SUPPLEMENTAL REMEDIAL WORK PLAN

Prepared for:

BLACK & DECKER (U.S.) INC.
Hampstead, Maryland

JUNE 1995

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W.O. No. 02501-004-001-0200

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SECTION 1
INTRODUCTION

1.1 OVERVIEW

The Black & Decker (U.S.) Inc. facility, located at 626 Hanover Pike, Hampstead, MD, has been the subject of a groundwater and soil investigation and remediation program for a number of years, under the supervision of the Maryland Department of the Environment (MDE). Previous activities at the site relative to the environmental investigation and subsequent remediation are described in Section 2 of this document.

This Supplemental Remedial Work Plan has been prepared in direct response to the requirements of an Administrative Consent Order between the State of Maryland Department of the Environment (MDE) and Black & Decker (U.S.) Inc. (Consent Order) finalized during April, 1995. Specifically, Condition IV.U.(1) through (7) of the Consent Order calls for statement of the potential problems posed by the site, a summary of known site conditions, development of a site conceptual model, plans for specific additional investigations, a health and safety plan, sampling and analysis methodologies and QA/QC procedures, and plans for additional sampling in two lagoons located at the facility. This document is one of several which are being prepared in response to the Consent Order; each of these documents are to be submitted to the MDE in accordance with the schedule outlined in the Consent Order. Final versions of the documents are to become part of the administrative record for the site which is to be maintained at a public repository in the town of Hampstead.

1.2 OBJECTIVES

The primary objective of this work plan is to provide the information required by Condition IV.U.(1) through (7) of the Consent Order. Each of the elements of that condition have been addressed in the plan. Additionally, details regarding health and safety planning and sampling and analysis methodologies and QA/QC procedures are provided in a companion document, the Sampling and Analysis Plan (SAP). The SAP is developed as a separate document because procedures described in that plan also apply to other activities and plans for the site (quarterly groundwater monitoring, etc.). In this manner, the SAP can serve as a single reference containing details related to field sampling and laboratory methodologies and QA/QC procedures. Hence, an objective of this Supplemental Remedial Work Plan is not to provide detailed information regarding methodologies; rather, the plan provides background technical and site characterization information and conceptual descriptions of the work to be performed.

SECTION 2
PREVIOUS SITE INVESTIGATIONS

2.1 INITIAL GROUNDWATER INVESTIGATION (G&M)

In April 1984, as part of an effort to determine the impact of a gasoline spill at the Hampstead Exxon service station, water samples of the supply wells at the Hampstead Black & Decker (U.S.) Inc. facility were collected and analyzed by the State of Maryland for volatile organic compounds (VOCs). As a result of the detection of VOCs, Geraghty & Miller, Inc. (G&M) was contracted to conduct a groundwater assessment of the site.

The field investigation was conducted to evaluate potential contaminant source areas in the northwestern corner of the property and included surface geophysics (EM and MAG), installation and analytical sampling of 21 monitor wells, packer testing of production wells 6 and 7, and a pumping test of production well 7.

In general, based on the initial groundwater investigation, G&M concluded that several source areas within the "drill site" area contributed to the groundwater contamination. G&M also concluded that the major pathway of contamination to Well 7 was from a single zone at the interface between weathered bedrock and competent bedrock and that all zones of groundwater flow seemed to be hydraulically connected. In addition, G&M suggested that aquifer remediation and contaminant migration control could potentially be achieved by a "pump and treat" technology.

2.2 PHASE I ACTIVITIES

In 1987, the Black & Decker Corporation retained Roy F. Weston, Inc. (Weston) to conduct a comprehensive environmental investigation of the facility. Phase I of Weston's environmental investigation, conducted in November and December 1987, utilized soil gas sampling, soil borings, geophysical surveying, test pit excavations, surface water (lagoon) and sediment sampling, and groundwater sampling in an effort to identify potential sources of the constituents found in the groundwater. Data collected during the Phase I investigation were evaluated and the resultant conclusions were incorporated in the design of the Phase II investigation. The following subsections summarize the field activities that were conducted as a part of Weston's Phase I investigation. Sampling procedures, sample locations and analytical results are described in detail in the Environmental Investigation Report (EIR) (Weston, April 1989). During all field activities, QA/QC procedures were followed as detailed in the September 1987 work plan (Weston, 1987).

2.2.1 Soil Gas Sampling

Soil gas analysis was one of the investigative techniques used to evaluate the storage tank area and the site near the corner of buildings 5 and 6. In the storage tank area, 19 soil-gas samples were collected and analyzed for TCE and PCE from Tank Farm 1 (eight samples), Tank Farm 2 (three samples), and the aboveground storage tank area (eight samples). Sample locations were concentrated around distribution pipes and the underground and aboveground tanks identified on the site plans.

An extensive soil gas survey was conducted near buildings 5 and 6 (northwest part of the main plant building) to assess the potential for heat treat residues and constituents found in the groundwater. Forty-four soil gas samples were collected and analyzed for TCE and PCE. As can be seen on Figure 3-15 in the EIR, the soil gas sampling grid extended from the west and northwest side of the main plant building west to then production well 7 (now extraction well EW-10). In general, both TCE and PCE were detected at low levels in the soil gas samples, which did not indicate a source area. The results were used to identify soil boring and proposed monitor well (Phase II) locations.

2.2.2 Soil Borings

Soil borings were conducted to evaluate further the storage tank area and the site near the corner of building 5 and 6. In the storage tank area, soil borings were performed at five locations based on the soil gas results. Samples were collected from the borings and submitted for TPH and VOC analysis. Sample results indicated that further characterization of the soils in Tank Farms 1 and 2 in Phase II was warranted.

At the site near buildings 5 and 6, seven soil borings were performed throughout the area and samples were collected for VOC and cyanide analyses. In general, the analytical results indicated that this area did not contain waste materials and did not contain significant levels of groundwater contaminants.

2.2.3 Geophysics

Weston conducted geophysical surveys, utilizing magnetics (MAG) and electromagnetics (EM) methods, to define the boundaries of buried tools in the suspected product disposal area and the suspected past burn area. The geophysical survey data was interpreted to determine suspected fill areas for further characterization by test pit excavations.

2.2.4 Test Pit Excavations

Test pits were excavated in the suspected heat treating residues area and, based on geophysical surveys, were also excavated in the fill site near the seep area, the suspected product disposal area, and the suspected burn area.

At the suspected heat treating residues area, four test pits were excavated in two areas where material may have been deposited from heat-treating furnaces that previously operated at the facility. Soil samples were collected and were analyzed for VOCs, based on the constituents present in the groundwater, and EP toxicity metals and cyanide, based on constituents typically associated with heat treatment. The analytical results indicated that the fill area was not a current source of groundwater contamination and that no further source characterization was warranted in this area.

At the fill site near the seep area (referred to as Zone B in the EIR), eight test pits were excavated in previously identified fill areas to characterize visually the material and to sample for VOC and EP toxicity metals. The analytical results indicated that the fill area was not a current source of groundwater contamination and that no further source characterization was warranted in this area.

After interpretation of the geophysical data, four test pits were excavated in the suspected product disposal area and soil samples were collected for VOCs and EP toxicity metals analyses. The analytical results indicated that the product burial area did not represent a source of groundwater contamination.

Based on anomalies identified in the geophysical survey, two test pits were also excavated in the suspected burn area. Samples for VOC and TPH analyses were collected from the test pit excavations. The analytical results did not confirm the reported possible use of this area for the burning of off-specification tool products, and indicated that the area did not contain waste materials. No significant contamination was detected in soil samples collected in this area.

2.2.5 Surface Water and Sediment Sampling

At the suspected heat treating residues disposal area, one stream sediment sample was collected for VOCs, EP toxicity metals, and cyanide analyses. The analytical results indicated that the stream sediment in this area did not represent a source of groundwater contamination.

At the lagoon areas, four sediment and two surface water samples were collected from the East Lagoon and four sediment and one surface water samples were collected from the West Lagoon. Both the sediment and surface water samples were analyzed for VOCs, EP toxicity metals, priority pollutant metals, and nitrates. The results of these analyses indicated that low to moderate concentrations of contaminants were present at several sampling locations in the lagoons and that a Phase II monitor well should be located in the lagoon area.

2.2.6 Groundwater Sampling

At the fill site near the seep area, groundwater samples were collected from six existing monitor wells and analyzed for VOCs in order to determine the effect pumping of well 7 had on PCE and TCE concentrations in the local groundwater. These analytical results were consistent with previous results, primarily showing concentrations of PCE in excess of 100 ppb.

2.3 PHASE II ACTIVITIES

Phase II of Weston's environmental investigation, conducted in June, July, and December 1988, involved supplemental monitor well installation, additional soil borings, and groundwater and soil sampling and analysis. These activities aided in further definition of the extent of contamination of the on-site soil and groundwater, characterized routes of migration, and provided preliminary data to be considered in developing remedial alternatives. The following subsections describe the field activities that were conducted as a part of the Phase II investigation.

2.3.1 Monitor Well Installation and Groundwater Sampling

During the Phase II investigation, 17 monitor wells were installed across the site. Groundwater samples were collected from the 17 newly installed monitor wells, 7 monitor wells previously installed by G&M, and 3 production wells (wells 5, 6, and 7). The samples were submitted for VOC analysis. The groundwater sample results confirmed that the major contaminants of concern in the groundwater were TCE and PCE and a remediation plan was recommended to recover contaminated groundwater and prevent its migration off-site.

2.3.2 Water Level Measurements

Following installation, monitor well elevations were surveyed to establish reference points for water level measurements. During Phase II, several sets of water level measurements were collected in order to determine groundwater flow directions at the site.

2.3.3 Soil Borings

In the tank farm area, a total of 13 soil borings were performed at Tank Farm 1 and a total of 14 soil boring were performed at Tank Farm 2. Soil samples were collected from borings at both areas and analyzed for VOCs and TPH. TCLP analysis was also conducted on selected samples to provide an indication of the mobility of the contaminants in the soil. An overall assessment of Tank Farm 1 suggested that the TPH and VOCs in the soil were present below concentrations which would impact groundwater on-site. However, an overall assessment of Tank Farm 2 suggested that VOCs, particularly TCE and PCE, in the soil were present at concentrations which could potentially impact the groundwater.

2.4 REMEDIATION SYSTEM DESIGN ACTIVITIES

Based on the Phase I and II investigations, remediation strategies to recover and treat the contaminated groundwater were proposed in the 1989 EIR. A work plan for soil and groundwater remediation was developed and submitted to MDE in December of 1989. In 1991, after receiving MDE approval of the work plan, Weston initiated a remediation system design investigation. The field investigation for the remedial design of the groundwater recovery and treatment system at the Black & Decker facility involved geophysics, well installation, aquifer testing and groundwater sampling. Each of these activities is summarized in the following subsections.

2.4.1 Geophysics

Prior to the installation of the recovery wells, surface geophysical investigations were conducted on the east and west sides of the property to locate areas which had the greatest potential of intercepting potential major water-yielding zones. Two different methods, EM and very low frequency (VLF) electromagnetics, were utilized to measure electrical conductance contrasts in the subsurface materials. These methods were selected because materials which have higher conductance properties typically indicate fracture locations.

2.4.2 Recovery Well Installation

Seven new recovery wells, capable of yielding significant quantities of water (> 20 gpm), were installed during the remediation system design investigation (ten recovery wells now exist; three of these are converted monitor or production wells). A series of pilot holes were drilled at locations which were chosen based on the results of the geophysical investigations. While fractures were intercepted at most of the pilot holes, many were filled with clay and did not produce significant water. Additional pilot holes were drilled as a result of a field reconnaissance of the site and were positioned in locations where recovery wells were suspected to be needed. Consistent with earlier findings, most yields were derived from the lower part of the saprolite and upper 10 to 20 feet of bedrock.

At each potential recovery well location, an 8-inch "pilot hole" was drilled a minimum of 25 feet into competent bedrock using the air rotary drilling method (previous drilling has indicated that no significant water-bearing zones are encountered further than 25 feet into competent bedrock). Once the total depth was reached, the borehole was developed and the yield was estimated. If the total yield was less than 40 gpm, and the pilot hole was in a location that could be used as an observation point, a 2-inch diameter well was installed to aid in the characterization of aquifer properties during pumping tests. In areas where there was an adequate number of observation wells, boreholes were abandoned.

In cases where the total yield of the borehole exceeded 40 gpm, the 8-inch borehole was widened to a diameter of 12 inches and a well was installed to a depth of approximately five feet below the deepest observed water producing zone.

