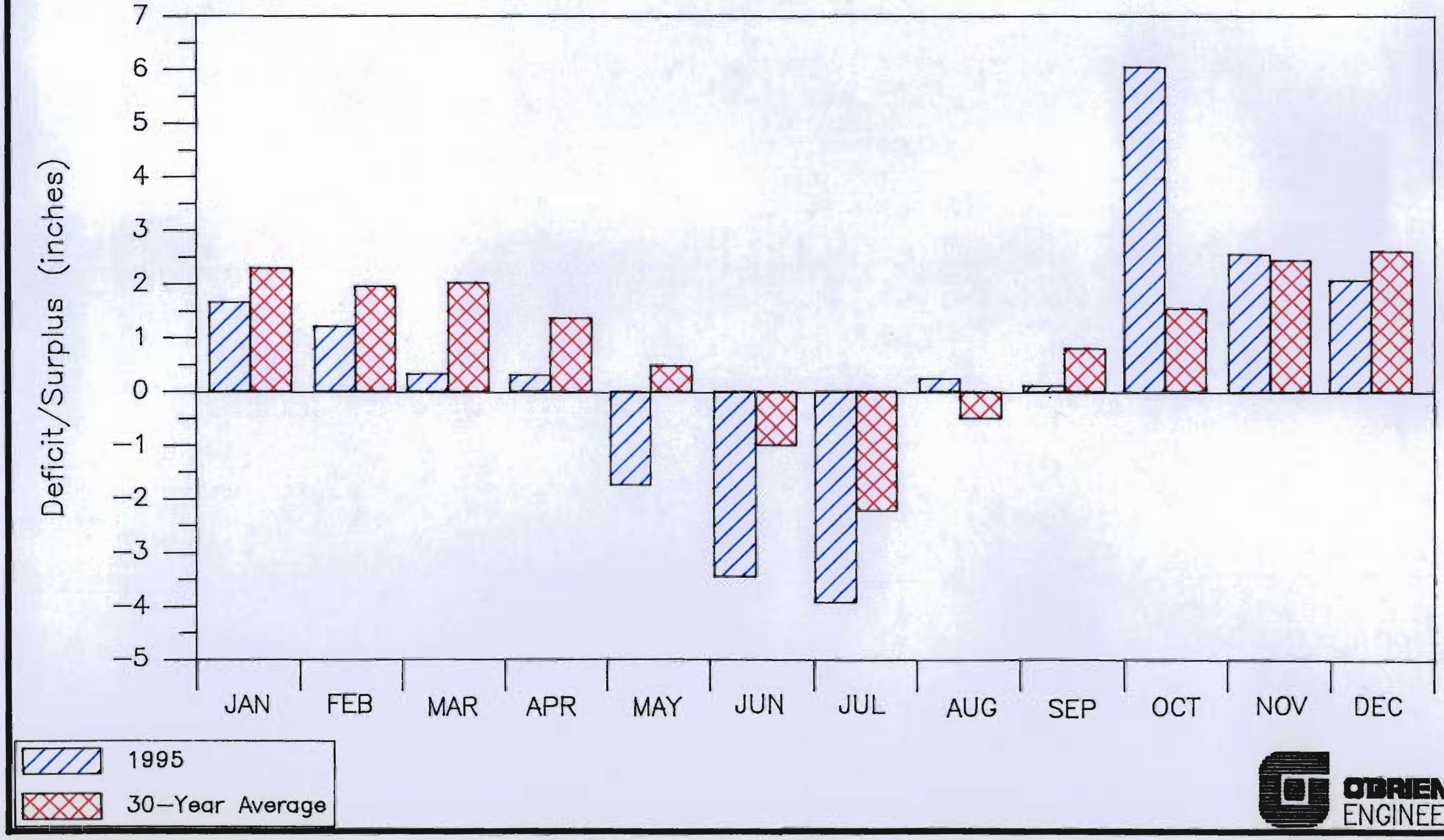


O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 5–2

PRECIPITATION LESS POTENTIAL EVAPOTRANSPIRATION
January 1 – December 31, 1995

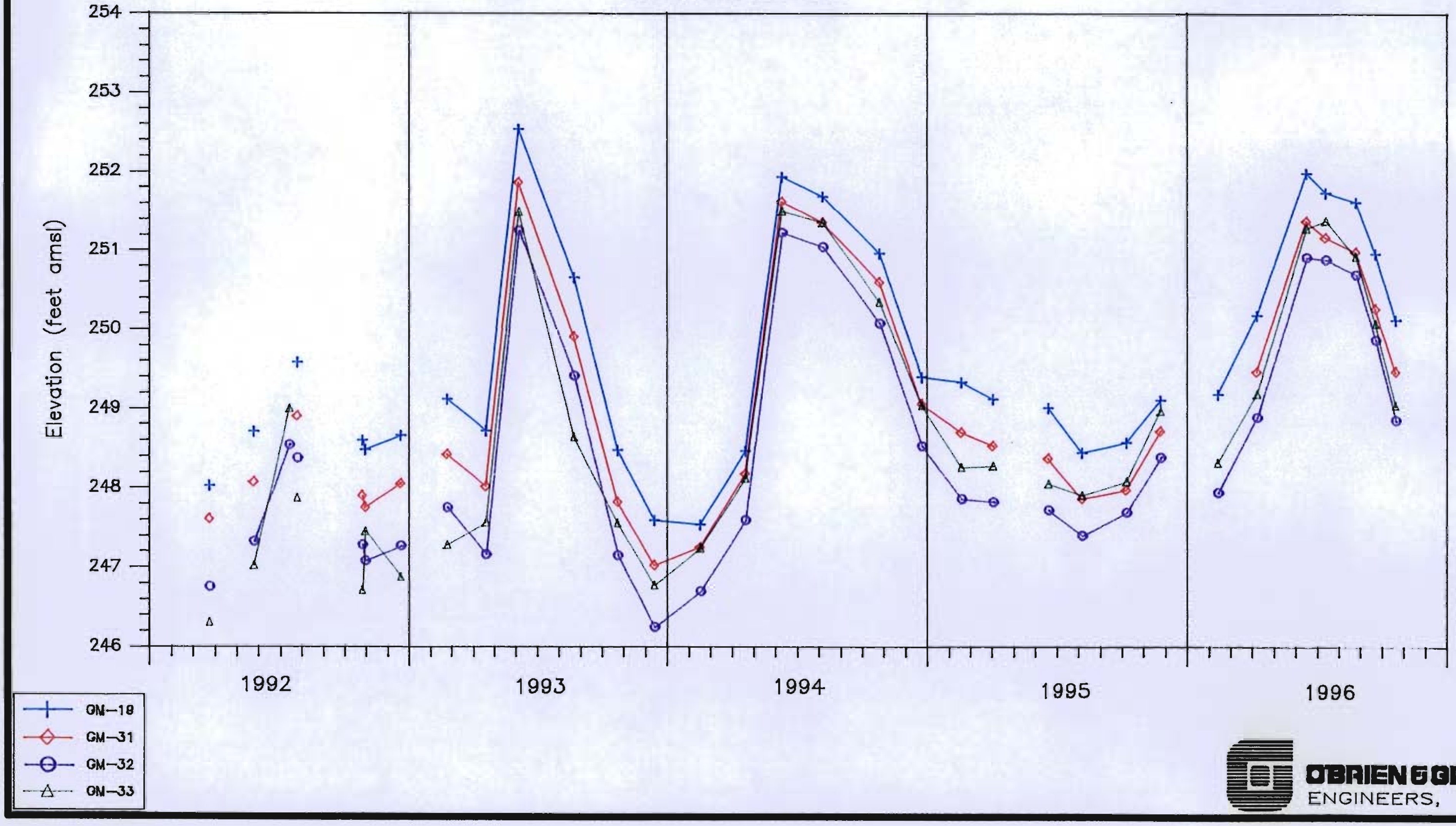
General Electric Facility
Fort Edward, New York



O'BRIEN & GERE ENGINEERS, INC.

FIGURE 5-12
WATER LEVEL ELEVATIONS AT MONITORING WELLS GM-19, GM-31, GM-32 AND GM-33

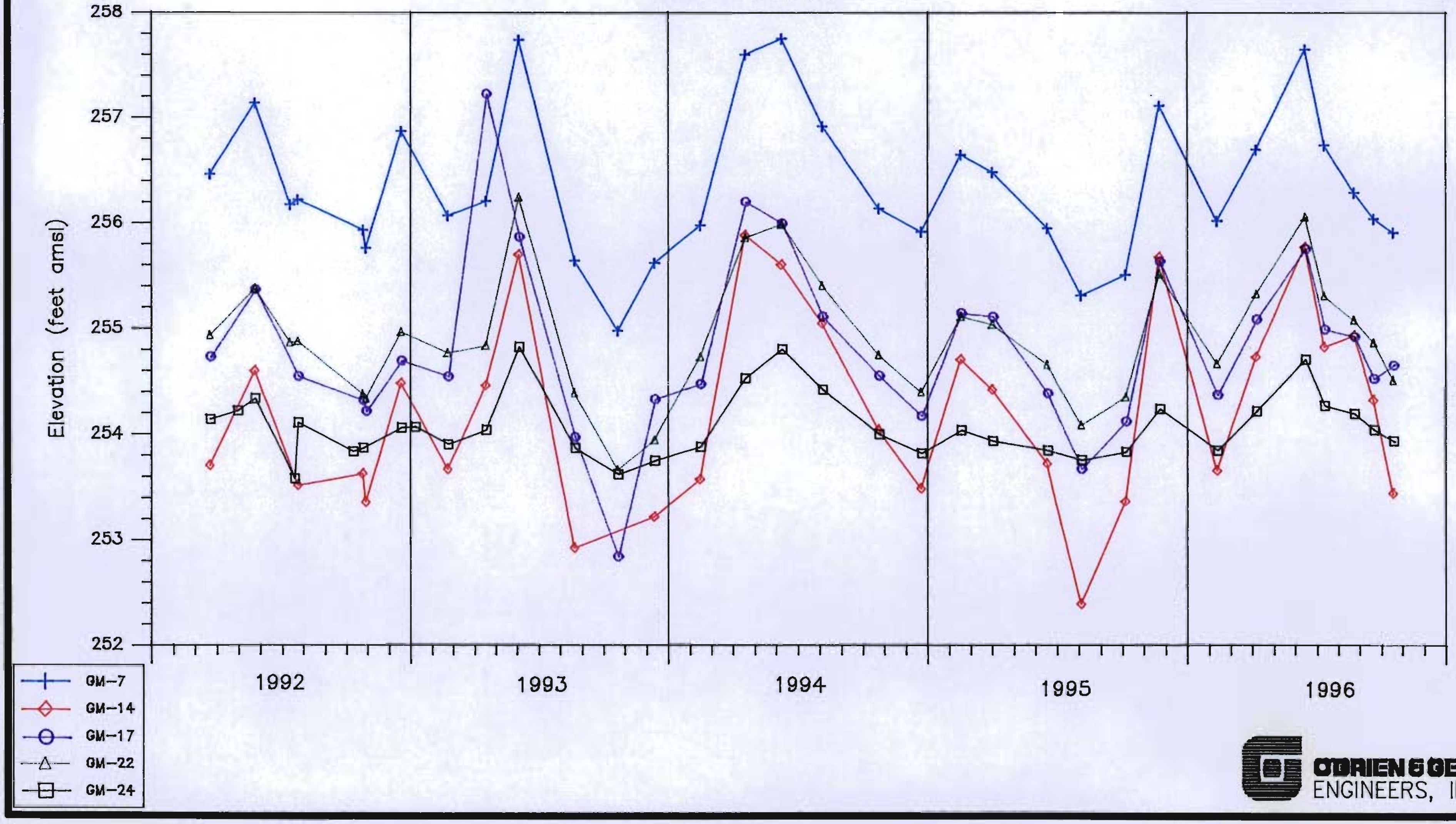
GE-Fort Edward Facility
Fort Edward, New York



