Final Report
Hydrogeologic Assessment
Western Processing
Kent, Washington

Prepared for
GCA Technology Division
Bedford, Massachusetts

Subcontract No. (1-625-172-222-001)
EPA Prime Contract No. 68-01-6769
Work Assignment No. 84-172

October 16, 1984
J-1377

HART CROWSER & associates inc.
GEOTECHNICAL & HYDROGEOLOGIC CONSULTANTS

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J-1377

October 15, 1984

GCA Technology Division
213 Burlington Road
Bedford, MA 01730

Attn: Mr. Pablo Huidobro

Re: Final Report
Hydrogeologic Assessment
Western Processing
Kent, Washington
Subcontract No. 1-625-172-222-001

Dear Mr. Huidobro:

Two copies of our final report related to the Western Processing site are attached. We have also forwarded two copies to Region X EPA. The final report incorporates comments 1, 2 and 4 outlined in your September 26, 1984 letter which was prepared after review of our draft report.

The other comments are requesting additional analyses which we are in the process of completing. As we discussed in our conversation on October 10, 1984, we will forward the results of the analyses to you in a separate letter.

If you have any questions please call.

Sincerely,

HART-CROWSER & ASSOCIATES, INC.

MATTHEW G. DALTON
Senior Associate Hydrogeologist

MGD:sek

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FINAL TECHNICAL REPORT
HYDROGEOLOGIC ASSESSMENT
WESTERN PROCESSING, KENT, WASHINGTON

INTRODUCTION

This report presents the results of our hydrogeologic assessment of the Kent Valley and the Western Processing site located in Western Washington State (Figure 1). The purpose of our work was to assist GCA Technology Division of Bedford, Massachusetts, in providing technical support to on-going investigations and litigation relative to the Western Processing site. Our work included:

- Compiling and preparing a bibliography of available data related to: hydrogeology, primary and secondary contaminant sources, and contaminated media.

- Assessing the available data for:
  - critical data gaps,
  - the hydrogeologic setting of Kent Valley, Washington,
  - primary and secondary contaminant sources, and contaminated media,
  - hydrogeologic factors affecting pollution migration,
  - potential pollution migration pathways.

- Providing input for evaluation of potential receptors.

- Attending meetings and briefings as requested.

Data sources are listed in Appendix B. This report was prepared using generally accepted hydrogeologic practice, for the exclusive use of GCA Corporation for specific application to the project site and the stated project objectives. No other warranty expressed or implied is made.

SITE BACKGROUND

The Western Processing site is situated within the Kent Valley, Washington within Township 22 North, Range 4 East, Section 1, west of the Cascade Mountains (Figure 1). The valley trends in a north to south direction with glacially capped uplands forming the valley walls to the east and west (Figure 2). Site elevations range between approximately 22 and 40 feet (mean sea level).

The major valley surface drainage course is the Green River which flows northward toward Puget Sound. In the vicinity of Western Processing the river flows along the west valley wall, approximately 4,000 feet to the west of the project site.

Surface water drainage in the immediate site vicinity includes Mill Creek on the west and two drainage ditches on the east (Figure 5). A tributary to Mill Creek located to the south was diked and filled between 1960 and 1968 (CH2M Hill Draft Report, 1983). Other shallow drainage courses are present within the valley floor.

The climate of the Kent Valley is predominately a mid-latitude, west coast marine type characterized by cool, dry summers and mild, rainy winters. The two weather stations closest the Western Processing site are located at Kent, Washington and at the Seattle-Tacoma Airport. Published weather data for the period of record from 1931 to 1960 at these stations (Washington State University, 1968) report the following average climatic conditions:

- Annual mean temperature is approximately 51 ^{o}F. Temperatures during the summer months average in the 70's (^{o}F), while the winter temperature ranges from the upper 30's to lower 40's (^{o}F).

- Average annual precipitation is 38 to 39 inches with approximately 85 percent occurring between October and April.

Western Processing purchased the site and started operations in 1961 (CH2M Hill Draft Report, 1983). Reported site activities include:

- Reprocessing of animal by-products and brewers yeast.
- Recovery of heavy metals and waste solvents.
- Reclamation of flue dust, metal finishing by-products, and ferrous sulfide in fertilizer production.
- Neutralization of acids and caustics.
- Chemical recombination to produce zinc chloride and lead chromate.
- Electrolytic destruction of cyanide.
- Reprocessing of pickle liquor.