2.4.3 Aquifer Testing

A series of well performance and aquifer tests were conducted as part of the field work to collect data required for the design of the groundwater recovery system. An 8 hour step-drawdown test was conducted at each potential recovery well to evaluate well performance and to estimate the maximum sustainable well yield. Three long-term (duration of 24 hours or longer) aquifer tests were conducted to characterize aquifer properties at the site. Table 2-1 summarizes the specifications of each of the aquifer tests conducted at the site. The results of the pumping tests were used to develop an analytical flow model to determine the number and spacing of wells needed to create a hydraulic barrier.

2.4.4 Groundwater Sampling

Time series groundwater samples were collected from selected recovery wells during five of the seven pumping tests. The time series samples were collected periodically during each pumping test to characterize potential trends in VOC concentrations as pumping continued. The results of the time series sampling were used to evaluate the efficiency of the wells in recovering contaminated groundwater and as input to the design of the treatment system.

Table 2-1

Pumping Test Specifications
Black & Decker
Hampstead, Maryland

Pumping Well	Duration of Test (hrs)	Purpose of Test
PH-8 (EW-9)	4	Well Performance
PH-8 (EW-9)	70	Aquifer Characterization
PH-1A (EW-3)	4	Well Performance
PH-1A (EW-3)	30	Aquifer Characterization
RFW-12 (EW-1)	8	Well Performance
PH-2A (EW-5)	24	Well Performance/ Aquifer Characterization
PH-13 (EW-6)	8	Well Performance
PH-10 (EW-8)	8	Well Performance
RFW-5B (EW-7)	8	Well Performance

In addition, groundwater samples were collected during the week of 17 February 1992 as part of the quarterly groundwater sampling program initiated at the Black & Decker facility based on agreement with the MDE Groundwater Investigation Division. Groundwater samples were collected at seven of the ten recovery wells and were analyzed for VOCs. Additionally, inorganic parameters (alkalinity, chloride, hardness, sulfate, total dissolved solids, and total suspended solids) were analyzed at six of the eight wells included in the quarterly sampling program. The purpose of collecting the groundwater samples was not only to characterize general groundwater quality, but also to quantify the levels of contamination present to aid in the design of the groundwater treatment system. The additional parameters were analyzed to evaluate whether pretreatment would be required prior to air-stripping to prevent scaling, bio-fouling, etc.

2.5 REMEDIATION SYSTEM OPERATION ACTIVITIES

During 1994, Black & Decker completed construction of the groundwater remediation system and, in August 1994, after MDE approval of the air, water appropriation and NPDES permit applications, the groundwater remediation system began operation. The following subsections summarize the on-going field activities that are conducted as a part of Weston's remedial system operation.

2.5.1 Quarterly Groundwater Sampling

Based on an agreement with the MDE Groundwater Investigation Division, groundwater samples have been collected during February, May, August, and November, since February 1992, as part of the quarterly groundwater sampling program initiated at the Black & Decker facility. Groundwater samples are collected from the ten recovery wells and 18 monitor wells and are analyzed for VOCs.

2.5.2 Water Level Measurements

After the startup of the treatment system, water level measurements were collected on a regular basis for the first two weeks, on a weekly basis for the next month, and then continued on a monthly basis. Water levels are measured in wells specified in the Water Appropriation Permit, issued by the Water Rights Division of the Maryland Department of Natural Resources.

SECTION 3
PHYSICAL CHARACTERISTICS

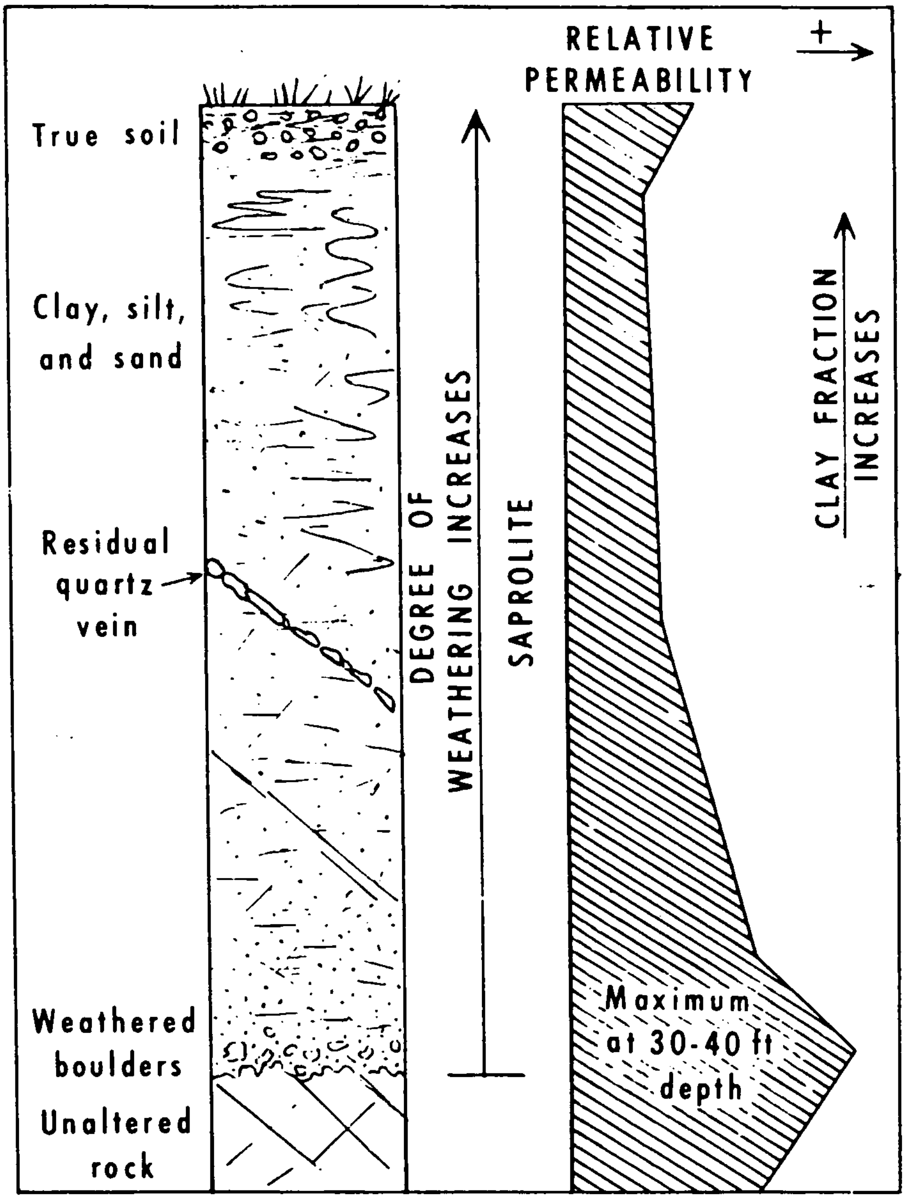
3.1 GEOLOGY

As in most of eastern Carroll County, an indeterminate thickness of the albite-chlorite schist facies of the Wissahickon Formation underlies the Black & Decker property. This facies consists principally of tightly folded albite schist or phyllite interbedded with layers of chlorite and or muscovite schist. Cream to yellow, vitreous, micaceous quartzite veins are locally present along the planes of foliation as well as transverse to primary foliation directions.

As is common in the Piedmont, the Wissahickon Formation underlying the site has been deformed and fractured. Zones of fracturing may have surface expression as valleys or subtle draws, or as other linear topographic features. Meyer (1958) reports that the principal strike of schistosity in the plant area ranges from N36°E to N46°E. However, because of the multiple deformational events in the regional geologic history, a wide variation in small-scale structural and relic bedding features is present.

The site stratigraphy is comprised primarily of weathered schist/phyllite, referred to as saprolite, that grades from a micaceous, clayey reddish-brown silt at shallow depths to a medium soft, grayish-brown, slightly weathered schist/phyllite near the interface with competent bedrock. Meyer (1958) describes this saprolite as being divided into two distinct zones described as a "soft, silty weathered schist" in the upper zone and a "firmer, less decomposed schist" in the lower or transitional zone between the saprolite and bedrock. Figure 3-1 presents an idealized profile of the zone of weathered rock in the Maryland Piedmont (Nutter and Otton, 1969).

This transitional zone is typical in the drilling logs collected at the Hampstead site. In general, the transitional zone between the saprolite and bedrock has an average thickness



Idealized weathering profile showing fresh crystalline rock grading upward into true soil.

FIGURE 3-1

Supplemental Remedial Work Plan
Black & Decker
Hampstead, Maryland

Source: Nutter, L.J. and E.G. Otton, "Groundwater Occurrence in the Maryland Piedmont", Report of Investigations No. 10, Maryland Geological Survey, 1969.

of 18 feet. It consists of slightly weathered green-gray schist with fractures and residual quartz veins encountered throughout the zone and with less fine-grained matrix than in the weathered rock encountered closer to the ground surface.

Twenty-nine of the forty well boreholes at the site (35 Weston installed monitor wells and 5 former production wells) have been advanced through the saprolite and into competent bedrock. Due to the gradational change between the saprolite and competent bedrock, as noted above, this interface is difficult to determine with certainty and is considered more of a "judgement call". However, based on the drilling logs, a bedrock topography map has been constructed and is presented in Figure 3-2. As can be seen in the figure, the depth to bedrock can be variable, especially in low-lying areas where the saprolite is generally thickest. However, this map is highly subjective due to the thickness and textural variability of the transitional zone between true saprolite and competent bedrock, as noted above. A distinct, well-developed textural contrast between saprolite and competent bedrock does not exist in the site area.

Based on best judgement, the depth to competent bedrock, or the thickness of the saprolite, ranged from approximately 32 to 119 feet bgs at the site, with an average of 76.2 ft bgs. Bedrock elevations varied mostly with surface topography and ranged from approximately 704.8 (PH-7) to 824.3 (RFW-19) feet MSL. The average bedrock elevation was 755.2 feet MSL. In addition, an isopach map showing the thickness of the saprolite is presented in Figure 3-3.

3.2 HYDROGEOLOGY

3.2.1 Regional Hydrogeology

In the Hampstead area, groundwater occurs predominately in secondary porosities (fractures, joints and shear zones) within the Wissahickon Formation, and in the pore spaces of the overlying transitional zone or lower part of the saprolite. Recharge to the