O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 5–13
WATER LEVEL ELEVATIONS AT MONITORING WELLS GM–7, GM–14, GM–17, GM–22 AND GM–24

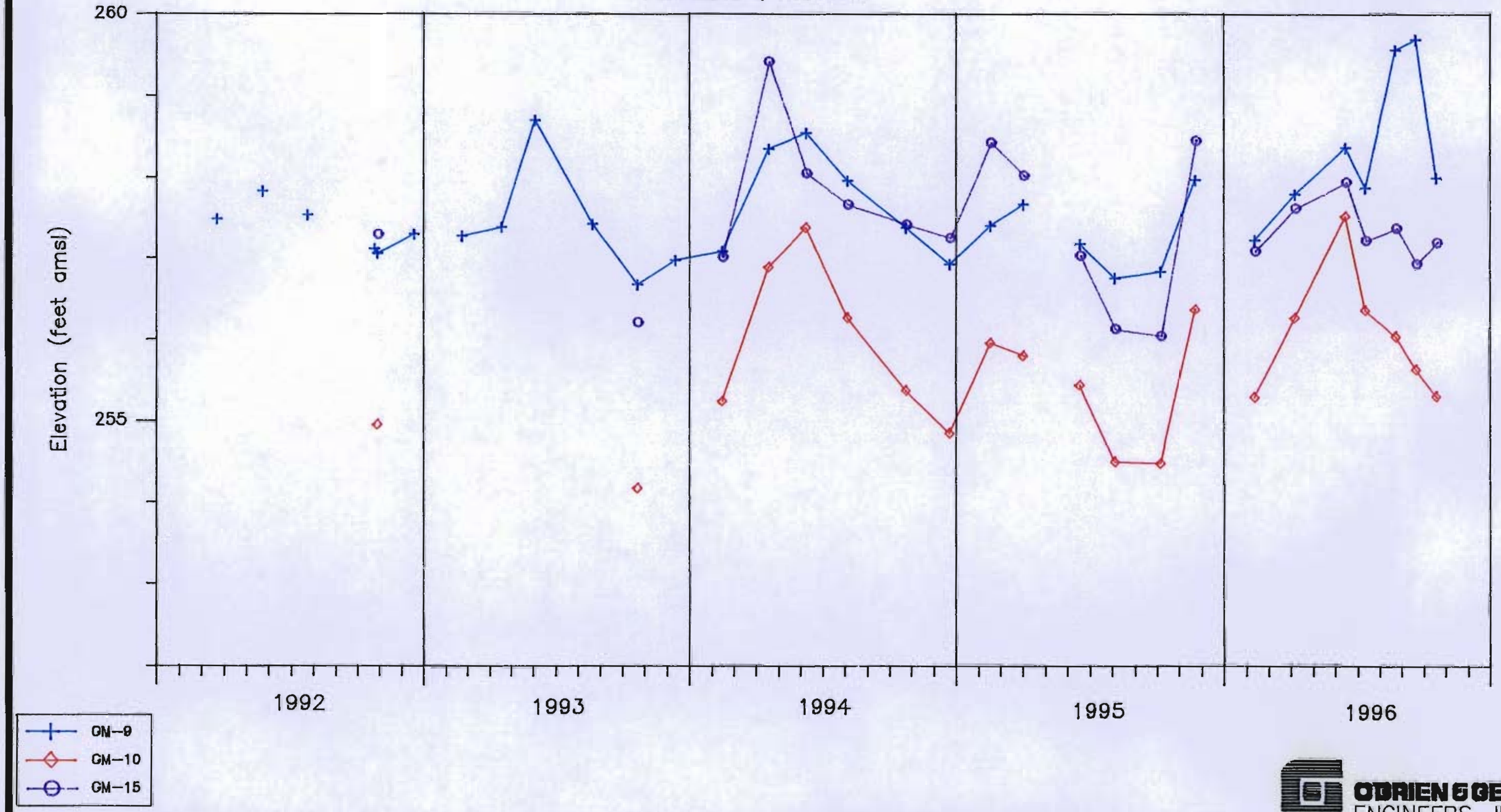
GE–Fort Edward Facility
Fort Edward, New York



O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 5-14
WATER LEVEL ELEVATIONS AT MONITORING WELLS GM-9, GM-10 AND GM-15

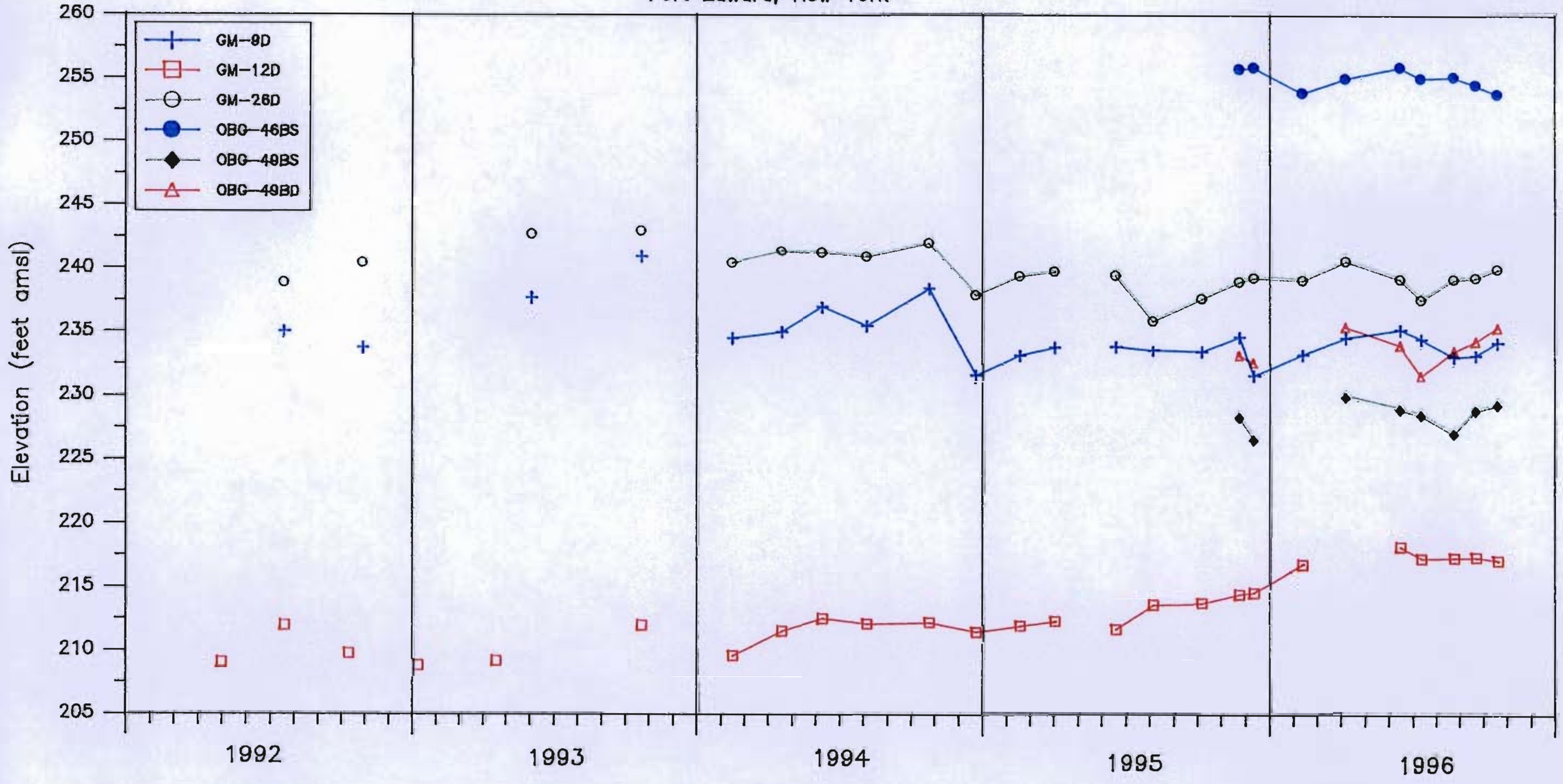
GE-Fort Edward Facility
Fort Edward, New York



O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 5–15
WATER LEVEL ELEVATIONS IN BEDROCK MONITORING WELLS
GM–9D, GM–12D, GM–26D, OBG–46BS, OBG–49BD AND OBG–49BS

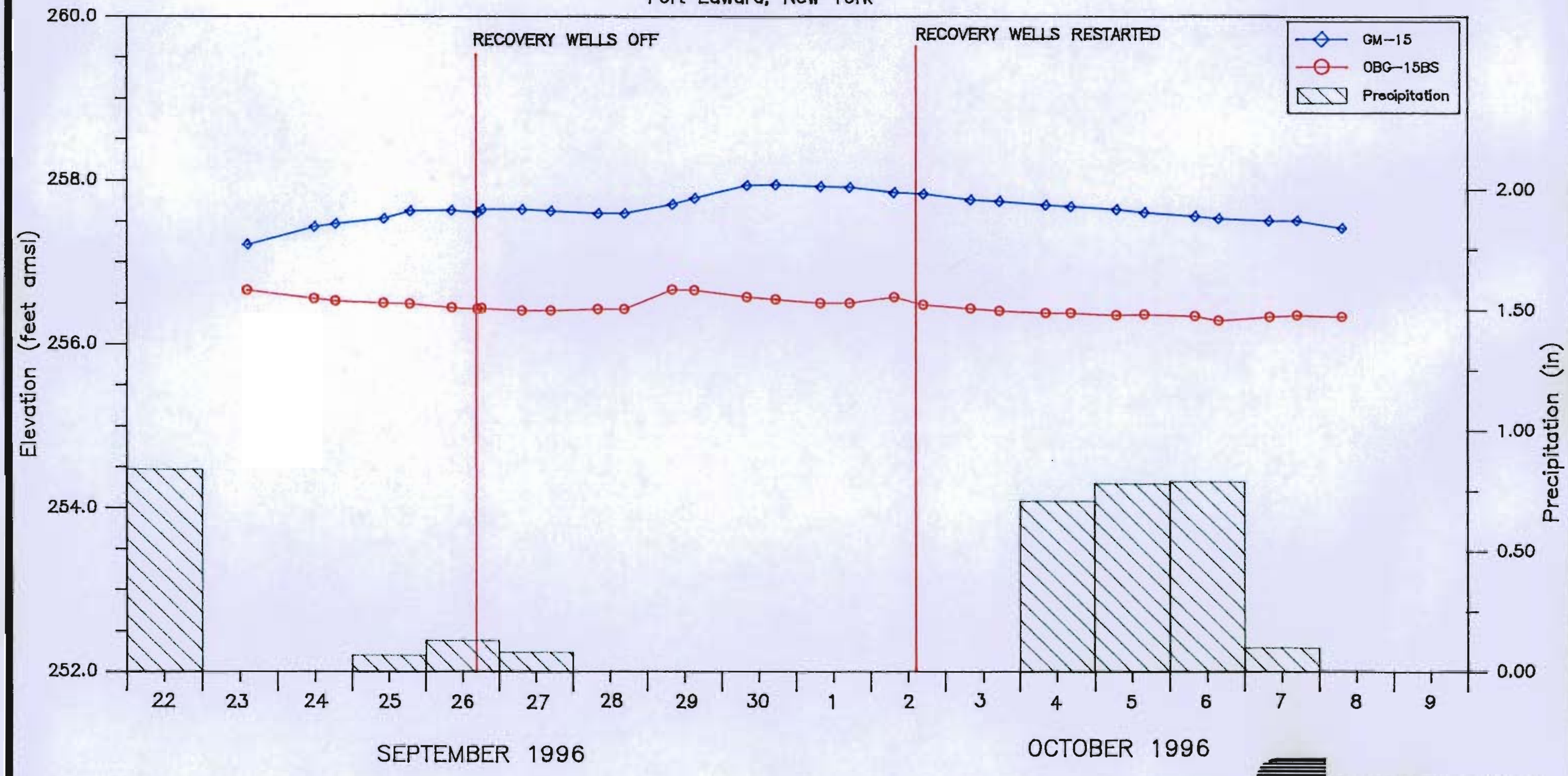
GE–Fort Edward Facility
Fort Edward, New York



O'BRIEN & GERE ENGINEERS, INC.