From 1961 to present, the site layout has been altered by excavation and filling; construction, abandonment and reconstruction (at differing locations) of storage and treatment lagoons, storage tanks and buildings; and deposition of wastes such as foundry sands and chromic hydroxide sludges. Inspections made in May 1982 by the Environmental Protection Agency (EPA) and Washington State Department of Ecology (WDOE) indicated that "housekeeping" on the site was poor (CH2M Hill Draft Report, 1983). Drums and bulk storage tanks containing various chemicals were in poor condition and were leaking. Numerous areas of spilled material were observed.

SUMMARY OF FINDINGS

- Soil, ground water, and sediment (Mill Creek and drainage ditches) have been contaminated with metals and organic chemicals by activities associated with Western Processing.

  - The greatest amount of soil contamination occurs on-site. Off-site soils have also been contaminated, but to a much lower degree. The off-site soil contamination was likely caused by spills, and surface water runoff (north of site). The spills may not have been directly related to on-site Western Processing operations.

  - Shallow ground water beneath the site (less than 40 feet) has been contaminated. However, ground water greater than 40 feet deep, and off-site ground water does not appear to have been significantly contaminated.

  - Creek and ditch sediments have also been contaminated either by surface water or ground water contaminant migration, or by spills.

- Contaminant migration off-site can occur either by surface or ground water flow. However, the possible extent of the migration is limited by:

  - Soils, at depths of less than about 40 feet, which are interbedded with low hydraulic conductivity strata (silt and clay layers), which restrict the downward migration of contaminants.

  - Regional upward flow gradients which also restrict the downward migration of contaminants.

  - Drainage courses (Mill Creek and east ditches) which act as ground water divides and discharge areas. These divides restrict the lateral migration of contaminants.

- Mill Creek is the major receptor of contaminant migration. This is reflected in Creek sediment contamination.

- No known major water supplies have been affected by the site. The nearest municipal well supplies are located approximately 6,500 feet to the southeast of the site. These wells serve the City of Kent. Contamination of the aquifer is very unlikely in that the aquifer does not extend into the valley sediments, the wells are hydraulically up-gradient, and high upward vertical flow gradients are present in the wells vicinity. The Kent water wells are reported to be flowing artesian wells with static water levels that are tens of feet higher than the ground surface.

- Secondary sources of contamination exist within the valley. However, based on the available data, it does not appear that these sources have affected soil, ground water or sediment quality in the vicinity of Western Processing.

CRITICAL DATA GAPS

- Limited ground water quality data exist for deep ground water beneath the site and shallow ground water located to the west and northwest of Mill Creek.

- Time series ground water quality data which are required to assess seasonal changes in contaminant concentrations are not available.

- Trans 1, 2 Dichloroethene was detected in two off-site deep wells (34 and 35). The source of this contamination is unknown in that the hydrogeology of the site would tend to make it difficult for this contaminant to migrate to these wells from the Western Processing site.

REGIONAL HYDROGEOLOGIC SETTING

Geologic History

The Western Processing site is situated in the lower Green River Valley, (hereafter called the Kent Valley), formerly a deep marine embayment that has been filled with sediments since the close of the last glaciation (Vashon Glaciation). The valley is bounded by glacial drift plain uplands to the west and the east. The valley extends north to Renton and south to Auburn. The general geologic history (Luzier, 1969) of the valley and vicinity is summarized as follows:

- Tertiary sedimentary and volcanic rocks of the Puget Group were deposited in a subsiding coastal plain which occupied the Puget Sound lowland area. This bedrock forms the base of the thick unconsolidated glacial and non-glacial deposits in the area. Bedrock outcrops intermittently near Tukwila and Renton along the east valley wall and occurs at depth in the east upland.

- Advance of the glaciers into western Washington deeply carved the Kent Valley while depositing meltwater outwash deposits chiefly composed of sand and gravel, and dense compacted glacial till in the upland area. Dense glacially overridden deposits found at depths of roughly 500 feet in the valley near Auburn (Hart-Crowser, 1982 and 1983) are believed to mark the original valley floor.

- Retreat of the glaciers left the valley as a deep marine embayment. The Green, White (pre-Osceola course), and Cedar Rivers deposited a thick accumulation of sediment in the valley which were eroded from the glacial drift uplands. The sediments are typically coarse sand and gravel near the mouth of the rivers at Auburn (Green River) and Renton (Cedar River) and become finer silt and clay with distance toward the Kent area.