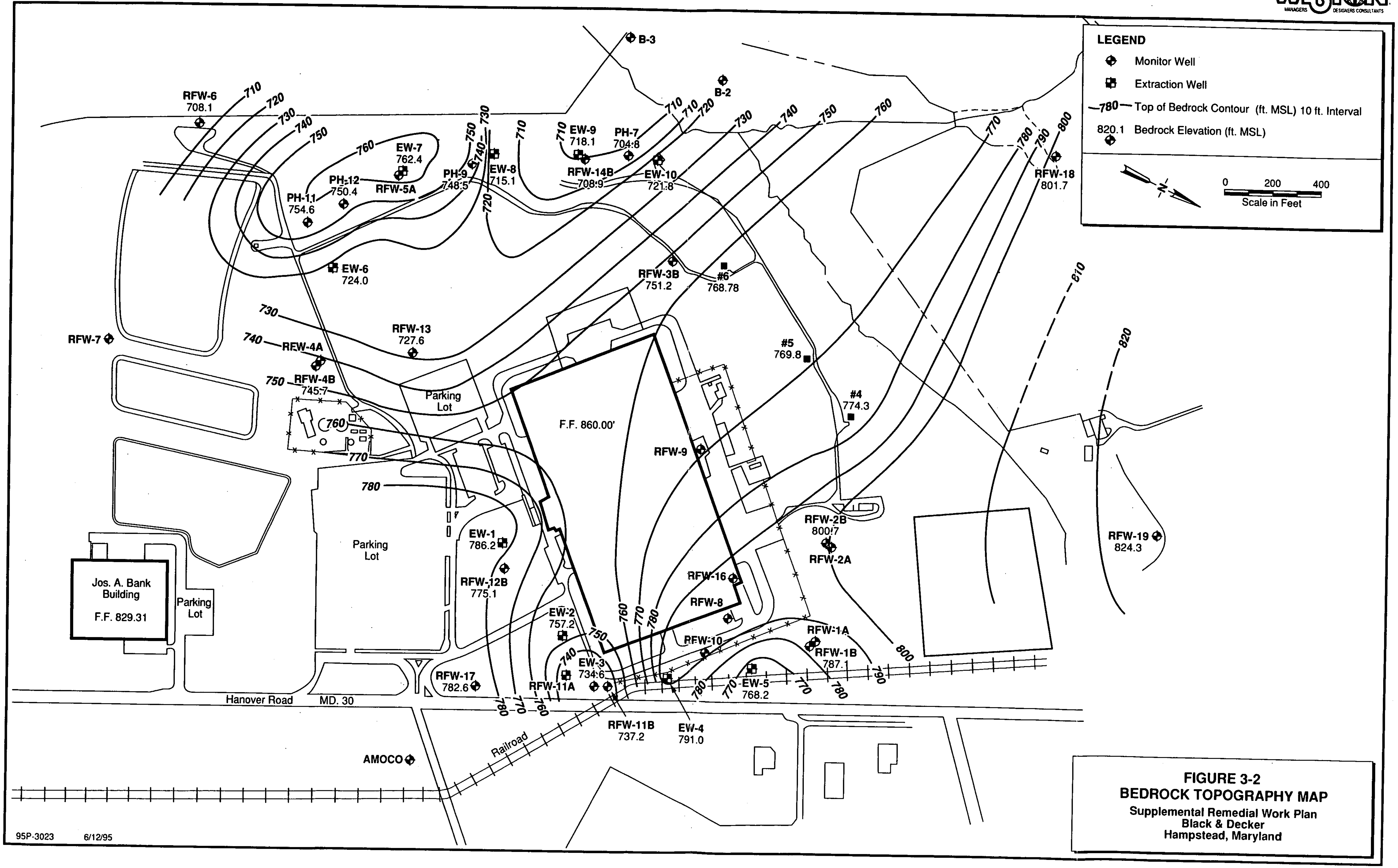


FIGURE 3-2
BEDROCK TOPOGRAPHY MAP

Supplemental Remedial Work Plan
Black & Decker
Hampstead, Maryland

WESTON
MANAGERS DESIGNERS CONSULTANTS

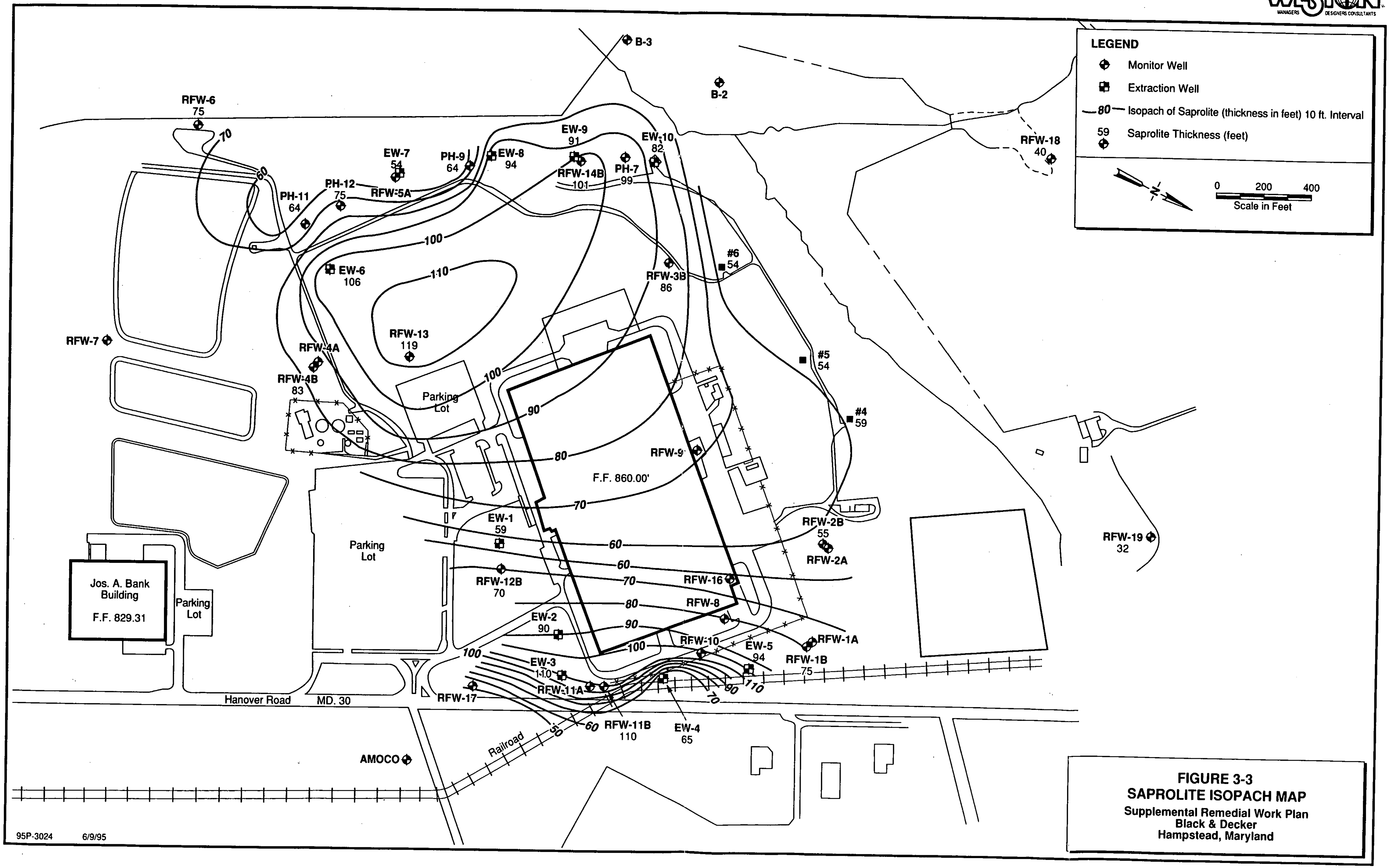


FIGURE 3-3
SAPROLITE ISOPACH MAP
Supplemental Remedial Work Plan
Black & Decker
Hampstead, Maryland

bedrock is principally from the downward percolation of water stored in the saprolite (Meyer, 1958). In the site area, these two lithologic units are hydrologically strongly inter-connected and act essentially as a single aquifer system. According to both Nutter and Otton (1969), the majority of the groundwater in the Maryland Piedmont crystalline rock aquifers is stored in the weathered zone or saprolite. Figure 3-1 illustrates that permeability significantly increases near the contact of the saprolite with competent bedrock. Stewart (1962) states that the porosity of the saprolite is greatest in this transition zone but "decreases with depth as saprolite grades into unweathered rock".

The yields of wells drilled in the area range from less than one gpm to a reported 300 gpm, and average about 16 gpm (Meyer, 1958). These variable yields are considered a result of the relatively limited storage capacity of the bedrock, and as a result of the highly transmissive capabilities of the fracture zones within the bedrock, as compared to the competent bedrock itself. With increasing depth, fracture spacing and intensity is consistently strongly reduced due principally to pressure from overlying rocks. In the Piedmont, fractures which will yield water are generally extremely rare below 300 feet; thus, most water supply wells are less than 200 feet deep (Richardson, 1980).

According to Nutter and Otton (1969), the degree to which rocks are jointed, fractured, and faulted is one of the most important factors determining the availability of groundwater in Piedmont crystalline rock terrains. Nutter and Otton also note that predicting where a given well will intersect a joint or fracture is virtually impossible.

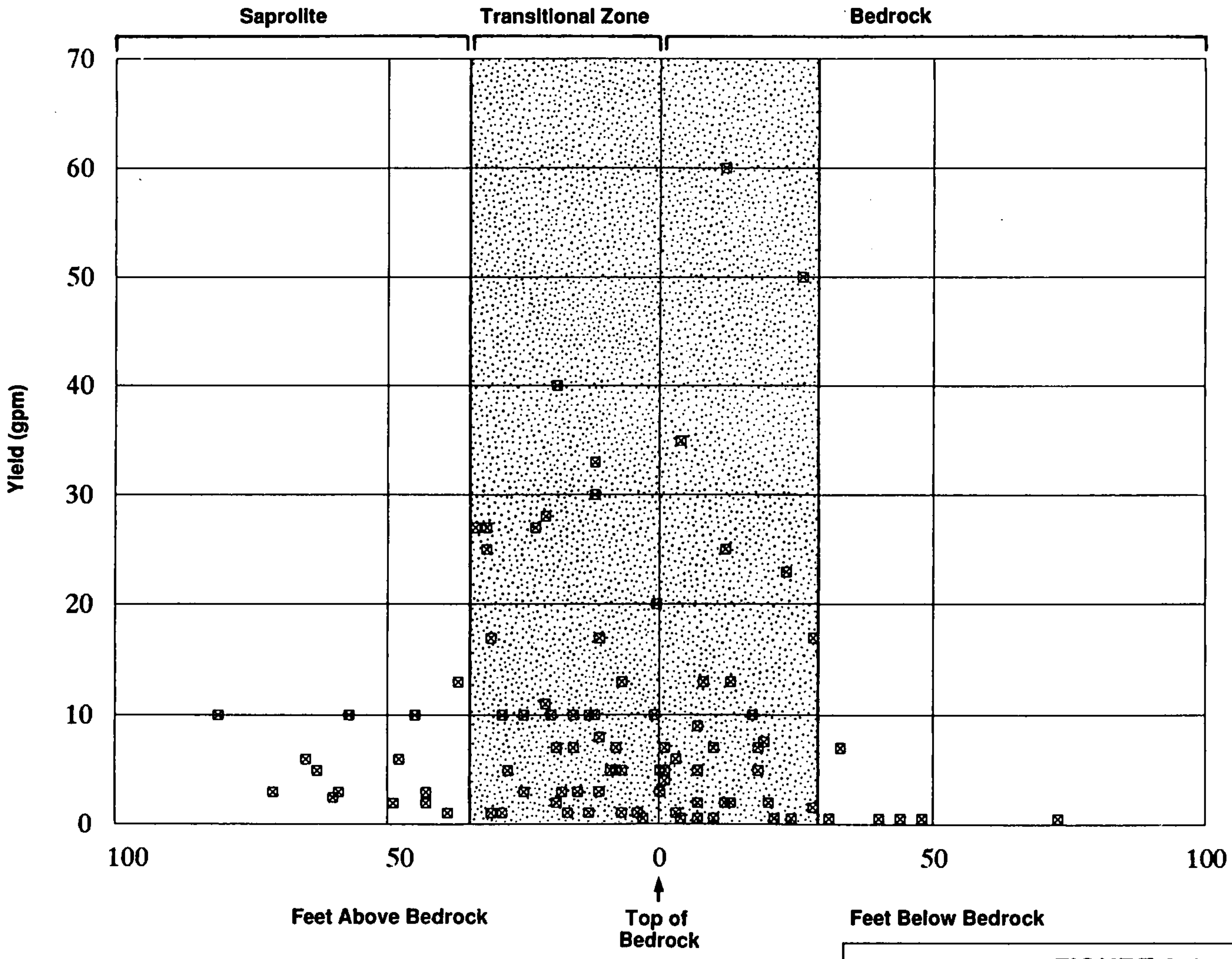
3.2.2 Site Hydrogeology

Information pertaining to site hydrogeology has been gathered during the extensive drilling program and by the series of well performance and aquifer tests completed at the site. The site hydrogeology is consistent with that described above, with the exception that the largest quantities of water appear to be associated with the transitional zone and uppermost 15-20 feet of bedrock, and with those wells that intersect fractures filled with quartz veins. This was evident during the installation of the pilot holes, particularly at EW-3 (PH-1A), where the highest yield was obtained after a large quartz vein was intersected.

In the monitor wells with the highest yields (35 to 80 gpm), no major water-producing zones were encountered more than approximately 30 feet into competent bedrock. In addition, at the nine open hole monitor wells installed at the site, ranging from 24 to 194 feet below the estimated top of competent bedrock, no significant quantities of water were encountered more than approximately 30 feet into competent bedrock. Below this zone, drilling indicated that very few fractures existed, and for those fractures which did exist, little or no water was associated with them. In general, in the majority of wells installed at the site, the highest well yields occurred within the approximately 30-foot thick transitional zone between the saprolite and bedrock and, to a somewhat lesser degree, within the upper 30 feet of bedrock. Yields of site wells in relation to depth above or below bedrock are illustrated on Figure 3-4. In addition, Figure 3-5 presents the quantity of water producing zones or fractures in relation to depth.