FIGURE 5-16
WATER LEVEL ELEVATIONS AT MONITORING WELLS OBG-15, OBG-15BS, AND PRECIPITATION DATA

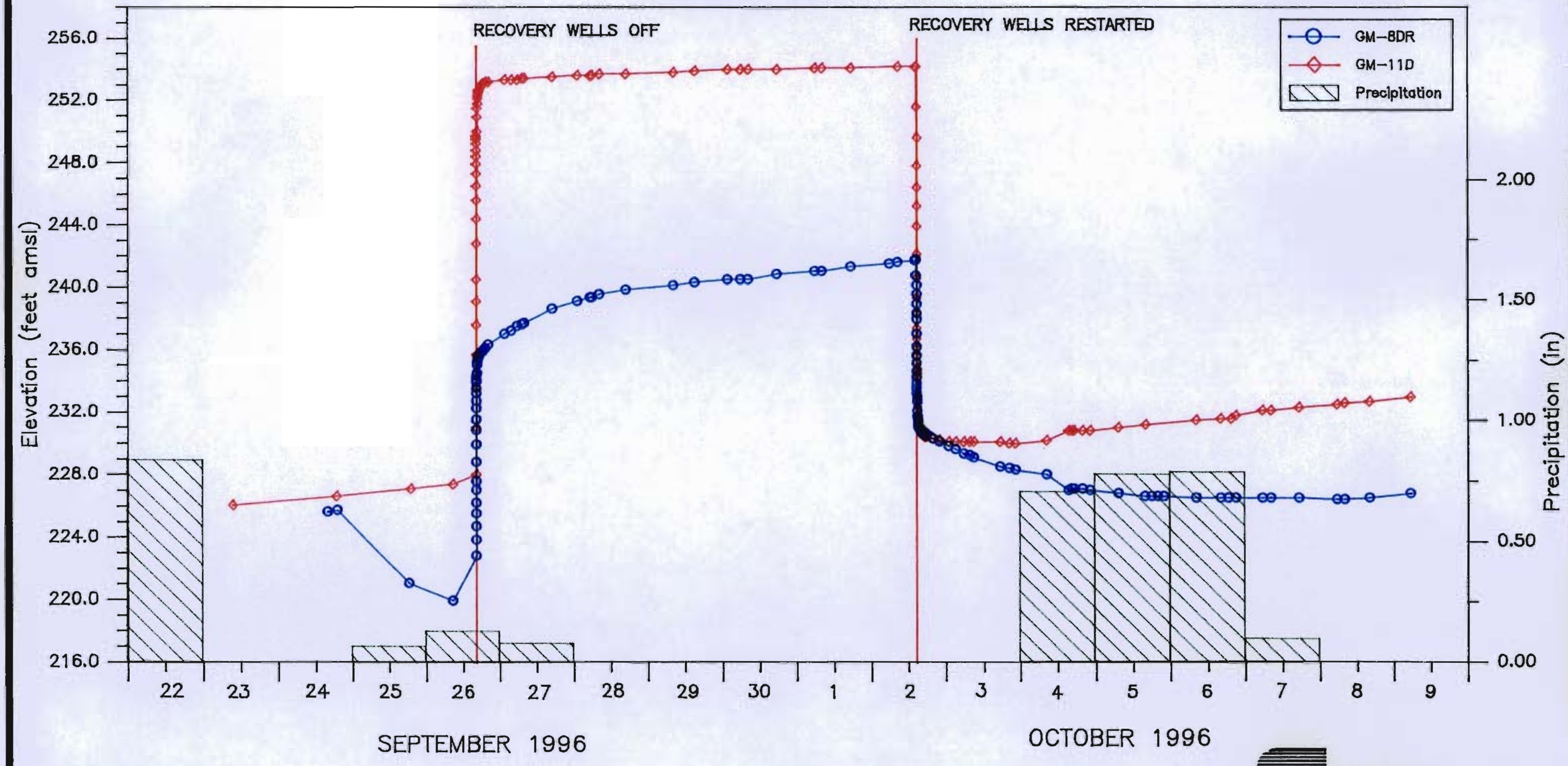
GE Fort Edward Facility
Fort Edward, New York



OBRIEN & GERE
ENGINEERS, INC.

FIGURE 5–17
WATER LEVEL ELEVATIONS IN BEDROCK RECOVERY WELLS GM–8DR AND GM–11D AND PRECIPITATION DATA

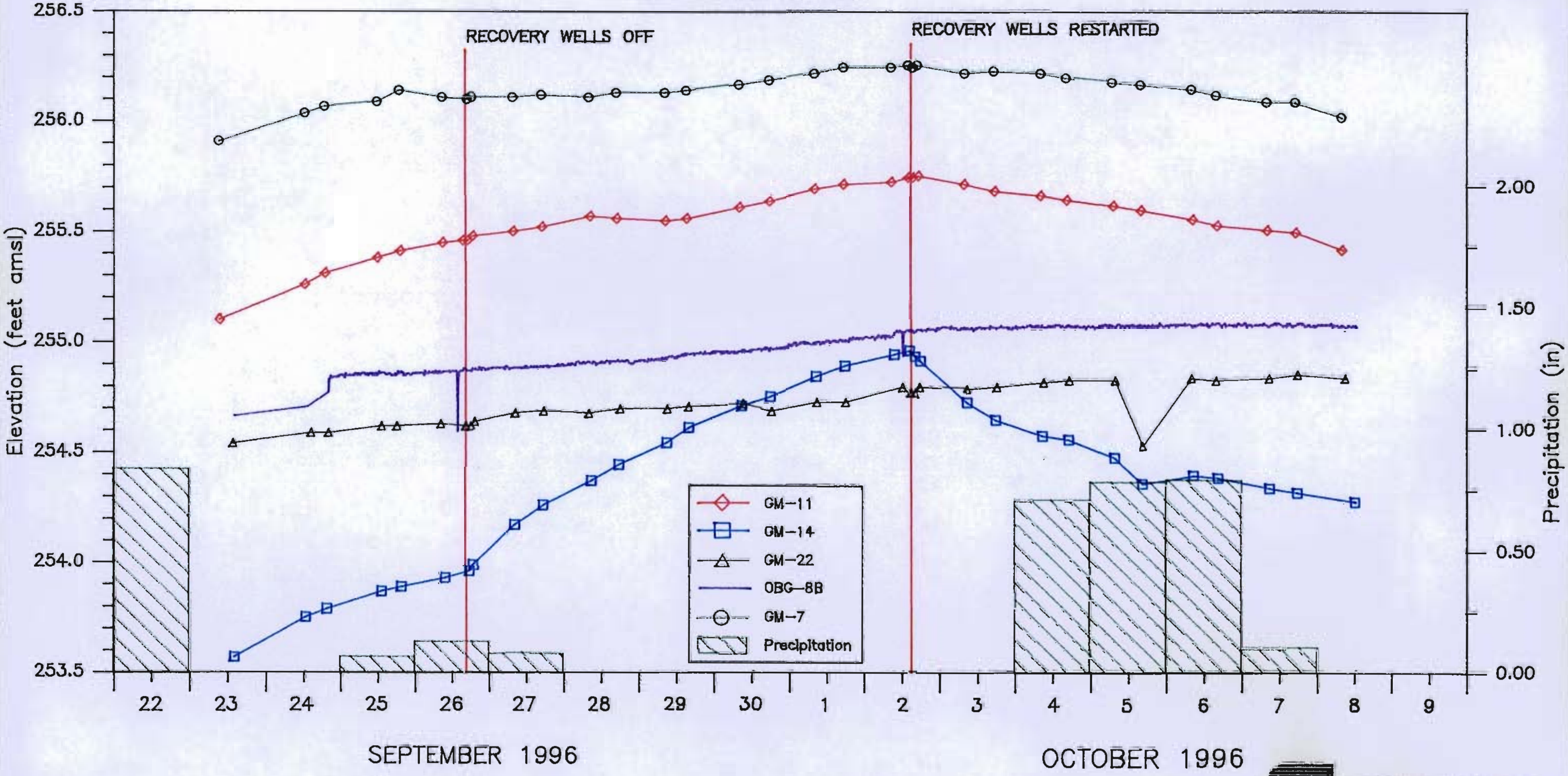
GE Fort Edward Facility
Fort Edward, New York



O'BRIEN & GERE ENGINEERS, INC.