- The Osceola Mudflow of Mount Rainier origin flowed down the former White River valley and into the embayment covering much of the older alluvial deposits. As a result of the mudflow, the White River changed its course to its present day mouth near Auburn. Deposits of the newly eroding White River filled the marine embayment to above sea level.

- The White and Green Rivers continued depositing sediments until the White River was rerouted to the south in 1906. Today only the Green River occupies the valley.

Geologic Units and Ground Water Resources

Five major geologic units occur in the area of the Western Processing site which are significant to understanding the regional ground water movement. These units are depicted in plan view on Figure 2 and are shown in cross section across the valley in Figure 3.

Several of these units act as aquifers and provide water used for domestic and municipal purposes. The general distribution of water wells in the area is presented on Figure 4. These locations are based on wells contained in publications and the well log files of the WDOE. An inventory of the wells on record was performed by Ecology and Environment Inc. (Memorandum, May 2, 1984) to locate existing water supply wells less than 200 feet deep and within a three mile radius of the Western Processing site. They identified only 4 wells (3J1 and 36H1 (T22N R4E), 6B1 (T22N R3E) and an undocumented one) still in existence. An actual field well inventory was not made.

From youngest to oldest the geologic units include:

1) White River Alluvium (Qaw) is a collective designation for the valley fill deposits that occur throughout the valley and beneath the Western Processing site. The alluvium consists predominately of sand, silt and clay with occasional layers of sandy gravel to depths of over 360 feet in the site vicinity as evidenced by the deep boring DB-01 and other wells drilled to below this depth (24C1 (T22N, R4E) on Figure 4, and Hart-Crowser, J-1079).

   White River alluvium is not considered to be a major ground water source in the Kent area because of generally low permeability and poor water quality. Many of the wells for which data is available indicate a sulfur odor, natural gas, and/or high iron levels in the water (Luzier, 1969, Table 9). The available well capacity data indicate well yields are generally less than 100 gallons per minute. In addition, electrical conductivity measurements made on water samples taken from off-site wells (Wells 35 to 44) showed the conductivity of the water to increase significantly with depth from approximately 250 micromhos/cm above 50 feet to over 1,000 micromhos below roughly 100 feet (See Table 3, Alternative Assessment Study, April, 1984).

2) Vashon glacial deposits (Qvu) constitute the surficial deposits of the upland areas and are estimated to be roughly 100 to 200 feet thick. The deposits generally consist of sand and gravel recessional outwash near the surface overlying a significant thickness of dense glacial till which in turn overlies advance outwash sand. Many wells tap the sand and gravel layers within these deposits in the west upland area, primarily for domestic water supply, however, the deposits appear to be largely unsaturated in the east upland area. The Vashon deposits occur well above sea level and the existing valley floor.

3) Salmon Springs Deposits (Qss) occur below the Vashon deposits and flank the valley wall on both the east and the west side. The Salmon Springs is known for its deposits of sand and gravel which form a good aquifer

tapped by many deep wells in the upland areas. The Salmon Springs occurs predominately above sea level with the base approximately at or near the elevation of the existing valley floor.

4) Older Undifferentiated Glacial and Interglacial (Qou) deposits lie below the Salmon Springs and consist of thick sequences of low permeability silt and sand with layers of more permeable sand and gravel. A deep sand and gravel layer occurs between roughly 100 and 200 feet below sea level. This zone is tapped by two King County Water District #75 (KCWD #75) wells in the west upland area and is the principal aquifer tapped by the City of Kent (Figure 4). This aquifer does not appear to extend across the valley as evidenced by deep wells which penetrate into valley alluvium below this elevation, and as indicated by the erosional glacial history of the valley (Figure 3).

5) Bedrock of the Puget Group (Tp) forms the base of the unconsolidated glacial and non-glacial deposits. The bedrock outcrops at the north end of the valley, and along the northeastern valley wall, and occurs at a depth of approximately 300 feet in the east upland area as shown on Figure 3. The bedrock is very roughly projected to lie at a depth of greater than 800 feet below the existing valley floor (Hall and Othberg, 1974). Bedrock does not generally yield significant quantities of good quality water to wells in the area.

Ground Water Flow System

The regional ground water flow system in the Western Processing vicinity can be characterized by recharge within the uplands and discharge to the Green River Valley. The principal regional ground water flow directions are illustrated in Figure 2.