All wells onsite have been surveyed to establish exact location and elevation. Depth to water measurements are routinely taken at each well; a representative set of data are listed in Table 3-1. Using this data, a groundwater contour map was constructed (see Figure 3-6), showing static groundwater conditions, prior to the start of the treatment system pumping. As evidenced by the groundwater potentiometric surface contour map, groundwater flow at the site is principally to the southwest, but also to the south and east.

In general, groundwater elevation contour lines mimic topography. Typically, the highest groundwater elevation is located at monitor wells RFW-2A and 2B, which corresponds to a site topographic high. These wells are located within a groundwater recharge area. In contrast, the lowest groundwater elevation is located at monitor well RFW-6, adjacent to the stream in the southwest portion of the site, which corresponds to the site topographic low. At this location, groundwater is typically located at ground surface or

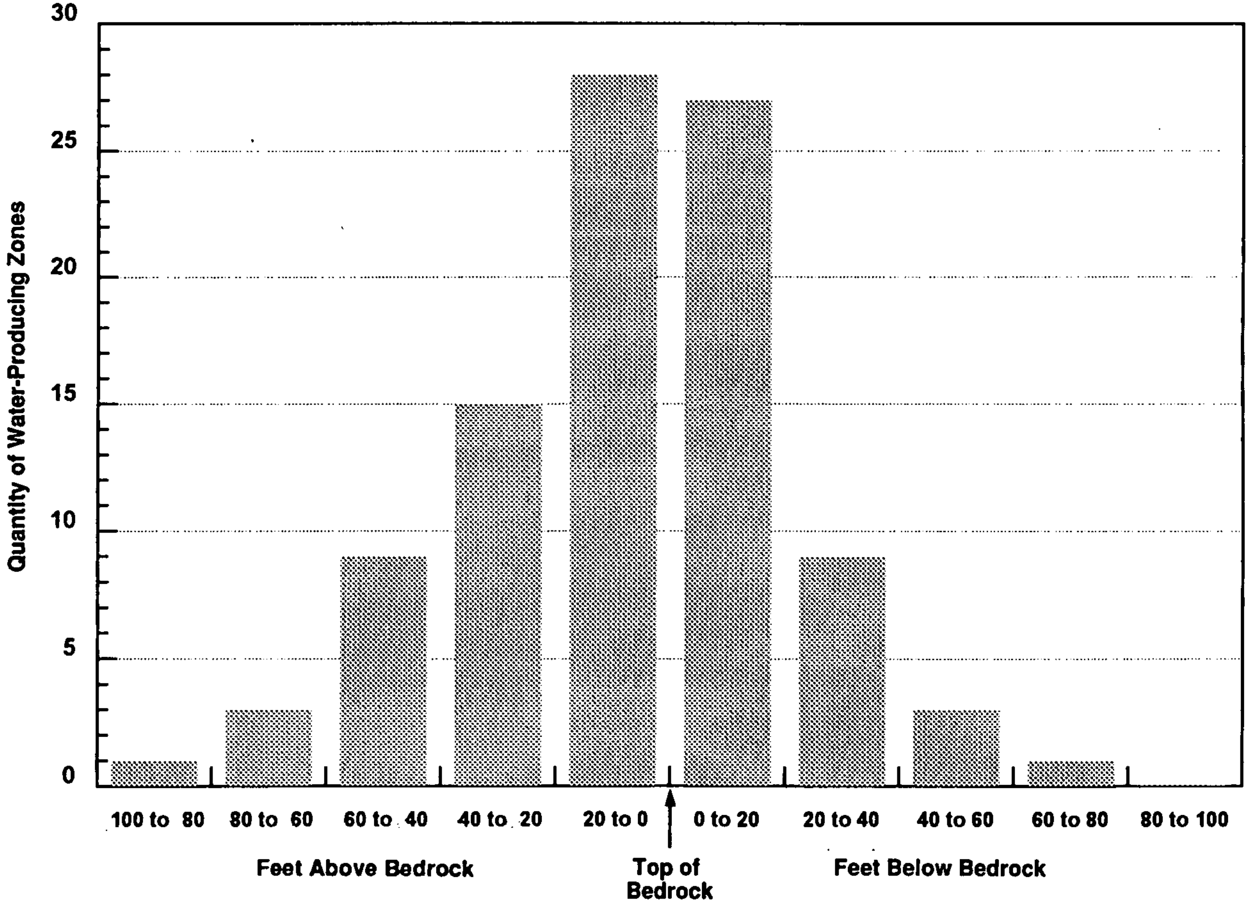


▨ Transitional Zone and Top 30 ft. of bedrock

Note: Point shown as "Top of bedrock" is highly subjective as noted in the text. Materials on either side of the "Top of bedrock" are typically virtually identical in terms of texture and conductivity.

FIGURE 3-4
YIELDS OF SITE WELLS IN RELATION TO THE BEDROCK SURFACE

Supplemental Remedial Work Plan
Black & Decker
Hampstead, Maryland



Note: Point shown as "Top of bedrock" is highly subjective as noted in the text. Materials on either side of the "Top of bedrock" are typically virtually identical in terms of texture and conductivity.

FIGURE 3-5
QUANTITY OF WATER-PRODUCING ZONES IN RELATION TO THE BEDROCK SURFACE
Supplemental Remedial Work Plan
Black & Decker
Hampstead, Maryland

Table 3-1

Static (Pre-pumping) Water Level Measurements and Groundwater Elevations

Black & Decker
Hampstead, Maryland

WELL ID	TOC ELEV (ft MSL)	6 June 1994	
		DTW (ft BTOC)	ELEV (ft MSL)
EW-1(RFW-12B)	847.21	25.65	821.56
EW-2(PH-3A)	849.21	27.56	821.65
EW-3(PH-1A)	846.64	25.82	820.82
EW-4(PH-4A)	858.01	35.15	822.86
EW-5(PH-2A)	864.17	36.80	827.37
EW-6(PH-13)	831.98	41.85	790.13
EW-7(RFW-5B)	818.38	15.83	802.55
EW-8(PH-10)	811.13	5.88	805.25
EW-9(PH-8)	811.35	8.63	802.72
EW-10(PW-7)	807.74	5.07	802.67
RFW-1A	864.37	31.54	832.83
RFW-1B	864.23	31.55	832.68
RFW-2A	857.41	13.99	843.42
RFW-2B	857.73	14.53	843.20
RFW-3B	839.21	21.75	817.46
RFW-4A	830.37	31.80	798.57
RFW-4B	830.37	31.90	798.47
RFW-5A	817.5	14.79	802.71
RFW-6	785.04	0.00	785.04
RFW-7	805.14	6.20	798.94
RFW-8	860.07	30.99	829.08
RFW-9	858.21	24.25	833.96
RFW-10	852.06	25.11	826.95
RFW-11A	849.32	27.87	821.45
RFW-11B	849.62	28.46	821.16
RFW-12B	844.87	23.34	821.53
RFW-13	849.11	47.75	801.36
RFW-14B	812.39	6.49	805.90
RFW-16	856.14	22.79	833.35
RFW-17	834.66	14.56	820.10
RFW-18	843.67	2.45	841.22
RFW-19	858.28	5.17	853.11
PH-7	805.94	3.84	802.10
PH-9	814.94	11.96	802.98
PH-11	820.68	30.55	790.13
PH-12	828.35	32.35	796.00
B-3	803.02	6.24	796.78
AMOCO	842.29	18.06	824.23
HAMP-22		0.69	

B&D-1\SRP-3-1.WK3

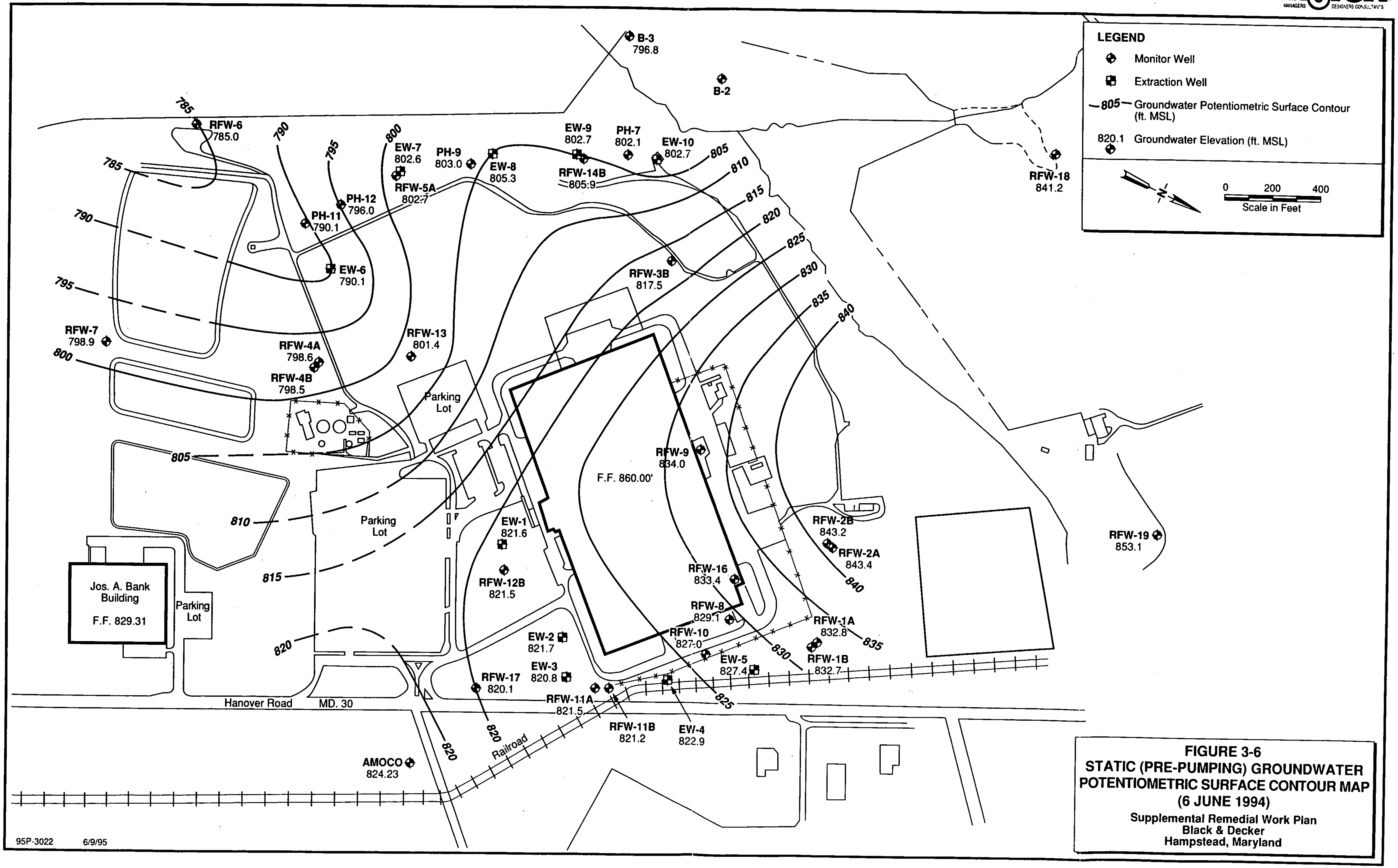


FIGURE 3-6
STATIC (PRE-PUMPING) GROUNDWATER POTENTIOMETRIC SURFACE CONTOUR MAP
(6 JUNE 1994)
Supplemental Remedial Work Plan
Black & Decker
Hampstead, Maryland

less than one foot below ground surface. In addition, the unsaturated or vadose zone is thickest in the northern portion of the site and thins gradually towards the southwest portion of the site (RFW-6). This information suggests the southwest corner of the site is a groundwater discharge area for the local hydrologic system.

Elevation differences between the groundwater in the shallow and deep well pairs are small, on the average less than 0.5 foot. Vertical gradients between the shallow and deep zones are downward, varying from approximately 1.0×10^{-2} to 1.0×10^{-3}, as measured from the base of the shallow well screened interval and the water-bearing fractures in the deep well. These gradients are relatively low, again indicating that considerable interconnection exists between the shallow and deeper groundwater.

3.2.2.1 Pumping Test Results

The results from the pumping tests conducted on site are summarized in Table 3-2. Semi-log graphs of time versus drawdown were constructed for each piezometer where drawdown was observed and are presented in Appendix C. Aquifer properties were characterized using both drawdown and recovery data. Analysis of the data was completed using Jacob's method and the Theis recovery method (Driscoll, 1986). A literature search revealed that a pumping test was conducted at the Black & Decker facility in 1958 and the results presented in Meyer and Beall (1958). The results of this aquifer test are also summarized in Table 3-2.