FIGURE 5-18
WATER LEVEL ELEVATIONS IN MONITORING WELLS GM-7,
OBG-8B, GM-11, GM-14 AND GM-22, AND PRECIPITATION DATA

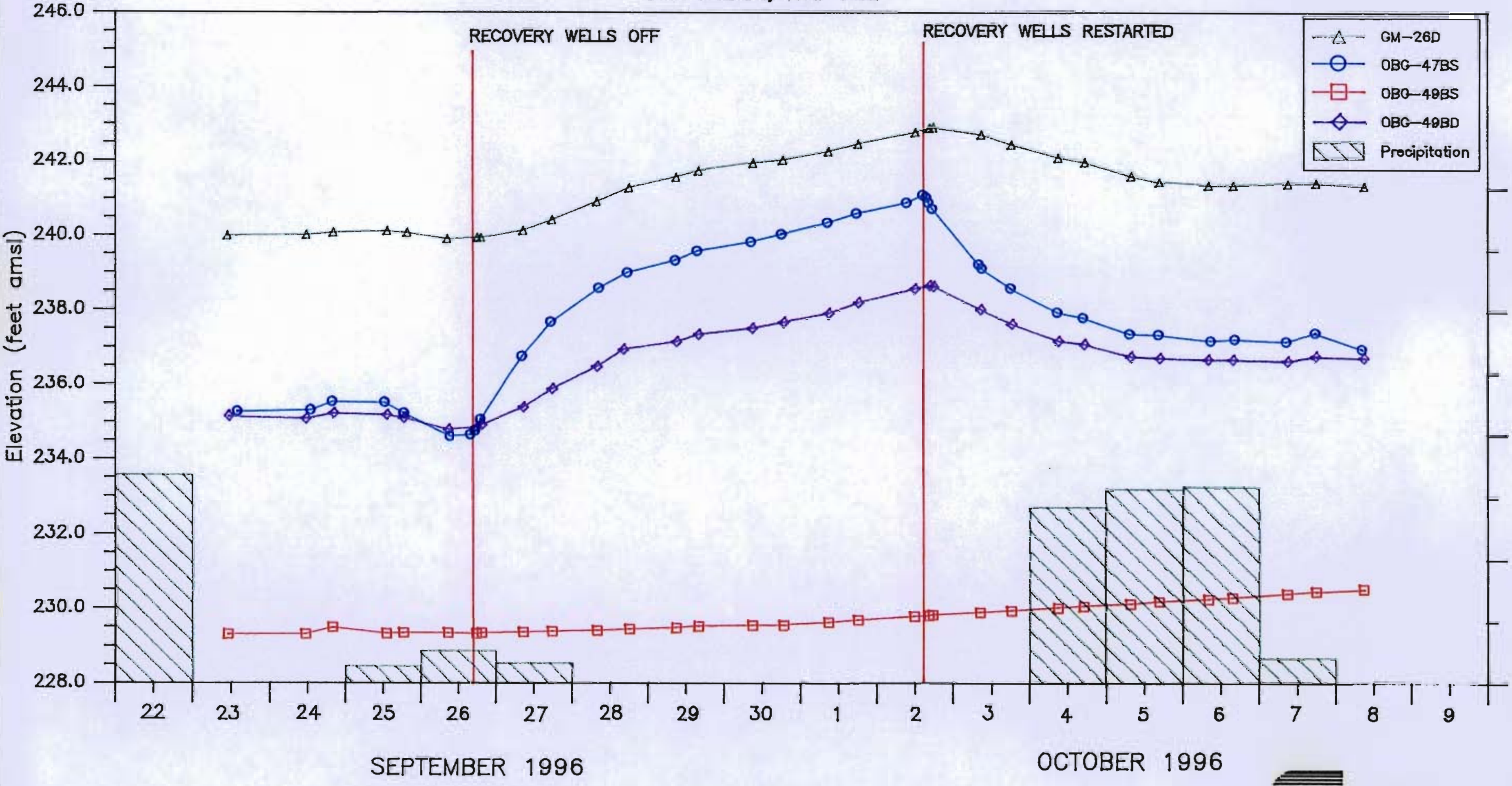
GE Fort Edward Facility
Fort Edward, New York



O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 5–19
WATER LEVEL ELEVATIONS IN BEDROCK MONITORING WELLS GM–26D, OBG–47BS, OBG–49BS, OBG–49BD, AND PRECIPITATION DATA

GE Fort Edward Facility
Fort Edward, New York

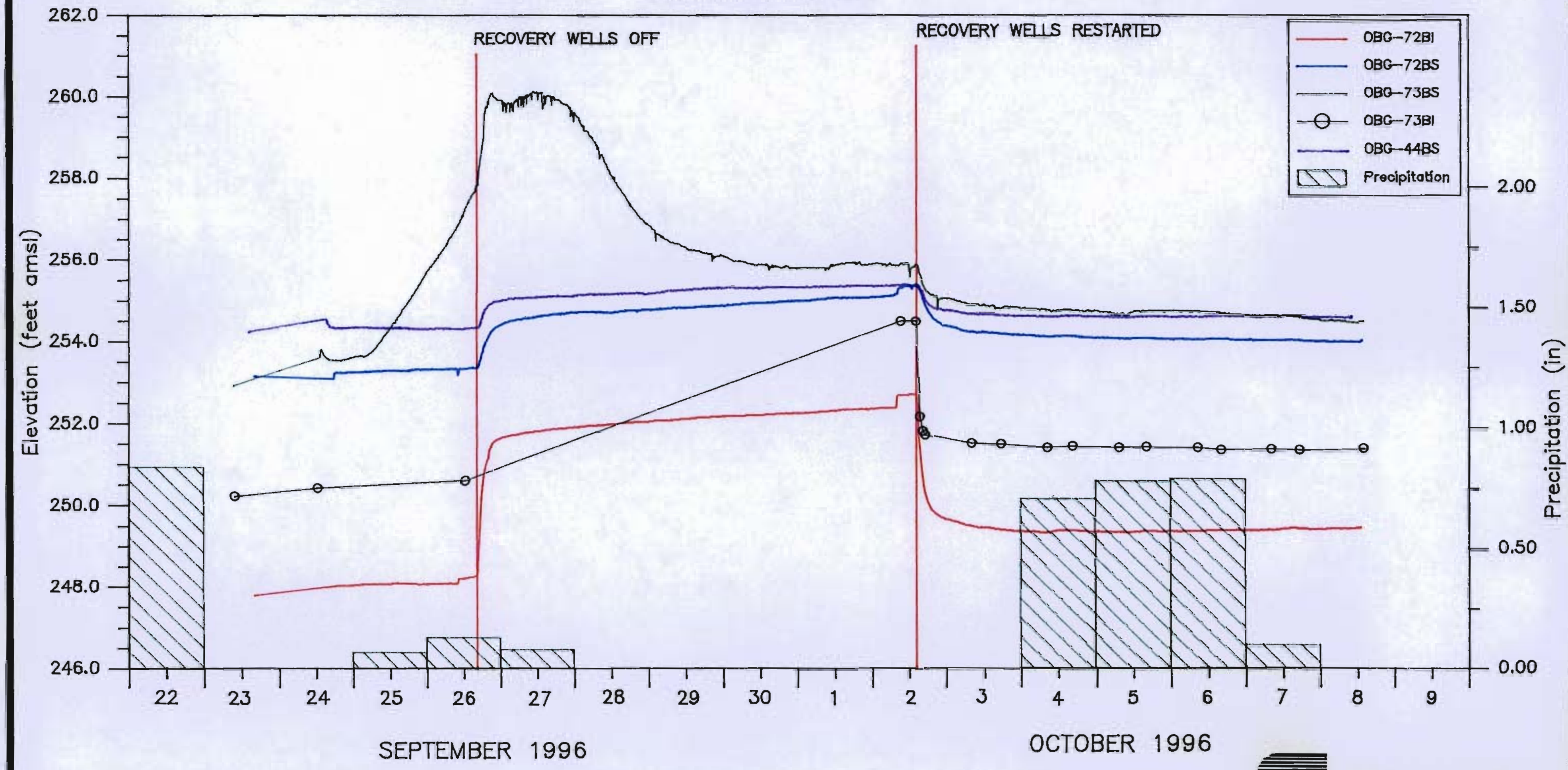


O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 5-20

WATER LEVEL ELEVATIONS IN BEDROCK MONITORING WELLS OBG-44BS, OBG-72BS, OBG-72BI, OBG-73BS AND OBG-73BI, AND PRECIPITATION DATA

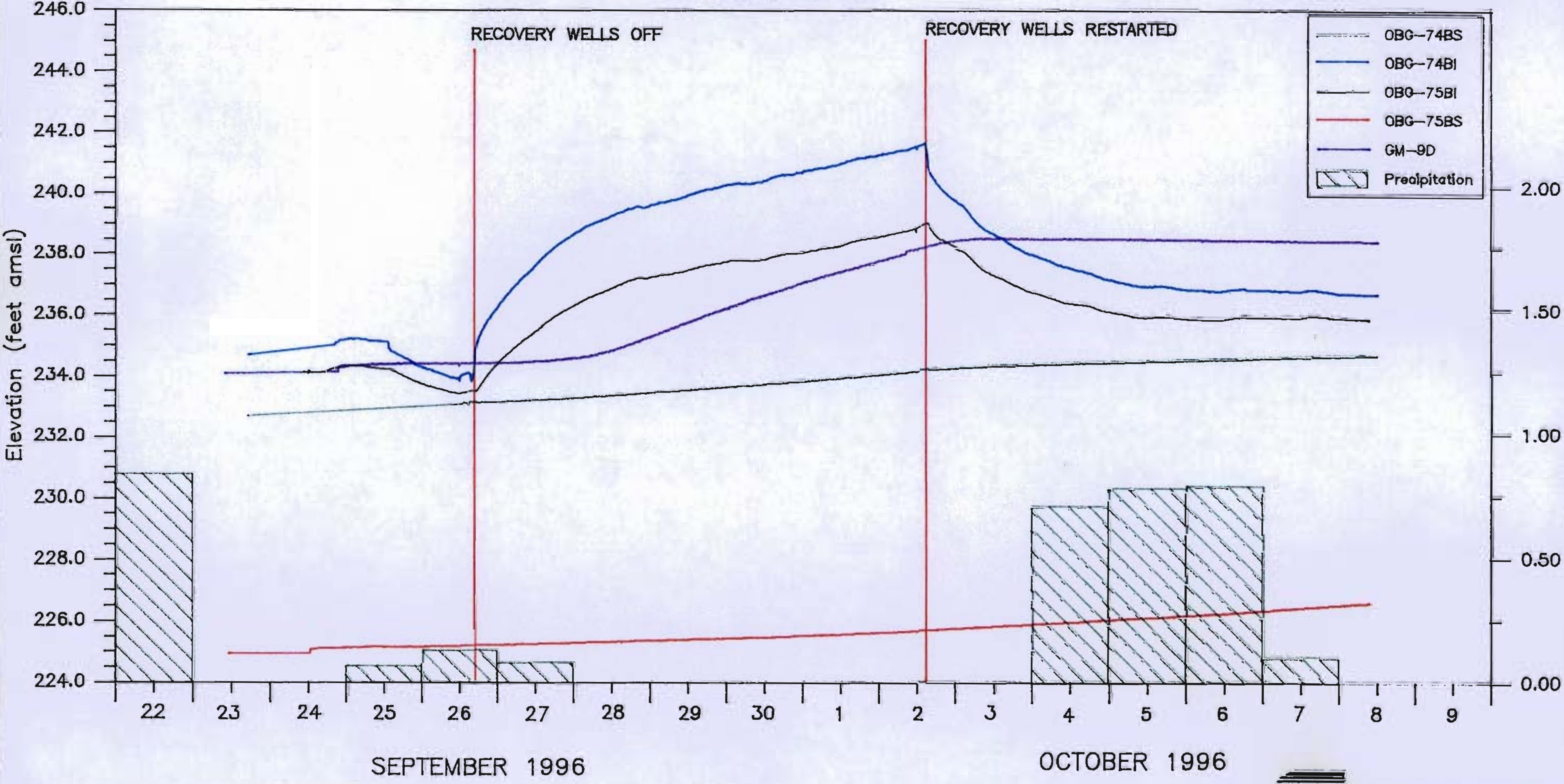
GE Fort Edward Facility
Fort Edward, New York



O'BRIEN & GERE
ENGINEERS, INC.