Recharge from precipitation is estimated to average between approximately 7 to 9 inches per year in the area (Hart-Crowser, 1982). In the uplands, rainfall that infiltrates the root zone flows downward under the influence of gravity to the saturated zone. Once in the saturated zone ground water flows through the more permeable layers both downward and laterally towards ground water discharge points within the system, such as streams and springs. Downward vertical flow in the uplands is indicated by water levels that show a distinct decline in the static head with depth. This is illustrated on Figure 3 where well water levels decline with depth. Horizontal flow towards the Kent Valley is indicated by water levels of wells completed (at similar elevations) in both the Salmon Springs and the Older Undifferentiated deposits.

The Green River acts as the primary discharge point for the regional hydrologic system. The valley vertical gradients show a general increase in static head (except directly beneath the Western Processing site) with well depth as illustrated by numerous flowing wells in the east valley area (including the City of Kent wells) where the static heads are above ground surface. Gaging data also indicates that the Green River is a gaining river.

VALLEY AND SITE HYDROGEOLOGIC SETTING

Geologic Units and Hydraulic Conductivity

White River alluvium lies beneath the Western Processing site as shown on Figures 2 and 3. In the vicinity of the site the alluvium consists predominately of interbedded silt, sand, clay and various combinations thereof with occasional intermittent thin gravelly layers. As previously mentioned, these deposits occur to over 300 feet. Available soil logs were assessed to determine the occurrence and layering of geologic units within the alluvium. Figure 5 presents a plot of the well and boring data locations for the vicinity within a mile of Western Processing (with the exception of wells and borings on and near the site which are located on Figure 6).

White River alluvium can be divided into two subunits within the top 100 feet in the site vicinity. These are designated as Unit 1 and Unit 2. The subsurface distribution of the two units is shown on three geologic cross sections presented in Figure 7.

Unit 1 occurs between the ground surface and roughly 40 feet depth. It consists of a mixture of sand, silt, clay and peat as well as pockets of fill material consisting of silt, sand and gravel which range from a few feet to as much as 24 feet in the south area of the site near Well 22 where battery casings were found to this depth. Boring data indicate that intermittent silty clay stratum 5 to 10 feet thick are present within Unit 1. Two distinct layers appear to be present including a layer situated at a depth of less than about 15 feet and a layer situated between a depth of 30 and 40 feet. The two fine grained layers are separated by coarser grained materials (mostly silt and sand). Figure 8 shows the aerial extent of the shallower silty clay layer. As shown, the layer appears to be present beneath the north portion of the site.

Unit 2 occurs roughly between 40 feet and 90 feet depth and consists predominately of fine to medium sand with occasional layers of silty and/or gravelly sand. The Unit 2 sand has often been logged as containing black, red, and white grains making it a distinctive marker between borings. Unit 2 was distinguishable primarily in the deep off-site wells (drilled below 30 feet) and was found to generally occur throughout the vicinity based on other soil borings available to us (See Other Consultant Reports in Data Sources). Although only a few wells extend below 40 feet on the site, these indicate the Unit 2 sand likely occurs below the fine grained Unit 1 strata.

The hydraulic conductivity of Unit 1 sand is approximately an order of magnitute lower than the Unit 2 sand. We estimate, using pump test and slug test data (CH2M Hill, April 1984), the hydraulic conductivity of Unit

1 to be approximately 1 to 10 ft/day (3 x 10^{-4} to 3 x 10^{-3} cm/sec) and Unit 2 to be 10 to 100 ft/day (3 x 10^{-3} to 3 x 10^{-2} cm/sec). These values appear reasonable for the type of soil tested, however, they are based on only three tests from wells completed in Unit 1 and four tests from wells completed in Unit 2 (Table 1). Tests conducted in wells which were screened in both Unit 1 and Unit 2 were not used to estimate the hydraulic conductivity range of the units. Lower hydraulic conductivity zones appear to exist within the units based on the soil logs.

Ground Water Flow Directions

The horizontal and vertical flow directions in the site vicinity are typical of a ground water discharge area with upward vertical hydraulic gradients and ground water discharge to the Green River and other surface water drainage courses. Ground water flow in the valley (based on water level data contained in Table 1) is generally to the northwest toward the Green River as shown on Figure 9. The regional horizontal flow gradient is estimated to be on the order of 0.002 feet/foot. These flow directions are likely most representative for conditions within Unit 2.

Ground water flow patterns within Unit 1 (shallow ground water system) are more complicated because of the hydraulic effects of surface drainage courses, such as Mill Creek. In these areas both the vertical and horizontal flow gradients may vary from the general conditions discussed above.