The individual pumping tests indicated that the maximum sustainable yield varied from 35 gpm (EW-1/RFW-12) to 84 gpm (EW-3/PH-1A and EW-5/PH-2A). The maximum sustainable yields were calculated using data collected during step-drawdown tests conducted at each well and reflect the maximum pumping rate which could be consistently relied upon given the following assumptions: 1) annual precipitation is normal; and 2) no other pumping wells exist nearby which would interfere with the ability of the well to produce water. Given the number of recovery wells that are located at the

Table 3-2

Pumping Test Summary
Black & Decker

Pumping Well	Observation Well	Duration of Pumping Test (hours)	Distance to Observation Well (ft)	Maximum Observed Drawdown (ft)	Transmissivity (gpd/ft)	Specific Yield	Method of Analysis	Estimated Maximum Sustainable Yield of Pumping Well (gpm)
PH-8 (EW-9)	B-1	70	73.5	27	160	0.04	Boulton	33
	PH-10	70	280	0.5	14,300	0.03	Jacob	
					*	*	Theis Recovery	
PH-2A (EW-5)	RFW-10	24	145	3.2	4,950	0.01	Jacob	75
	RFW-8	24	220	1.4	8,080	0.01	Jacob	
	RFW-1B	24	272	0.1	***	***	***	
					930	--	Theis Recovery	
Well #3	(Meyer & Beall 1958)**	107	--	--	5,000	0.02	Jacob	
PH-1A (EW-3)	RFW-11B	30	224	5.8	5,100	0.001	Jacob	90
					6,720	--	Theis Recovery	
RFW-5B (EW-7)	PH-9	8	315	0.4	***	***	***	70
	RFW-5A	8	8	1.75	11,800	0.25	Jacob	
					4,750	--	Theis Recovery	
PH-13 (EW-6)	PH-11	8	228	1.6	7,600	0.002	Jacob	45
					1,570	--	Theis Recovery	
RFW-12 (EW-1)	--	8	--	--	3,000	--	Theis Recovery	35
PH-10 (EW-8)	PH-9	8	97	0.15	*	*	Jacob	80
	PH-8	8	280	0.2	*	*	Jacob	
					*	*	Theis Recovery	

*Unable to accurately estimate due to heavy precipitation.

**Meyer, G., & Beall, R.M., 1958, *The Water Resources of Carrol and Frederick Counties*, Maryland Board of Natural Resources, Dept. of Geology, Mines and Water Resources, Bulletin 22, 355 p.

***Insufficient drawdown to reliably estimate aquifer properties.

Black & Decker facility, it is known that each well will not produce the maximum sustainable yield. Actual maximum sustainable yields are lower when each of the recovery wells is operational.

Calculated values for transmissivity ranged from 160 gallons per day per foot (gpd/ft) to 100,000 gpd/ft. The majority of the values were between 4,000 and 8,000 gpd/ft. This range of values is common for fractured bedrock aquifers. Table 3-2 also lists values for specific yield. Once again, the variability of these values is common to fractured bedrock aquifers. A value of 0.02 is considered the best estimate for specific yield, and is characteristic of unconfined aquifers (Fetter, 1988). During the pumping tests at wells EW-3 (PH-1A) and EW-5 (PH-2A) water levels in off-site Well #22 (owned by the Town of Hampstead) were monitored. No drawdown was observed in Well #22 during either pumping test.

Potential anisotropy in the bedrock was evaluated using the aquifer test data reported by Meyer and Beall (1958). This aquifer test was conducted on Black & Decker supply well No. 3 for a duration of 107 hours. Nine piezometers were installed and were used to monitor aquifer response throughout the aquifer test. The data from Meyer and Beall's test was evaluated for anisotropy by Weston using two methods. The first evaluation of anisotropy utilized the Hantush method (Kruseman and DeRidder, 1990) which estimates the directions of the major and minor axes of anisotropy and also calculates the anisotropy ratio. The second method involved plotting the observed drawdown from each piezometer after 1,000 minutes of pumping on a map. A line connecting points of equal drawdown was drawn, and the resulting shape of the cone of depression was used to characterize aquifer anisotropy. The results of the Hantush method indicate the major anisotropy axis is oriented N84°E and the anisotropy ratio is 1.9. The anisotropy ratio indicates that the hydraulic conductivity in the direction of the major axis is nearly two times greater as compared to the direction of the minor axis, which is located 90° from the major axis. The results of the graphical method indicate the major anisotropy axis is orientated N22°E and the anisotropy ratio is 1.2. The significance of these findings is that, in the bedrock, the anisotropy ratio can be expected to vary from 1.0 (isotropic conditions) to 2.0 and is dependent upon the degree of inter-connectivity of the local fracture network and fracture spacing. The direction of the major anisotropy axis likely varies with local fracture orientation, but can be assumed to be coincident with regional lineaments which are oriented approximately N25°E (Weston, 1989).

3.2.2.2 Treatment System Operation

The groundwater treatment system began operation on 18 August 1994. Water levels were monitored on a regular basis for the first two weeks of the system operation, on a weekly basis for the next month, and since that time have continued on a monthly basis. Each month, water levels are evaluated to determine if an effective capture zone is maintained. Pumping rates are adjusted, as necessary, to ensure hydraulic control across the site without excessive drawdown. Significant drawdown has been observed in both shallow and deeper monitor wells throughout the long-term pumping of the extraction well system, further indicating that considerable interconnection exists between the shallow and deeper groundwater.

Using the data from the most recent round of water level measurements (15 May 1995), a groundwater contour map was constructed and is presented in Figure 3-7. At the time the data was collected, the extraction wells were pumping at a combined rate of approximately 172 gpm. As evidenced by the groundwater potentiometric surface contour map, groundwater flow is still principally to the southwest, with some components to the south and east. However, depressions in the potentiometric surface, due to the pumping of the extraction wells, are evident on the map and the flow lines indicate that direction of groundwater flow is toward the extraction wells.

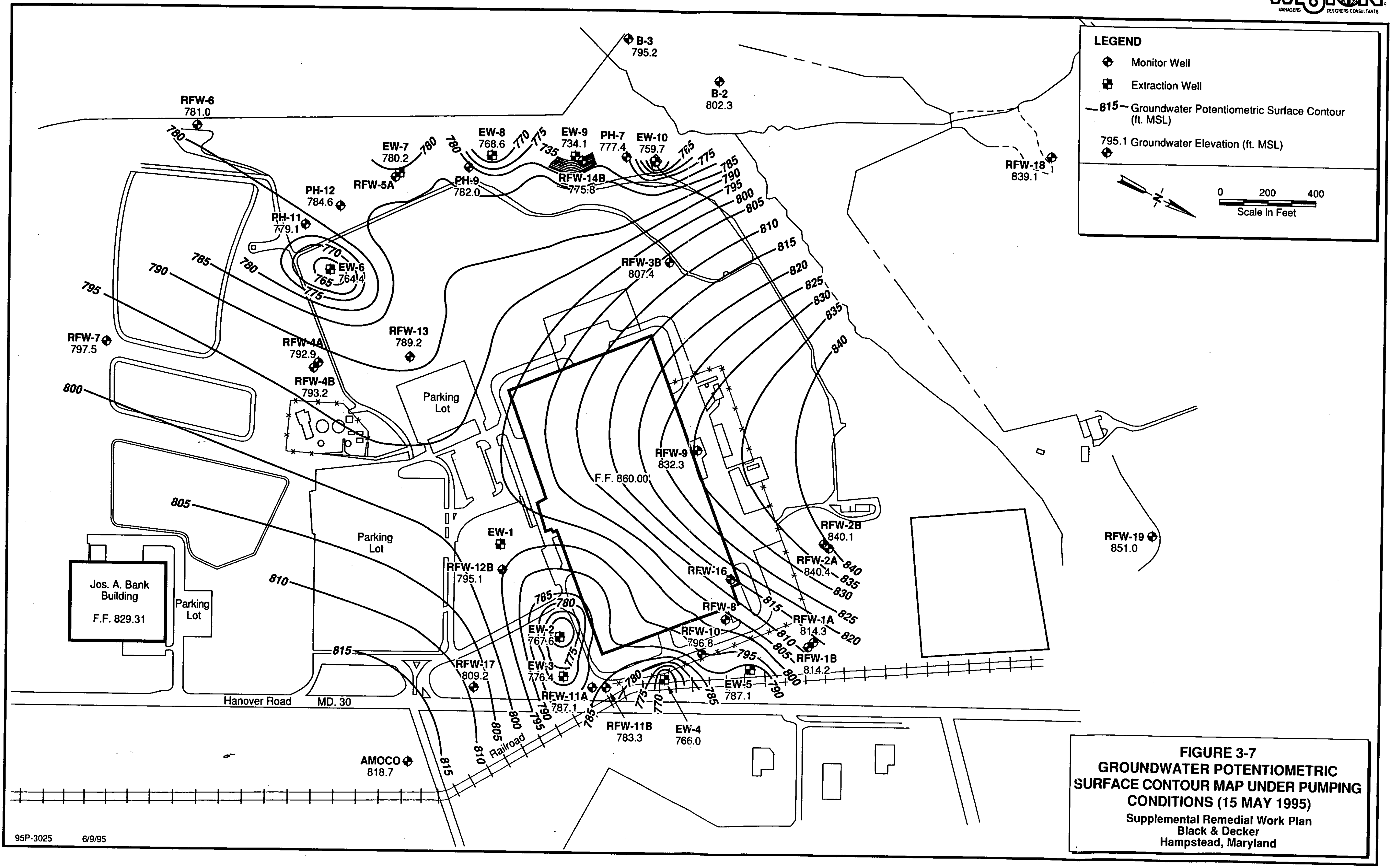


FIGURE 3-7
GROUNDWATER POTENTIOMETRIC SURFACE CONTOUR MAP UNDER PUMPING CONDITIONS (15 MAY 1995)
Supplemental Remedial Work Plan
Black & Decker
Hampstead, Maryland

SECTION 4
NATURE AND EXTENT OF CONTAMINATION

4.1 GROUNDWATER QUALITY

As detailed in Subsection 2.5.1, quarterly groundwater samples have been collected from the recovery wells and selected monitor wells on site since February 1992. The results of the March 1995 quarterly sampling event are summarized in Table 4-1.

The volatile organic compounds (VOCs) detected in the highest concentrations were trichloroethene (TCE) and tetrachlorethene (PCE). Those compounds detected at lower concentrations are 1,2-dichloroethene, 1,1,1-trichloroethane, 1,1-dichloroethene, and 1,1,2-trichloroethane. The remainder of VOCs present were detected at levels well below the Federal Maximum Concentration Levels (MCL).

As found in earlier sampling events at the Black & Decker facility, the highest concentrations of TCE are found on the eastern half of the Black & Decker facility in monitor well RFW-16. The highest concentrations of PCE were found in the vicinity of former production well 7 (now EW-10) and recovery well EW-9. Figures 4-1 and 4-2 show the distribution of TCE and PCE in groundwater, respectively, based on the March 1995 analytical data.

4.2 DNAPL BEHAVIOR AND SITE GEOLOGY: PROBLEMS POSED BY THE SITE

As discussed above, of the contaminants detected in groundwater at the site, only TCE is known to have been used at the facility. The TCE likely entered the subsurface as a liquid. The likely source area for the TCE is recognized as being near the northeast corner of the plant building. PCE, on the other hand, is not known to have been used at the plant, and a source area has not been found in spite of extensive investigations.

4-1

Quarterly Groundwater Sampling Analytical Results
March 1995
Black Decker (U.S.) Inc.