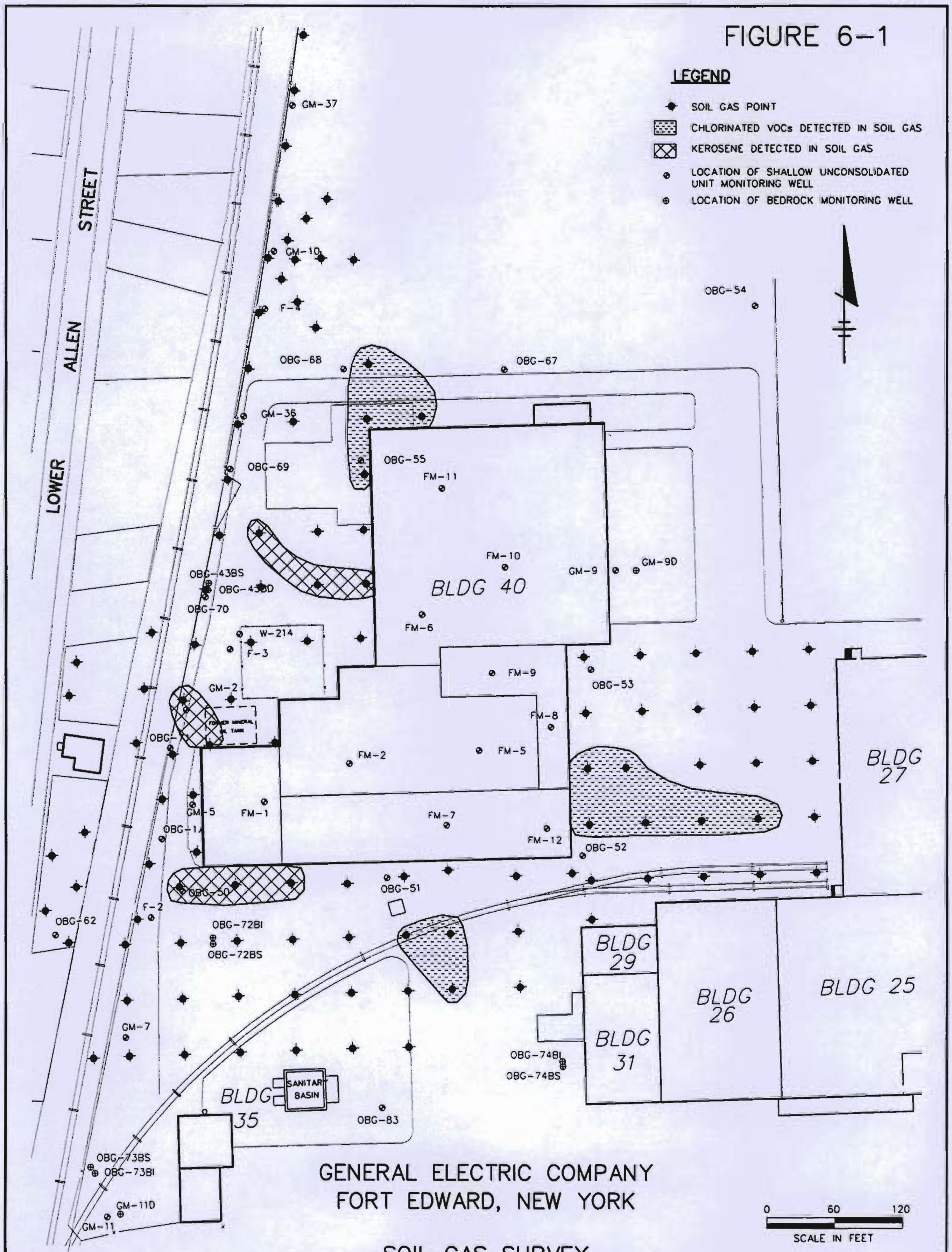
FIGURE 5-21
WATER LEVEL ELEVATIONS IN BEDROCK MONITORING WELLS GM-9D, OBG-74BS, OBG-74BI, OBG-75BS AND OBG-75BI, AND PRECIPITATION DATA

GE Fort Edward Facility
Fort Edward, New York



O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 6-1



GENERAL ELECTRIC COMPANY
FORT EDWARD, NEW YORK

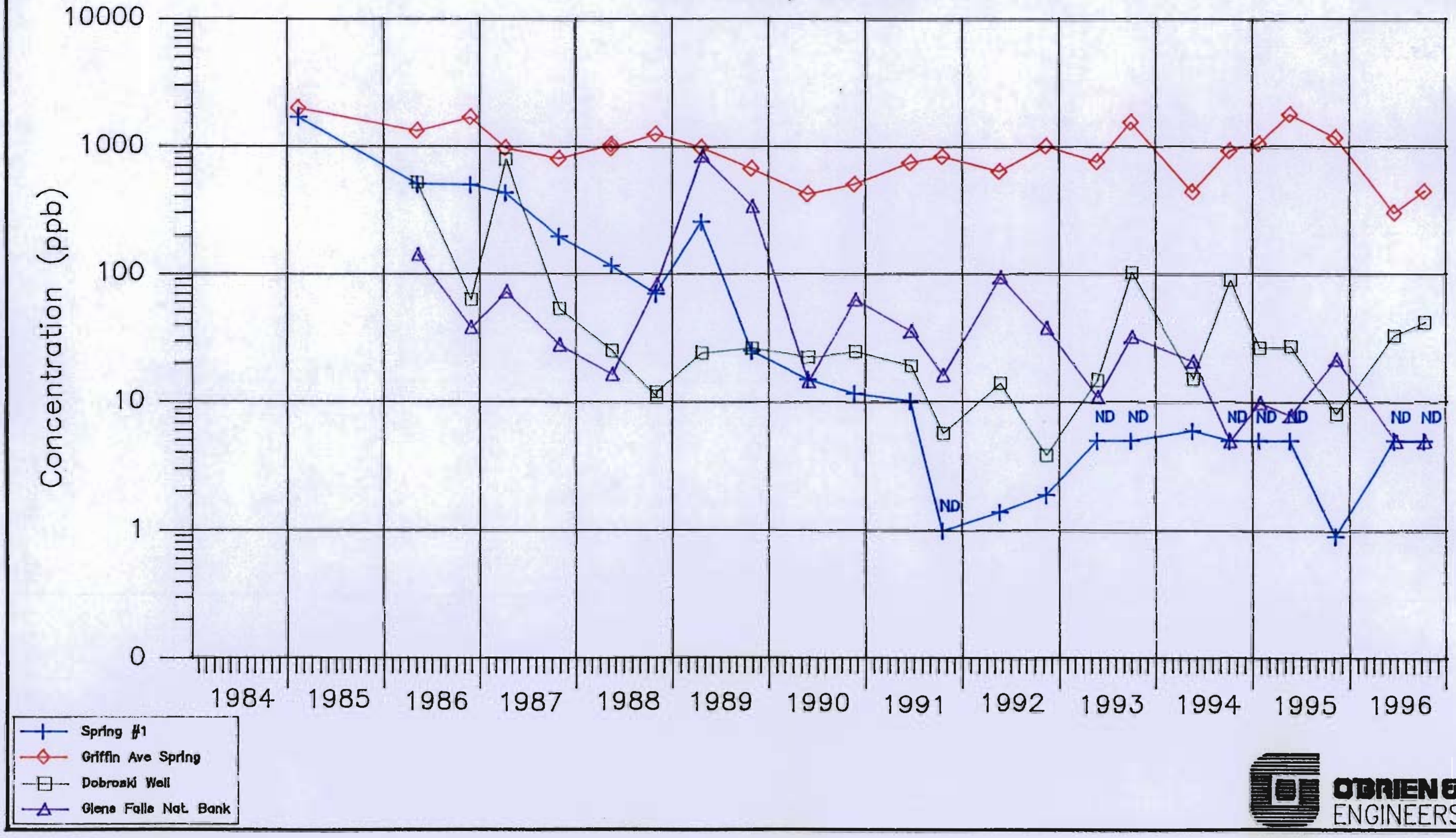
SOIL GAS SURVEY
DETECTED KEROSENE AND
CHLORINATED VOCS

O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 6–6

TOTAL VOLATILE ORGANIC COMPOUND CONCENTRATIONS IN OFF–SITE WELLS AND SPRINGS

General Electric Company
Fort Edward, New York

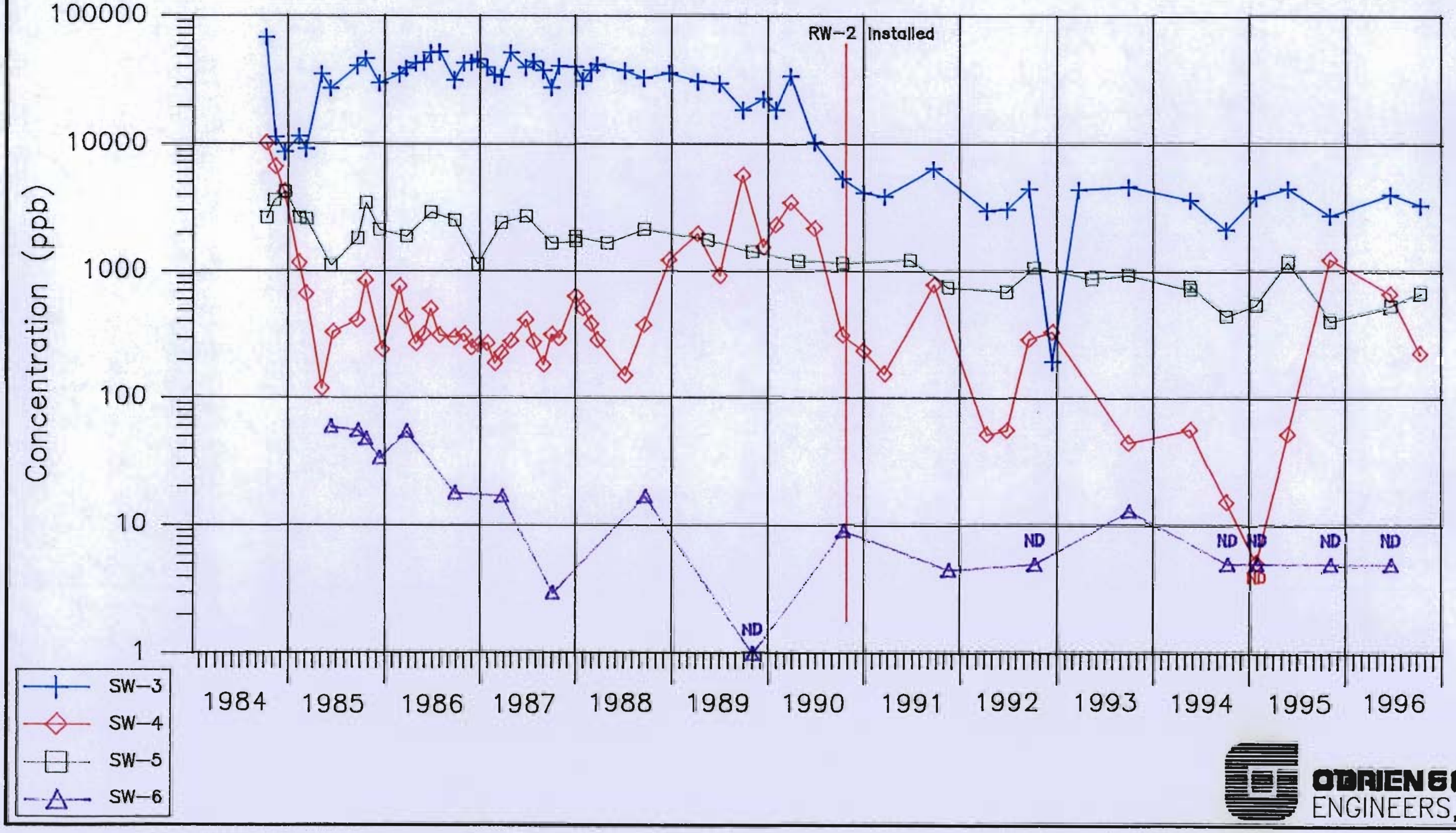


O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 6-7

TOTAL VOLATILE ORGANIC COMPOUND CONCENTRATIONS IN STATE WELLS SW-3, SW-4, SW-5 AND SW-6

General Electric Company
Fort Edward, New York

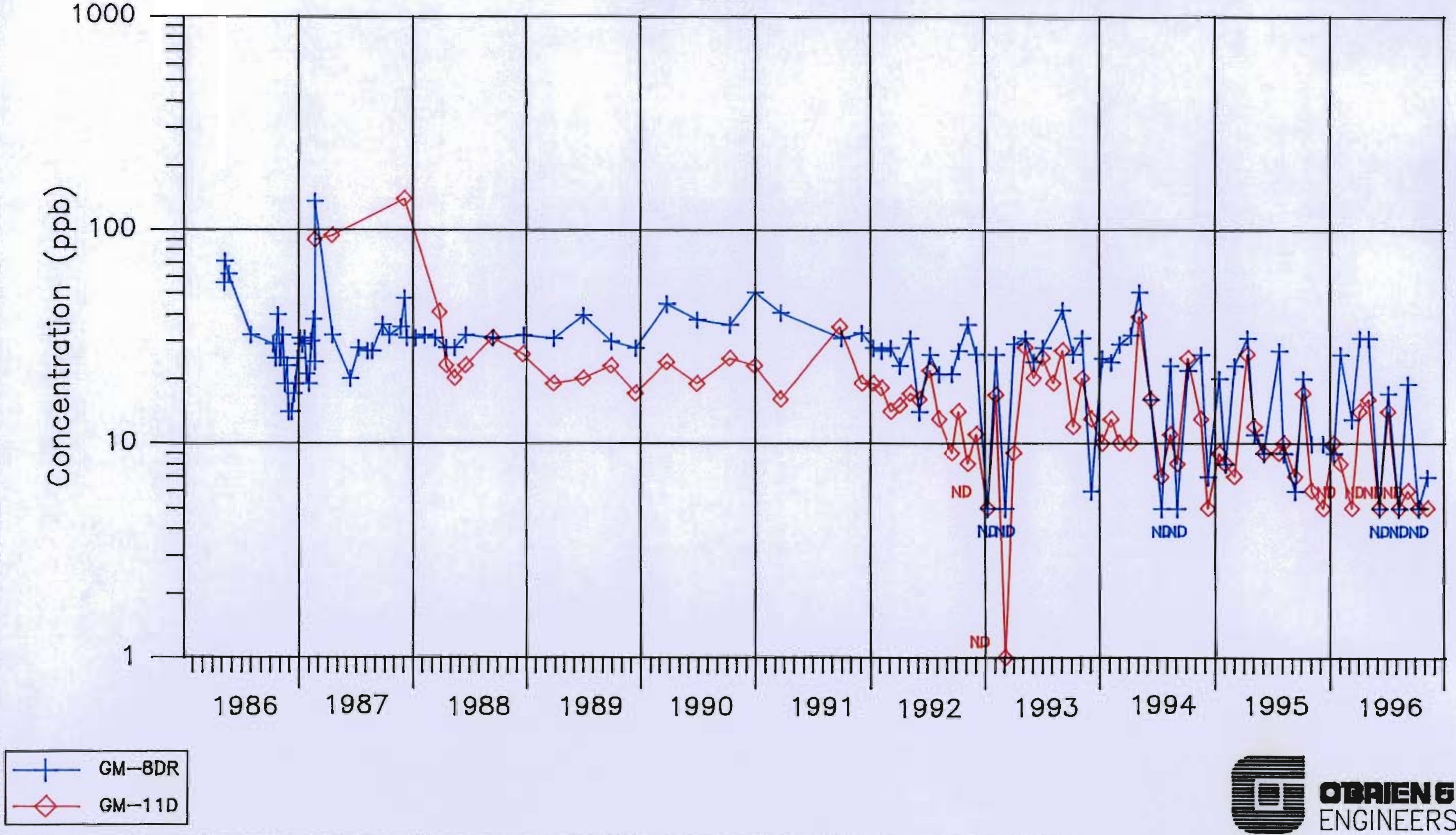


O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 6–8

TOTAL VOLATILE ORGANIC COMPOUND CONCENTRATIONS IN BEDROCK RECOVERY WELLS GM–8DR AND GM–11D

General Electric Company
Fort Edward, New York

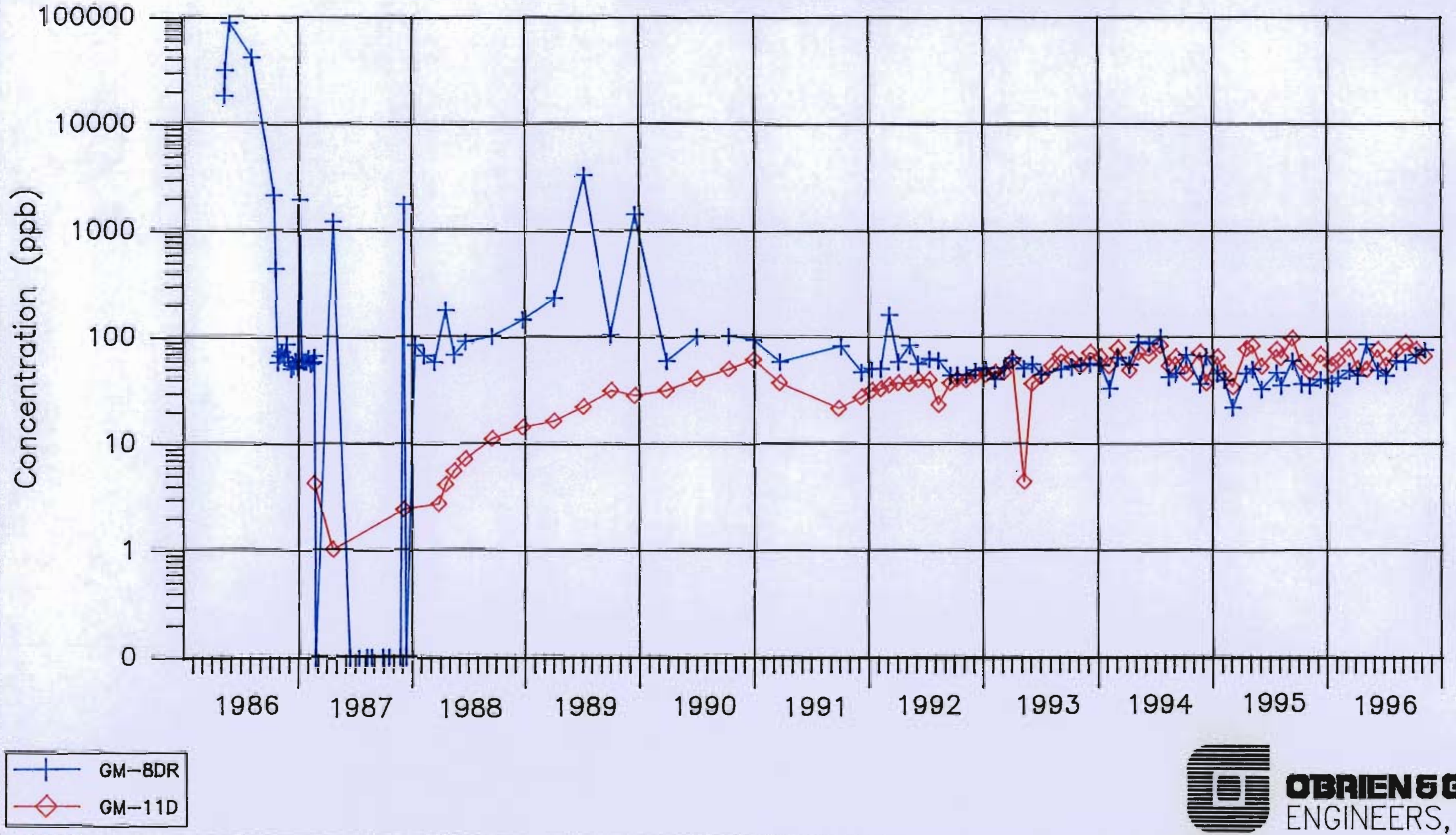


O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 6–9

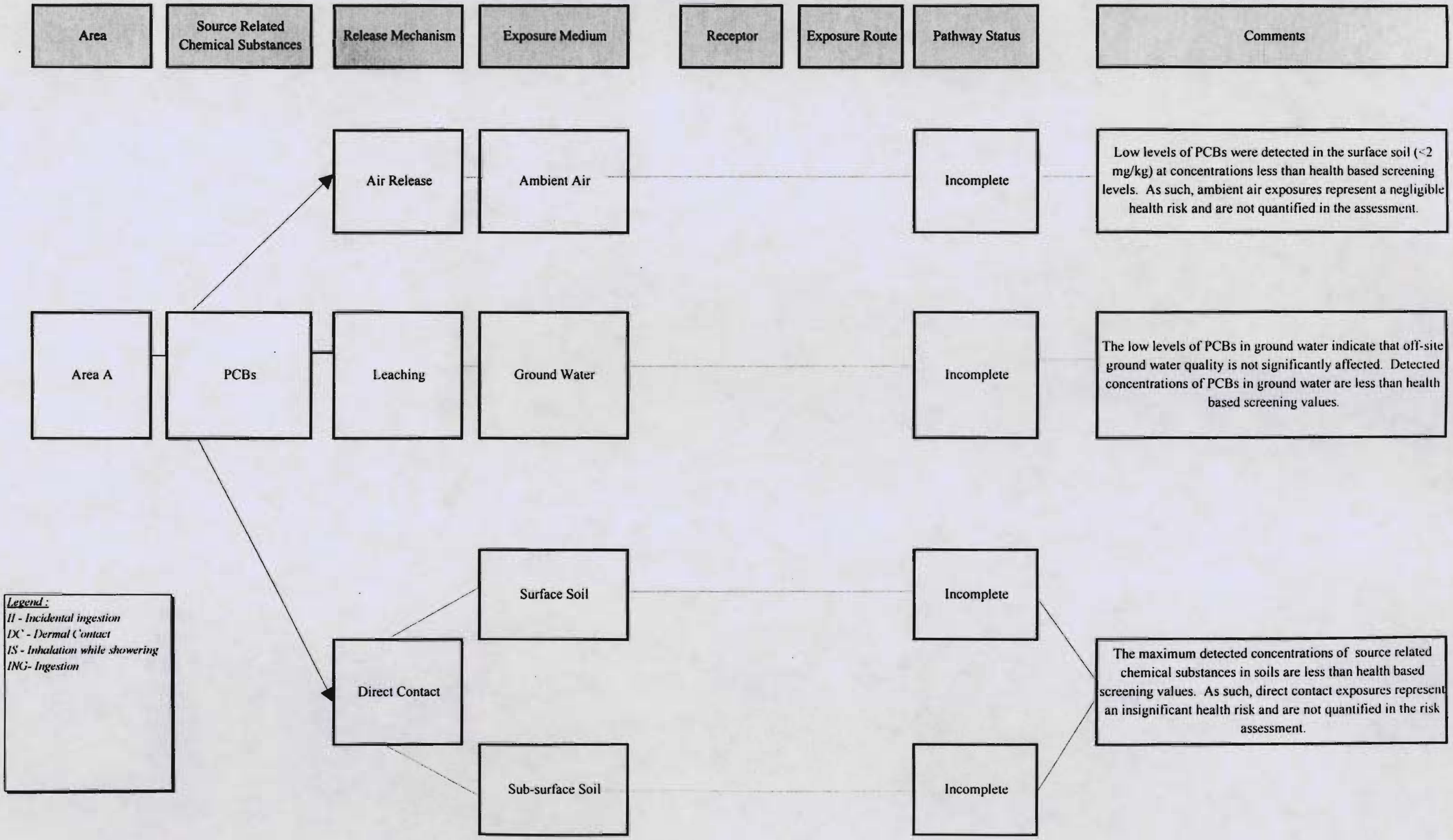
POLYCHLORINATED BIPHENYL CONCENTRATIONS IN BEDROCK RECOVERY WELLS GM–8DR AND GM–11D

General Electric Company
Fort Edward, New York



O'BRIEN & GERE ENGINEERS, INC.