Parameter	Units	RFW-1A	RFW-2A	RFW-2B	RFW-4A (2)	RFW-4A (5)	RFW-4A (DUP) (2)	RFW-4A (DUP) (5)	RFW-4B (2)	RFW-6
Chloromethane	ug/L	10 U	10 U	10 U	20 U	NA	20 U	NA	20 U	10 U
Bromomethane	ug/L	10 U	10 U	10 U	20 U	NA	20 U	NA	20 U	10 U
Vinyl Chloride	ug/L	10 U	10 U	10 U	20 U	NA	20 U	NA	20 U	10 U
Chloroethanane	ug/L	10 U	10 U	10 U	20 U	NA	20 U	NA	20 U	10 U
Methylene Chloride	ug/L	14 B	16 B	6 B	11 B	NA	11 B	NA	28 B	7 B
Acetone	ug/L	10 U	10 U	5 J	20 U	NA	20 U	NA	20 U	10 U
Carbon Disulfide	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
1,1-Dichloroethene	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
1,1-Dichloroethane	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
1,2-Dichloroethene (tota	ug/L	5 U	5 U	5 U	10	NA	10	NA	10	10
Chloroform	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
1,2-Dichloroethane	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
2-Butanone	ug/L	10 U	10 U	10 U	20 U	NA	20 U	NA	20 U	10 U
1,1,1-Trichloroethane	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
Carbon Tetrachloride	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
Vinyl Acetate	ug/L	10 U	10 U	10 U	20 U	NA	20 U	NA	20 U	10 U
Bromodichloromethane	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
1,2-Dichloropropane	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
cis-1,3-Dichloropropene	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
Trichloroethene	ug/L	5 U	5 U	5 U	290	NA	290	NA	210	70
Dibromochloromethane	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
1,1,2-Trichloroethane	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
Benzene	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
Trans-1,3-Dichloroprope	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
Bromoform	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
4-Methyl-2-pentanone	ug/L	10 U	10 U	10 U	20 U	NA	20 U	NA	20 U	10 U
2-Hexanone	ug/L	10 U	10 U	10 U	20 U	NA	20 U	NA	20 U	10 U
Tetrachloroethene	ug/L	5 U	5 U	5 U	E	440	E	500	380	84
1,1,2,2-Tetrachloroethan	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
Toluene	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
Chlorobenzene	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
Ethylbenzene	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
Styrene	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U
Xylene (total)	ug/L	5 U	5 U	5 U	10 U	NA	10 U	NA	10 U	5 U

(2.5) = Dilution factor.

[illegible] 4-1
Quarterly Groundwate[illegible]mpling Analytical Results
March 1995
Black Decker (U.S.) Inc.

Parameter	Units	RFW-7	RFW-8 (5)	RFW-8 (10)	RFW-9	RFW-10 (10)	RFW-10 (50)	RFW-11A	RFW-11B	RFW-13
Chloromethane	ug/L	10 U	50 U	NA	10 U	100 U	NA	10 U	10 U	10 U
Bromomethane	ug/L	10 U	50 U	NA	10 U	100 U	NA	10 U	10 U	10 U
Vinyl Chloride	ug/L	10 U	50 U	NA	10 U	100 U	NA	10 U	10 U	10 U
Chloroethanane	ug/L	10 U	50 U	NA	10 U	100 U	NA	10 U	10 U	10 U
Methylene Chloride	ug/L	21 B	66 B	NA	4 JB	76 B	NA	5 B	4 JB	6 B
Acetone	ug/L	10 U	50 U	NA	10 U	100 U	NA	10 U	10 U	10 U
Carbon Disulfide	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
1,1-Dichloroethene	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	1 J
1,1-Dichloroethane	ug/L	5 U	25 U	NA	4 J	50 U	NA	5 U	5 U	5 U
1,2-Dichloroethene (tota	ug/L	5	25 U	NA	8	50 U	NA	5 U	5 U	5 U
Chloroform	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
1,2-Dichloroethane	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
2-Butanone	ug/L	10 U	50 U	NA	10 U	100 U	NA	10 U	10 U	10 U
1,1,1-Trichloroethane	ug/L	5 U	25 U	NA	2 J	190	NA	5 U	5 U	5 U
Carbon Tetrachloride	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
Vinyl Acetate	ug/L	10 U	50 U	NA	10 U	100 U	NA	10 U	10 U	10 U
Bromodichloromethane	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
1,2-Dichloropropane	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
cis-1,3-Dichloropropene	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
Trichloroethene	ug/L	19	E	1500	38	E	6800	150	42	6
Dibromochloromethane	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
1,1,2-Trichloroethane	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
Benzene	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
Trans-1,3-Dichloroprope	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
Bromoform	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
4-Methyl-2-pentanone	ug/L	10 U	50 U	NA	10 U	100 U	NA	10 U	10 U	10 U
2-Hexanone	ug/L	10 U	50 U	NA	10 U	100 U	NA	10 U	10 U	10 U
Tetrachloroethene	ug/L	5 U	8 J	NA	12	190	NA	3 J	5 U	66
1,1,2,2-Tetrachloroethan	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
Toluene	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
Chlorobenzene	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
Ethylbenzene	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
Styrene	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U
Xylene (total)	ug/L	5 U	25 U	NA	5 U	50 U	NA	5 U	5 U	5 U

(2.5) = Dilution factor.

4-1

Quarterly Groundwater Sampling Analytical Results
March 1995
Black Decker (U.S.) Inc.

Parameter	Units	RFW-16 (250)	RFW-16 (500)	RFW-17	RFW-18	RFW-19	FIELD BLANK	TRIP BLANK	EW-1 (20)	EW-2 (50)
Chloromethane	ug/L	2500 U	NA	10 U	10 U	10 U	10 U	10 U	200 U	500 U
Bromomethane	ug/L	2500 U	NA	10 U	10 U	10 U	10 U	10 U	200 U	500 U
Vinyl Chloride	ug/L	2500 U	NA	10 U	10 U	10 U	10 U	10 U	200 U	500 U
Chloroethanane	ug/L	2500 U	NA	10 U	10 U	10 U	10 U	10 U	200 U	500 U
Methylene Chloride	ug/L	1100 JB	NA	13 B	20 B	13 B	3 JB	8 B	230 B	500 B
Acetone	ug/L	1400 JB	NA	10 U	10 U	10 U	7 JB	10 U	200 U	500 U
Carbon Disulfide	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
1,1-Dichloroethene	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
1,1-Dichloroethane	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
1,2-Dichloroethene (tota	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	270	250 U
Chloroform	ug/L	1200 U	NA	5 U	5 U	5 U	3 J	5 U	100 U	250 U
1,2-Dichloroethane	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
2-Butanone	ug/L	2500 U	NA	10 U	10 U	10 U	10 U	10 U	200 U	500 U
1,1,1-Trichloroethane	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
Carbon Tetrachloride	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
Vinyl Acetate	ug/L	2500 U	NA	10 U	10 U	10 U	10 U	10 U	200 U	500 U
Bromodichloromethane	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
1,2-Dichloropropane	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
cis-1,3-Dichloropropene	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
Trichloroethene	ug/L	E	75000	5 U	5 U	5 U	5 U	5 U	2200	5800
Dibromochloromethane	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
1,1,2-Trichloroethane	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
Benzene	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
Trans-1,3-Dichloroprope	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
Bromoform	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
4-Methyl-2-pentanone	ug/L	2500 U	NA	10 U	10 U	10 U	10 U	10 U	200 U	500 U
2-Hexanone	ug/L	2500 U	NA	10 U	10 U	10 U	10 U	10 U	200 U	500 U
Tetrachloroethene	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	42 J	120 J
1,1,2,2-Tetrachloroethan	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
Toluene	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
Chlorobenzene	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
Ethylbenzene	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
Styrene	ug/L	1200 U	NA	5 U	5 U	5 U	5 U	5 U	100 U	250 U
Xylene (total)	ug/L	1200 U	NA	5 U	5 U	5 U	5	5 U	100 U	250 U

(2.5) = Dilution factor.

4-1
Quarterly Groundwater Sampling Analytical Results
March 1995
Black Decker (U.S.) Inc.

Parameter	Units	EW-4 (100)	EW-5 (25)	EW-6	EW-7	EW-8	EW-9 (10)	EW-10 (2.5)	EW-10 (DUP)
Chloromethane	ug/L	1000 U	250 U	10 U	10 U	10 U	100 U	25 U	25 U
Bromomethane	ug/L	1000 U	250 U	10 U	10 U	10 U	100 U	25 U	25 U
Vinyl Chloride	ug/L	1000 U	250 U	10 U	10 U	10 U	100 U	25 U	25 U
Chloroethanane	ug/L	1000 U	250 U	10 B	10 U	10 U	100 U	25 U	25 U
Methylene Chloride	ug/L	1000 B	250 B	6 JB	9 B	9 B	110 B	19 B	26 B
Acetone	ug/L	1000 U	120 U	10 U	10 U	10 U	44 J	25 U	25 U
Carbon Disulfide	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
1,1-Dichloroethene	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
1,1-Dichloroethane	ug/L	500 U	120 U	5 U	2 J	5 U	50 U	12 U	12 U
1,2-Dichloroethene (tota	ug/L	500 U	120 U	2 J	19	26	50 U	12 U	12 U
Chloroform	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
1,2-Dichloroethane	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
2-Butanone	ug/L	1000 U	250 U	10 U	10 U	10 U	100 U	25 U	25 U
1,1,1-Trichloroethane	ug/L	500 U	27 J	5 U	2 J	1 J	50 U	12 U	12 U
Carbon Tetrachloride	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
Vinyl Acetate	ug/L	1000 U	250 U	10 U	10 U	10 U	100 U	25 U	25 U
Bromodichloromethane	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
1,2-Dichloropropane	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
cis-1,3-Dichloropropene	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
Trichloroethene	ug/L	11000	3800	8	24	14	19 J	4 J	4 J
Dibromochloromethane	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
1,1,2-Trichloroethane	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
Benzene	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
Trans-1,3-Dichloroprope	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
Bromoform	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
4-Methyl-2-pentanone	ug/L	100 U	250 U	10 U	10 U	10 U	100 U	25 U	25 U
2-Hexanone	ug/L	1000 U	250 U	10 U	10 U	10 U	100 U	25 U	25 U
Tetrachloroethene	ug/L	310 J	80 J	76	63	180	1300	460	490
1,1,2,2-Tetrachloroethan	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
Toluene	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
Chlorobenzene	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
Ethylbenzene	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
Styrene	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U
Xylene (total)	ug/L	500 U	120 U	5 U	5 U	5 U	50 U	12 U	12 U

(2.5) = Dilution factor.

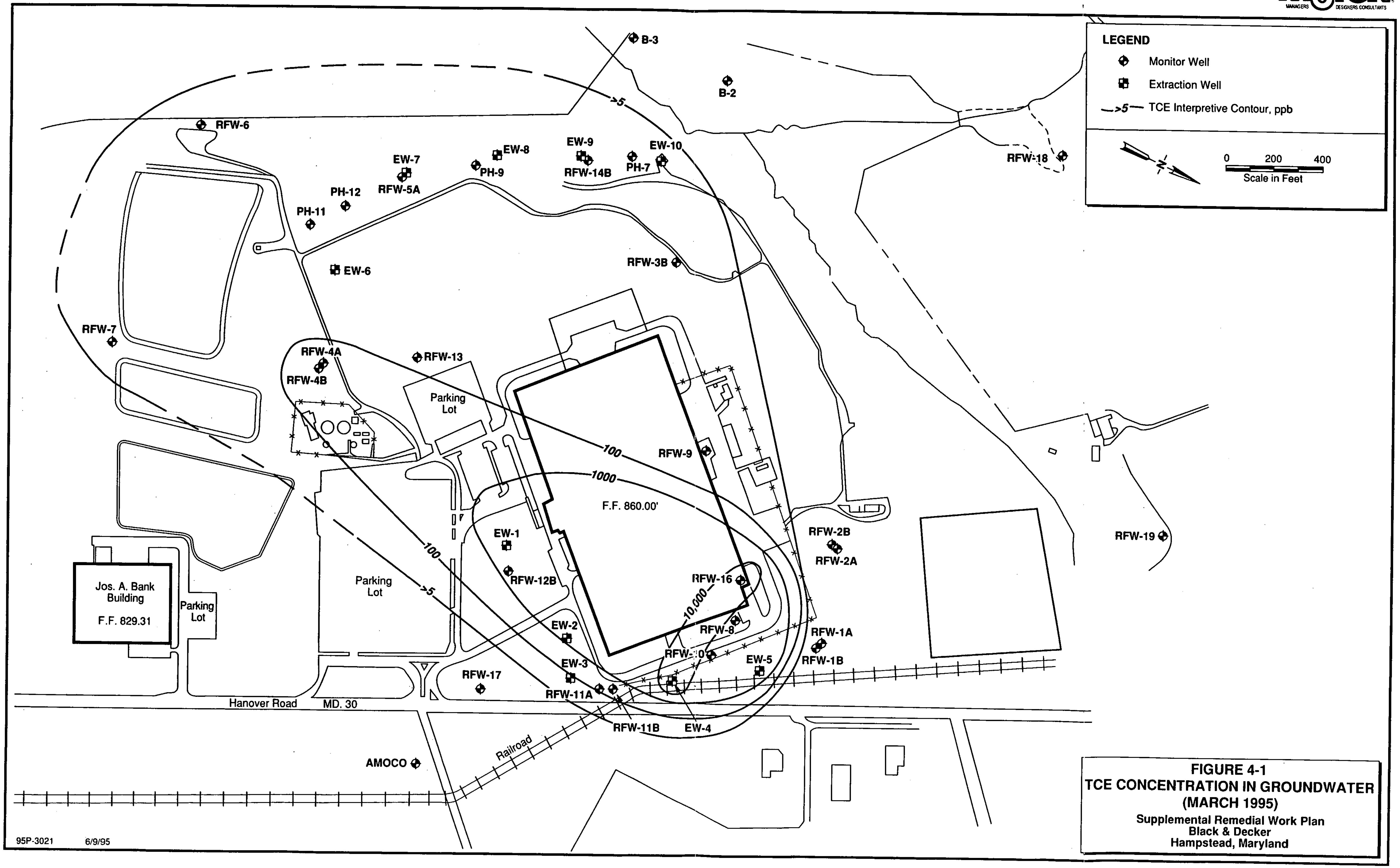


FIGURE 4-1
TCE CONCENTRATION IN GROUNDWATER
(MARCH 1995)
Supplemental Remedial Work Plan
Black & Decker
Hampstead, Maryland