Figure 7-1
General Electric Company
Fort Edward, New York
Exposure Pathway Analysis for Area A



Low levels of PCBs were detected in the surface soil (<2 mg/kg) at concentrations less than health based screening levels. As such, ambient air exposures represent a negligible health risk and are not quantified in the assessment.

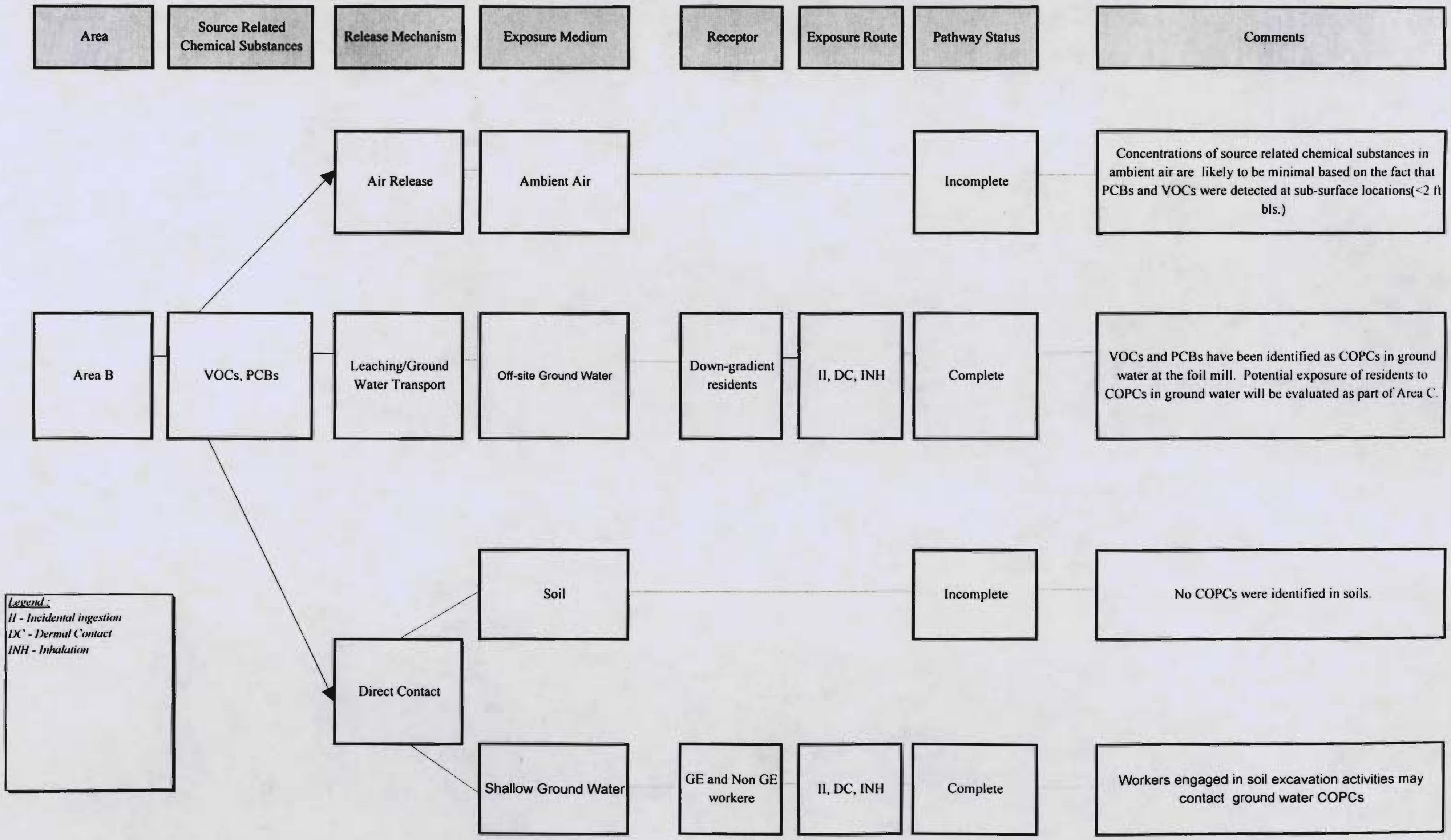
The low levels of PCBs in ground water indicate that off-site ground water quality is not significantly affected. Detected concentrations of PCBs in ground water are less than health based screening values.

The maximum detected concentrations of source related chemical substances in soils are less than health based screening values. As such, direct contact exposures represent an insignificant health risk and are not quantified in the risk assessment.

Legend :
II - Incidental ingestion
DC - Dermal Contact
IS - Inhalation while showering
ING- Ingestion

O'Brien & Gere Engineers, Inc. Confidential

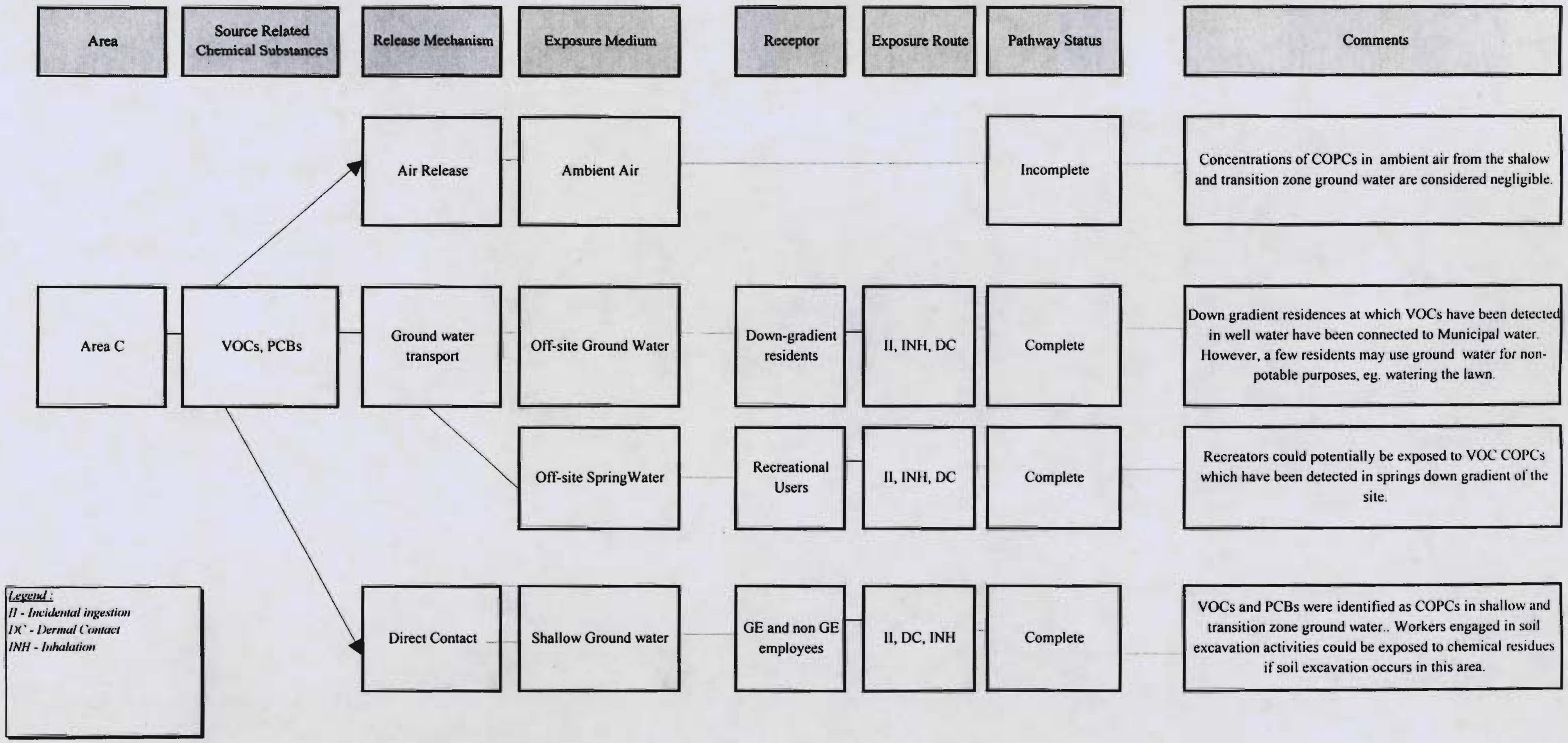
Figure 7-2
General Electric Company
Fort Edward, New York
Exposure Pathway Analysis for Area B



Area	Source Related Chemical Substances	Release Mechanism	Exposure Medium	Receptor	Exposure Route	Pathway Status	Comments
Area B	VOCs, PCBs	Air Release	Ambient Air			Incomplete	Concentrations of source related chemical substances in ambient air are likely to be minimal based on the fact that PCBs and VOCs were detected at sub-surface locations(<2 ft bls.)
		Leaching/Ground Water Transport	Off-site Ground Water	Down-gradient residents	II, DC, INH	Complete	VOCs and PCBs have been identified as COPCs in ground water at the foil mill. Potential exposure of residents to COPCs in ground water will be evaluated as part of Area C.
		Direct Contact	Soil			Incomplete	No COPCs were identified in soils.
			Shallow Ground Water	GE and Non GE workere	II, DC, INH	Complete	Workers engaged in soil excavation activities may contact ground water COPCs

Legend :
II - Incidental ingestion
DC - Dermal Contact
INH - Inhalation

Figure 7-3
General Electric Company
Fort Edward, New York
Exposure Pathway Analysis for Area C



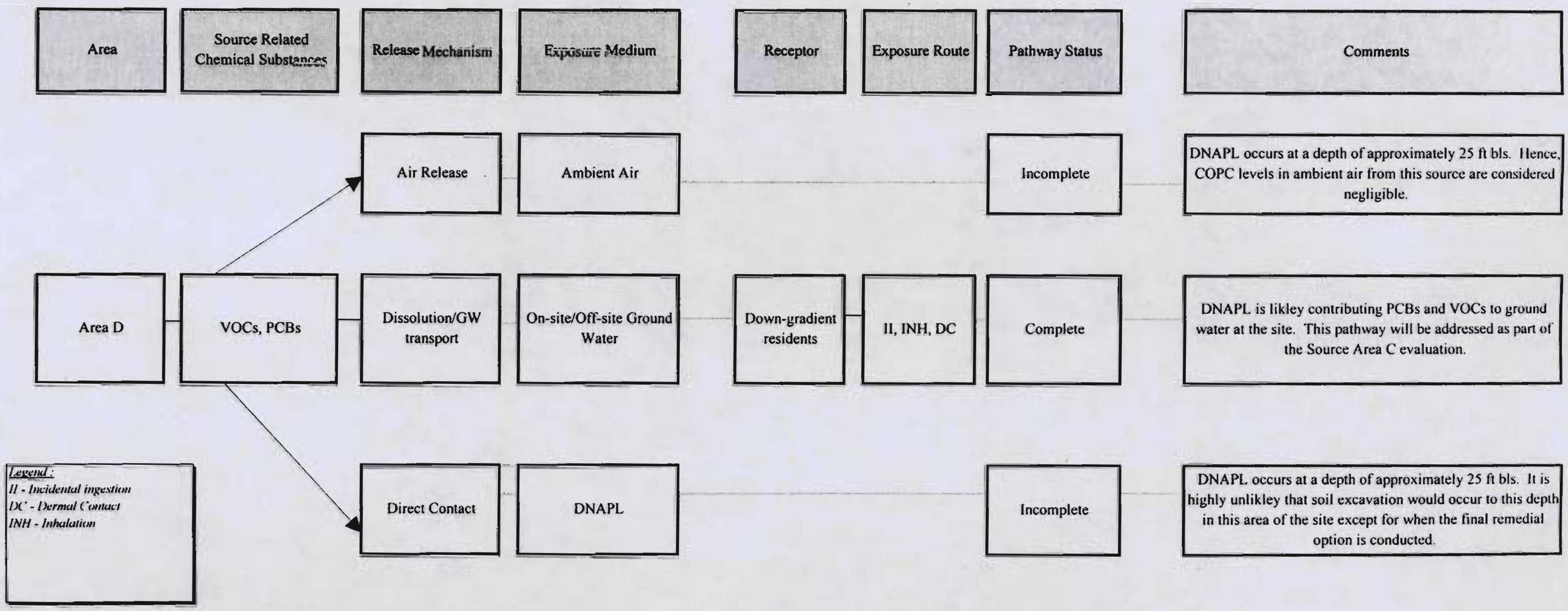
Concentrations of COPCs in ambient air from the shalow and transition zone ground water are considered negligible.

Down gradient residences at which VOCs have been detected in well water have been connected to Municipal water. However, a few residents may use ground water for non-potable purposes, eg. watering the lawn.

Recreators could potentially be exposed to VOC COPCs which have been detected in springs down gradient of the site.

VOCs and PCBs were identified as COPCs in shallow and transition zone ground water.. Workers engaged in soil excavation activities could be exposed to chemical residues if soil excavation occurs in this area.

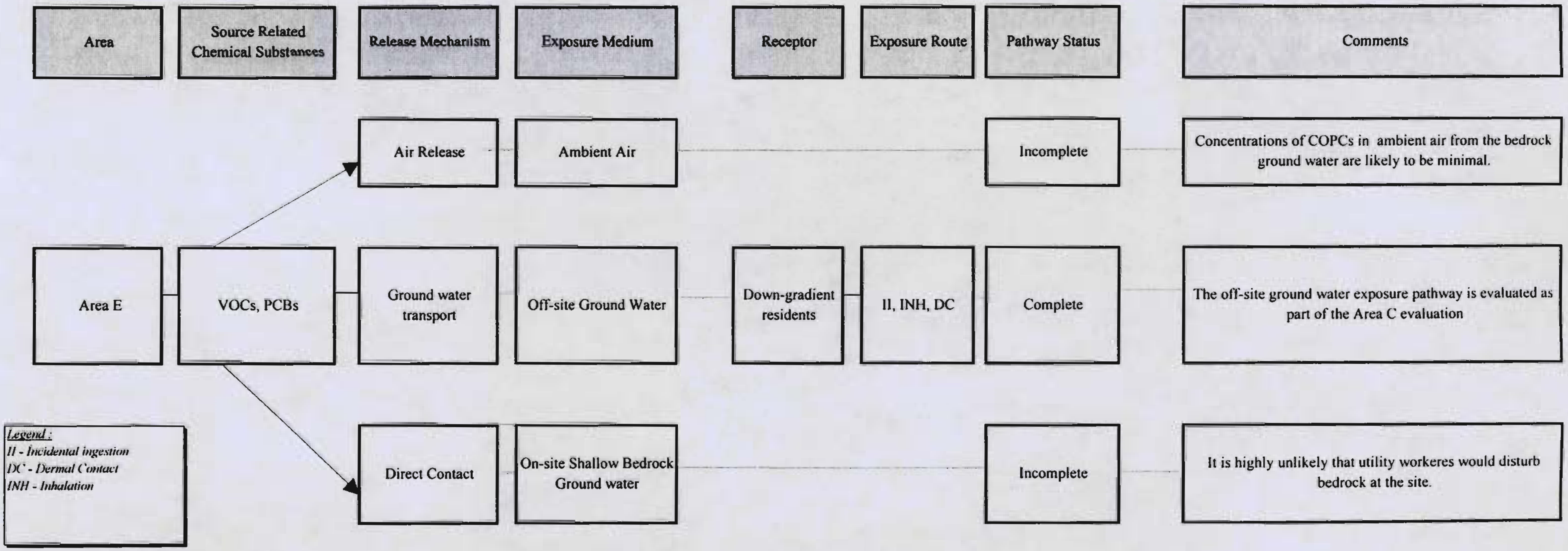
Figure 7-4
General Electric Company
Fort Edward, New York
Exposure Pathway Analysis for Area D



Area	Source Related Chemical Substances	Release Mechanism	Exposure Medium	Receptor	Exposure Route	Pathway Status	Comments
Area D	VOCs, PCBs	Air Release	Ambient Air			Incomplete	DNAPL occurs at a depth of approximately 25 ft bls. Hence, COPC levels in ambient air from this source are considered negligible.
		Dissolution/GW transport	On-site/Off-site Ground Water	Down-gradient residents	II, INH, DC	Complete	DNAPL is likley contributing PCBs and VOCs to ground water at the site. This pathway will be addressed as part of the Source Area C evaluation.
		Direct Contact	DNAPL			Incomplete	DNAPL occurs at a depth of approximately 25 ft bls. It is highly unlikley that soil excavation would occur to this depth in this area of the site except for when the final remedial option is conducted.

Legend :
II - Incidental ingestion
DC - Dermal Contact
INH - Inhalation

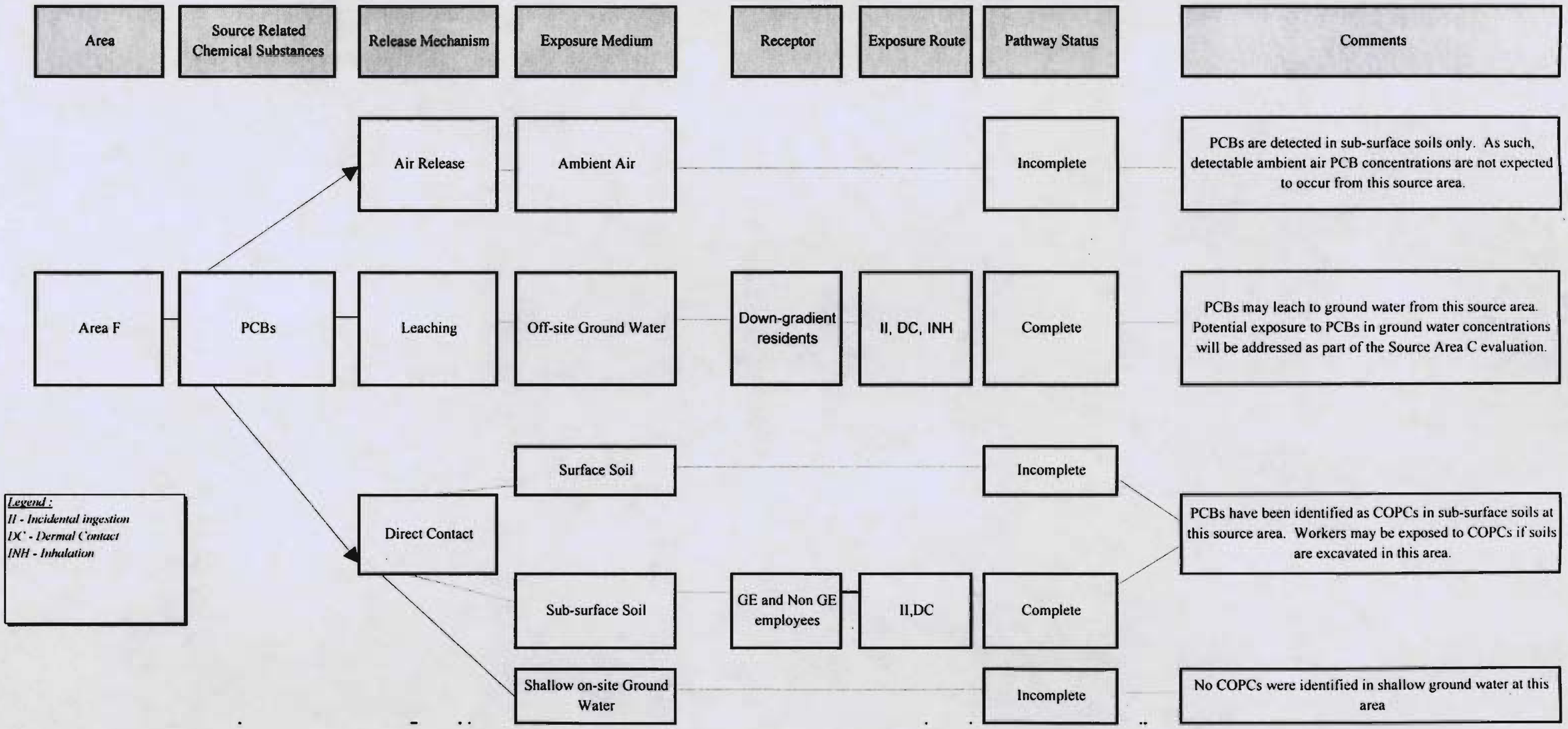
Figure 7-5
General Electric Company
Fort Edward, New York
Exposure Pathway Analysis for Area E



Area	Source Related Chemical Substances	Release Mechanism	Exposure Medium	Receptor	Exposure Route	Pathway Status	Comments
		Air Release	Ambient Air			Incomplete	Concentrations of COPCs in ambient air from the bedrock ground water are likely to be minimal.
Area E	VOCs, PCBs	Ground water transport	Off-site Ground Water	Down-gradient residents	II, INH, DC	Complete	The off-site ground water exposure pathway is evaluated as part of the Area C evaluation
		Direct Contact	On-site Shallow Bedrock Ground water			Incomplete	It is highly unlikely that utility workeres would disturb bedrock at the site.

Legend :
II - Incidental ingestion
DC - Dermal Contact
INH - Inhalation

Figure 7-6
General Electric Company
Fort Edward, New York
Exposure Pathway Analysis for Area F



PCBs are detected in sub-surface soils only. As such, detectable ambient air PCB concentrations are not expected to occur from this source area.

PCBs may leach to ground water from this source area. Potential exposure to PCBs in ground water concentrations will be addressed as part of the Source Area C evaluation.

PCBs have been identified as COPCs in sub-surface soils at this source area. Workers may be exposed to COPCs if soils are excavated in this area.

No COPCs were identified in shallow ground water at this area