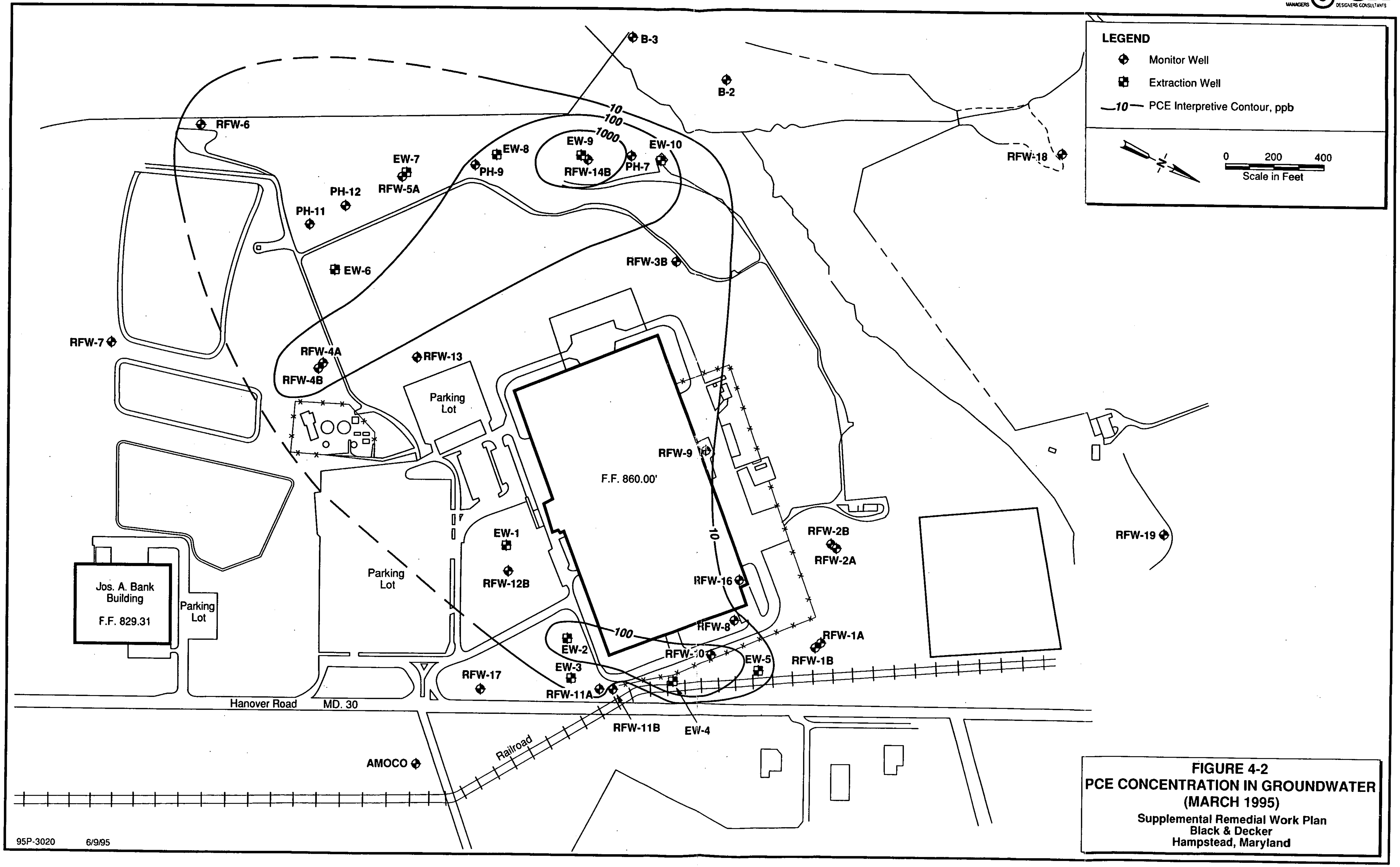


FIGURE 4-2
PCE CONCENTRATION IN GROUNDWATER
(MARCH 1995)
Supplemental Remedial Work Plan
Black & Decker
Hampstead, Maryland

There are several properties of liquid TCE which affect its behavior in the subsurface. Two of the more important parameters are density and absolute viscosity. Liquid TCE is more dense (specific gravity of 1.46) and less viscous than water (0.57 centipoise compared to 1 centipoise for water) (Huling and Weaver, 1991). These characteristics greatly affect the potential distribution of TCE in the subsurface because the high density allows the liquid to sink through the saturated zone and the lower viscosity results in a permeability with respect to TCE that is higher than the hydraulic conductivity of a medium. An excellent summary of these factors along with the other important properties of DNAPLs is provided in Huling and Weaver (1991).

Provided that a sufficient amount is released, TCE can travel as a separate phase to depths well below the zone of groundwater saturation. The porous medium properties which affect the movement of phase separate TCE include capillary pressure and the pore size distribution of the medium. These parameters are also reviewed in more detail in Huling and Weaver (1991). Research has demonstrated that small changes in pore size distribution of the medium can result in significant changes in both the capillary pressure and the permeability. These changes can affect the depth of penetration of the phase separate plume and the direction of horizontal movement in the subsurface(Mackay and Cherry, 1989; Huling and Weaver, 1991).

Although research has shown that extreme groundwater gradients can affect the movement of a dense phase separate fluid, and can result in extremely limited removal of fluid, groundwater withdrawal does not represent an effective method of remediating DNAPL movement(Huling and Weaver, 1991; Feenstra and Cherry, 1988). Newell et al (1991) report that between 30 and 90 percent of a DNAPL spill will likely remain immobile in the subsurface.

The complexities of the media will have the greatest effect on movement and the eventual distribution of the phase separate TCE. Unobservable microscale variations in unconsolidated materials can alter the distribution of the DNAPL, as will the presence of fractures on any scale in bedrock or in dense unconsolidated medium.

In the context of the Hampstead facility, the distribution of the phase separate TCE or PCE (if present) would be extremely complex. The geology, as described in this document, consists of schist/phyllite saprolite which grades from clayey silt at the ground surface to the underlying competent bedrock. The underlying bedrock is albite-chlorite schist phase of the Wissahickon Formation which is a tightly folded schist with quartzite vein intrusions, which are generally variable in orientation. The nature of the bedrock lithology along with the numerous deformational events recorded in the regional geologic record suggest wide variation in the relic bedding features and related fracture distribution and orientation on every scale. Since the overlying unconsolidated materials are weathered in place from the bedrock, the relic bedding and macro scale depositional features are reflected as lithologic changes in the overburden material. Given that these changes in saprolite lithology affect grain size distribution, effective porosity, and intrinsic permeability of the material, it follows that the capillary pressure conditions will be extremely variable in all directions. This means that the movement of a dense phase separate fluid would be very complex and erratic. The pathway from a suspected leak or spill site is expected to be tortuous.

In addition, the gradational change from highly weathered saprolite to slightly weathered bedrock, typical of the site and of the Wissahickon Formation in general (see Subsection 3.1), does not present a sudden and predictable change in material parameters that could be reliably used to identify DNAPL traps. The gradual change in material with depth creates a scenario where a dense phase separate fluid would tend to spread horizontally in unpredictable directions until some potentially very small zone of lower resistance is encountered. Such a zone may be represented by a quartzite vein or a micro fracture zone or related to relic bedding. In either case, predicting the likely pathway of the DNAPL and therefore locating a DNAPL pool if one exists is extremely problematic. In a review of groundwater remediation done in 1989, Mackay and Cherry state that:

"Furthermore, even after exceptionally detailed site investigations are conducted, it is normally not possible to predict reliably where these NAPL pools are."

Because predicting the pathway of a DNAPL through the subsurface at the Hampstead site is essentially impossible and the likely distribution and retention by the subsurface materials make removal equally unlikely, any additional attempt to locate a DNAPL pool is not recommended. A summary provided by Feenstra and Cherry (1988) states that "Regulatory agencies and industry must recognize the unique and exceptionally difficult nature of the problem posed by DNAPL chemicals in the subsurface in order to avoid futile or ill-conceived attempts to achieve aquifer cleanup."

SECTION 5
CONCEPTUAL SITE MODEL

5.1 GEOLOGIC COMPONENT

The geologic component of the Hampstead Site conceptual model is based on the more detailed discussion of the geologic setting provided in Section 3.0 of this work plan. The material underlying the facility consists of unconsolidated materials ranging from 32 to 119 feet thick, which result from the chemical and mechanical weathering of the underlying bedrock. The bedrock is the albite-chlorite schist facies of the Wissahickon Formation. A schist is a metamorphic rock which has been subjected to multiple deformational events which result in the folding and fracturing of the bedrock. These repeated stresses result in relic bedding features and fracture sets which are oriented in many different directions over relatively short horizontal and vertical distances. In addition, the recent deformational events have included the intrusion of hydrothermal quartzite deposits into weakened areas of the bedrock. These quartzite veins serve to further complicate the pattern of fractures and relic bedding features that represent the secondary porosity of the bedrock.

Since the unconsolidated overburden is weathered in place from the highly variable bedrock, the texture of the overburden material is also highly variable. The degree of weathering also varies both horizontally and vertically which serves to compound the variations possible in the unconsolidated zone. The weathering process is generally made up of two major components. They are the mechanical weathering that initially breaks the bedrock into fragments along the upper surface of the rock, and the chemical weathering that continues to weaken the rock matrix and create successively smaller fragments. Since chemical weathering depends upon the exposure of the rock to air and water (precipitation), the process proceeds from the surface downward. As depth increases, the degree of mechanical weathering increases and the degree of chemical weathering decreases. As a result, the saprolite decreases in clay/silt content with depth, gradually transforming into severely broken bedrock and then to fewer and fewer fractures in increasingly competent bedrock until a point is reached where there has been no significant chemical weathering. This gradational change from soil through saprolite to competent bedrock occurs through a thickness of a few feet in places to several tens of feet in other areas but is always present. For the purposes of this conceptual model, the vertical profile is broken into three zones: the saprolite which contains the lower soil horizons and the most highly weathered material, the transition zone which is made up of the lowest portion of the highly weathered zone in which some relic bedrock structural features are present and the portion of the profile that includes highly fractured bedrock with some chemical weathering in the fractures, and finally the competent bedrock which has few to no fractures and little chemical weathering. This conceptual model is illustrated by Figure 3-1. It is important to note that this conceptual model involves a gradual change in subsurface conditions rather than an abrupt change from unconsolidated material to a smooth competent bedrock surface. Also because of the highly fractured nature of the transition zone, no primary orientation of fracture sets is expected to remain.

5.2 HYDROGEOLOGIC COMPONENT

The hydrogeologic component of the conceptual model is based on the geologic model described above along with the hydrogeologic setting described in Section 3.2 of this Work Plan. Using the terminology developed above for the geologic conceptual model and the water elevation data collected for the Hampstead facility, the groundwater at the site occurs in the transition zone. Review of the data collected from the onsite wells suggests that the transition zone ranges from 20 to 60 feet in thickness and that wells located in this zone consistently provide the highest yields. Pumping tests performed at the site show that the transmissivity of the transition zone ranges from 4000 gpd/ft to 8000 gpd/ft which is typical of highly fractured bedrock conditions.

Since the majority of the observed groundwater at the site is occurring in the transition zone where any bedrock fracture orientation originally present has been largely overwhelmed by subsequent weathering, no preferred regional flow pathways are expected. The results of the pumping tests performed on the site were evaluated for anisotropy and the results confirm that there are no strong preferential flow directions present in the zone tested. The values calculated for the ratio of highest transmissivity to lowest transmissivity based on direction from the pumping well varied from 1.2 to 1.9 (Section 3.2.2.1). This suggests that the highest transmissivity is approximately twice the lowest value. This variation is less that the variation typical between pumping tests performed in the same well at different times and does not reflect the magnitude expected from fracture influenced flow. More typical of conditions where bedrock fracture fabric controls actual groundwater flow directions are anisotropy ratios of 10 to 1000. Based on this analysis, the transition zone behaves as a porous medium at the scale of the site groundwater flow regime.

Groundwater flow under natural conditions in the transition zone is generally southwest with secondary components to the south and east. This is illustrated in Figure 3-6 which also shows that the groundwater potentiometric surface generally mimics topography. The groundwater high is located near the topographic high in wells RFW-2A and 2B. Based on topographic position and evaluation of vertical hydraulic gradients, the area of the groundwater high represents a groundwater recharge area. Well RFW-6 shows the lowest groundwater elevation of the onsite wells and is also located in a topographic low near the stream in the southwest portion of the site. Groundwater is typically less than 1 foot below the ground surface in this area. The apparent relationship between groundwater levels and the level of water in the adjacent stream along with topographic position suggests that this area is a groundwater discharge zone. Under natural conditions, groundwater is being recharged in the higher portions of the site to the northeast and moves generally toward the southwest to a discharge point along the stream.

The natural groundwater flow pattern has been redirected with the installation of the groundwater remediation system at the Hampstead site. This system is designed to control groundwater flow from the Hampstead site such that contaminated groundwater is captured by the recovery well network. The groundwater flow direction on the northeast portion of the site remains similar to pre-pumping conditions; however, as groundwater moves to the southwest, it is diverted by the pumping stress into one of the recovery wells. The modification of the flow patterns also effects the flow components which were previously to the east and south. These patterns are modified such that no groundwater which passes near or under the former plant or potential source areas continues to move off site but is captured by a recovery well instead.

5.3 CONTAMINATION COMPONENT

The distribution of contamination is an important component of the conceptual model and is based on the data reviewed in Section 2.0 of this Work Plan. The distribution of observed contaminants can be grouped into three topics: the TCE in groundwater, the PCE in groundwater and the TCE and PCE in the soil near Tank Farm 2. The TCE distribution in groundwater is based on the monitor and recovery well network and is shown in Figure 4-1. This distribution of TCE is believed to be a result of activities in the area of Tank Farm 2 and the natural flow pattern of groundwater at the site. TCE inadvertently released in the area of the former Tank Farm 2 location would distribute as residual DNAPL and would be available for solution into groundwater directly or into infiltrating rainwater.

The PCE contamination in the groundwater is much more problematic. The distribution of the PCE in the groundwater is limited compared to TCE, suggesting a more complex movement scenario. The highest PCE concentrations are found along the western boundary near well EW-9, which is inconsistent with the distribution of contaminants likely released near Tank Farm 2.

The soil around and beneath the former Tank Farm 2 was found to have potentially significant levels of TCE and PCE. Although sampling showed concentrations in the vadose zone that were determined to be high enough to contribute to groundwater contamination, no clear evidence of phase separate TCE was found. It is possible that residual TCE still resides in the soils near the Tank Farm; however, because of the nature of DNAPL behavior in the subsurface and the highly variable nature of the unconsolidated material at this site, it is unlikely that any recoverable DNAPL exists. Still, because this source area is recognized, vadose zone remediation in this area is warranted and planned to achieve an accelerated groundwater remediation.

5.4 CONCEPTUAL MODEL SUMMARY

Groundwater exists at the Black & Decker Hampstead facility primarily in the transition zone between unconsolidated material and competent bedrock. The transition zone varies in thickness and in aquifer parameters based on the nature of the parent material and the topographic position. The groundwater flow in the transition zone under natural conditions was generally southwest from recharge areas located on topographic highs to discharge areas located on streams in topographic lows. The high degree of mechanical weathering in the transition zone results in a high degree of isotropy and resulting ability to maintain pumping influence laterally throughout the zone. Contaminants entered the groundwater through spills around the former Tank Farm 2 and from another unidentified and potentially offsite source. Contaminant migration was controlled by natural groundwater flow regime flowing primarily to the southwest and bounded by discharge zones. The current remediation system is effectively capturing the groundwater in the transition zone and controlling continued migration of contaminants.

SECTION 6
DATA GAPS AND RECOMMENDATIONS

6.1 BEDROCK TOPOGRAPHY

Mapping of bedrock topography using surface geophysics or other methods has been suggested by the MDE as a means of identifying potential DNAPL accumulation areas at the site. Based on the site conceptual model (Section 5), further refinement to the bedrock topography using surface geophysical techniques does not seem feasible or warranted at the Hampstead site. Surface geophysical methods are used to delineate various buried targets or features (including bedrock topography), by indirectly measuring various physical properties of a target in relation to its surrounding environs. The effectiveness of the method is, in large part, a function of the contrast between the physical properties of the target with its surroundings. If the contrast is small, or gradational, then the target may not be resolved, and the data can lead to an erroneous interpretation.

Seismic refraction is the principal method for the mapping of bedrock topography, as well as other hydrogeologic units. The seismic refraction method measures the rate (or velocity) at which acoustic wave energy propagates through the various units of the subsurface. A detailed explanation of the applications of the seismic refraction method and the theory of wave energy propagation (Snell's Law) have been widely published (e.g. Dobrin, 1976, Redpath, 1973, and Telford et. al., 1976), and will not be discussed here. The key aspect of the refraction method is that the travel path of an acoustic wave (raypath) is refracted, or bent, at some subsurface velocity contrast boundary according to Snell's Law. The more distinct the velocity contrast boundary, the more accurate the depth calculation.

The contact between overburden and bedrock at the Hampstead site, however, is not distinct. Reduction in the degree of chemical weathering with depth in the saprolite has caused the contact to be gradational from the standpoint of acoustic velocities, and, as a result, the interface between weathered and competent bedrock is too gradational to be resolved in a meaningful way relative to potential DNAPL accumulation areas.

In his paper, "Problems of Shallow Refraction Investigations," Domzalski (1956) points out that where bedrock has been exposed to weathering, the interface will not be a well-defined plane but rather a transition zone. Typically, the refracting horizon will correspond to a deeper bedrock reflector and not to the target horizon. As such, based on WESTON's experience and on published material, seismic refraction would only be useful to evaluate regional bedrock structure, and not site-specific features.

Other geophysical methods (such as seismic reflection, resistivity, and conductivity), would also not be applicable for bedrock refinement at the Hampstead site. Again, the gradational nature of the saprolite/bedrock interface would not provide sufficient contrast for these remote sensing techniques. Further, as noted in the conceptual model (Section 5) and as previously discussed in the work plan, even if bedrock lows could be identified, due to the complex fabric of the saprolite underlying the site, that DNAPL would reach a "bedrock surface" and accumulate in low areas seems highly unlikely.

6.2 FRACTURE TRACE ANALYSIS

Fracture trace analysis has been requested by the MDE as a means to identify potential preferred zones of groundwater movement. Fracture traces are defined as "... natural linear features consisting of topographic, vegetation, or soil tonal alignment, visible primarily on aerial photographs and expressed continuously for less than one mile." (Lattman, 1958). In many locales, fracture traces have been found to be expressions of zones of higher fracture concentrations, and as such can be ideal candidates for increased groundwater flow along their length.

As indicated in the site conceptual model discussion in Section 5, and elsewhere in the work plan, most of the water produced by wells at the site is derived from the lower part of the saprolite, above bedrock, an interval referred to here and in the literature as a "transitional zone". This zone behaves as a porous media, being composed largely of mechanically weathered and broken rock. Preferred orientations of flow have not been observed; rather, a test for bedrock anisotropy revealed very minimal structural influence on groundwater flow. As a result, complete capture of on-site groundwater flow by the groundwater remediation system is indicated. However, a plan for fracture trace analysis on the site is herein developed and will be implemented in accordance with the schedule provided in Section 7.

WESTON will obtain stereographic pairs of aerial photographs encompassing the Hampstead facility and immediately surrounding area. Each pair to be viewed will consist of at least two consecutive aerial photographs with overlapping coverage of an area that will create a three-dimensional image when viewed through a stereoscope.

Photographs will be selected to provide coverage of the area under natural conditions and during different seasons. Aerial photographs taken prior to the construction of the facility and development in the surrounding area, if of sufficient quality and detail, may be preferable because development and urbanization tend to obscure fracture traces. Photographs taken at different seasons allow seasonal effects to be identified.

Photographs will also be selected, if possible, to provide different scales. Variable scales will allow different sizes of features to be identified; for example, a suspected fracture trace seen only on a coarser scale photograph may be clearly resolved as a fence or other feature on a finer scale photograph. Some fracture traces may only be visible at finer scales, and others at coarser scales.

To complete the fracture trace analysis, the three-dimensional images on the stereo pairs selected will be studied to observe features such as tonal changes, vegetative patterns, straight stream segments, and other anomalies that may be indicative of fracture traces. The observed potential traces will be annotated on overlays to the photographs. The overlays will then be enlarged or reduced as appropriate to the same scale as a site map and will be transferred to the map.

The site map showing the tentatively identified fracture traces then will be used to perform field checking. Field checking will be performed to determine if the photolineations mapped from the aerial photographs are actually cultural features or natural features by locating and walking the tentatively identified traces.

Following the field checking exercise, the results of the fracture trace analysis will be documented in a report to be submitted to the MDE. The report will incorporate a map of the traces, a map plotting the orientations of the traces on a rose diagram to show any major trends detected, a summary of the results of the field review, and any other significant observations or conclusions.

6.3 LAGOON SAMPLING

Sampling of surface water and sediment in the East and West Lagoons at the site has been requested by the MDE. Surface water and sediment sampling results were initially reported in the EIR.

WESTON will collect three surface water and three sediment samples from each of the two lagoons. The sampling will occur twice during a one year period following incorporation of the work plan into the administrative record. Samples will be collected following procedures described in the Sampling and Analysis Plan (SAP), and will be analyzed for VOCs following EPA approved methods as outlined in the SAP. Because samples will be collected from a boat, the exact locations are not determined, but will be generally evenly spaced in each of the lagoons. Results of the sampling and analysis will be documented and reported to the MDE.

6.4 BRUSH PILE INVESTIGATION

Sampling of soils in an area near the west side of the facility has been requested by the MDE. This area, referred to as the "brush pile", is an area approximately 50 feet long and 25 feet wide where downed tree limbs and other vegetative debris has been piled and allowed to decompose.

Sampling of soil in the brush pile area will be performed using a backhoe to excavate test pits. Procedures to be followed to excavate the test pits are described in the SAP. In general, the backhoe will be used to remove the vegetative debris, and then to excavate soil until either groundwater is encountered, the reach of the backhoe is exceeded, bedrock refusal is encountered, or some other condition prohibits continued excavation. All soils excavated will be field screened for the potential presence of VOCs; representative samples will be submitted to the WESTON Environmental Metrics laboratory for VOC analysis following EPA approved methods as described in the SAP. It is anticipated that approximately six test pits will be excavated to provide a thorough picture of subsurface conditions in the brush pile area. All results from the brush pile investigation will be documented, summarized, and submitted to the MDE in report form.

SECTION 7

SCHEDULE AND REPORTING

Consistent with Condition IV.V. of the Consent Order, it is anticipated that implementation of the tasks described in the Supplemental Remedial Work Plan will begin within 30 calendar days following approval of the plan by the MDE. The work will begin with mobilization and planning activities, to be followed by field investigative efforts as described in Section 6 and as further detailed in the SAP. The MDE will be notified five business days prior to mobilization.

Following completion of investigations and receipt of laboratory data, reports will be prepared as described in Section 6 of the work plan. It is anticipated that reporting will be complete within 60 days following receipt of final analytical reports from the laboratory for the samples collected as part of the described investigations.

In addition, it is anticipated that during implementation of the field tasks, monthly progress reports will be provided to the MDE. These reports will describe briefly the status of the investigative efforts and will note any findings of particular significance to the remediation efforts at the site.

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