Vertical flow gradients were determined using well nests (i.e., two or more piezometers or wells installed at the same location and completed at different depths) that were installed for the Western Processing site studies. Figure 10 presents a plot of the well depth versus water level elevation for the available well nest data for three different time periods.

The graph illustrates that for wells located off the site and below approximately 30 feet in depth, as well depth increases, the well water levels rise in elevation (indicating upward vertical flow gradients). The data indicates an average upward hydraulic gradient of about 0.02 feet/foot. It is likely that, off the Western Processing site, this condition will be present at depths less than 30 feet (data was not available to assess this condition).

Immediately beneath the site in Unit 1, vertical downward flow gradients are present which appear to be related to a ground water mound which has formed beneath the site. The downward gradients are strongest within the middle of the site (approximately 0.10 feet/foot) as indicated by water levels made in wells 17S and 17D. The downward trend becomes less pronounced as the site periphery is approached as indicated by water level data in wells 1 and 25.

The well data which shows the upward gradients below 30 feet was obtained from off-site wells. Two well nests MB-01 and MB-02 and the Westbay installation MB-03 were installed on site. Data from these wells indicate that a horizontal flow condition occurs at depth beneath the site. Only one data set for the MB-01 and MB-02 installation has been collected to date and it is reported that the Westbay has not been fully developed. The limited deep well data beneath the site indicate that the mound may be locally reducing the upward vertical flow gradients.

A ground water mound occurs in the center of the site which controls the local ground water flow system. The mound can be seen by the water table elevation contours presented on Figure 8. The contours show flow from the mound to Mill Creek on the west, the drainage ditches on the east, and a portion of flow to the south near the area of Well 22S and Well 22D. The mound is likely caused by a variety of factors including ponding of water on-site, variations in soil hydraulic conductivity and drainage outlets located on the site periphery.

Seasonal variations in water level of at least four feet occur based on the available data, with the highest water levels occurring during the spring months and the lowest in the early fall. This is consistent with precipitation and stream flow data for this area.

PRIMARY AND SECONDARY CONTAMINANT SOURCES

The primary sources of contamination at the Western Processing site are due to reclamation and recycling activities which occurred during the site's operation. These activities are summarized by a report prepared by CH2M Hill (Draft Report, October, 1983). Figure 11 shows a summary of the major locations of metal and/or organic compound storage and processing areas.

Potential secondary sources were considered as those manufacturers, processors, tranporters and/or users of the contaminants found in the vicinity of the Western Processing site. These companies were identified by Ecology & Environment (Table 4, August, 1983) and in conversation with Fred Wolf of the EPA Region X. They are located on the Vicinity Well Location Map, Figure 5. A general description of the company activities (where known) is given below:

- <u>LIDCO</u> was a hauler of liquid hazardous waste. They were associated with Western Processing (located directly adjacent to Mill Creek and the northwest area of the site) and closed down about the same time as Western Processing. It is reported that liquid waste tankers were staged along South 196th Street.

- <u>LIQUID WASTE DISPOSAL</u> handled waste by trucking. They have a storage lot for tankers adjacent the railroad tracks to the east of the site and have been in operation for some time. They provided support to Western Processing in haulage.

- HYTECK runs a metal plating operation. The site has 13 monitoring wells and is reported to have detected cyanide contamination in ground water.

- CROSBY AND OVERTON are liquid waste handlers. They were used during the Western Processing initial on-site clean up work. They have been in operation a long time and are reported to do on-site solvent distillation. They have a storage yard and waste holding capacity.

- STANDARD EQUIPMENT is a heavy equipment storage yard located adjacent to the Western Processing site to the south and southwest, west of Mill Creek.

- SEATTLE AUTO AUCTION fixes and cleans up automobiles for sale at auctions. Their work area is directly adjacent to Western Processing to the northeast.

- CHICAGO MILWAULKIE ST. PAUL AND PACIFIC RAILROAD is the railroad which runs adjacent along the east side of the Western Processing site. It appears two railroad beds are located in this area.

- STERNOFF METAL are a metal plating facility located a large distance downstream and down gradient from the site.

- CENTRAL SOLVENTS - unknown

CONTAMINATED MEDIA

Metals

Of the priority pollutant metals, zinc, lead, chromium and cadmium are the most common metal contaminants on the site. The contaminated soil and relative concentration groupings of the priority pollutant metals in the soil is presented in Figure A-1, Appendix A.

Concentrations of zinc of greater than 100 times background have been detected throughout the site. Concentrations of lead exceeding 1,000 times background are found in the central and south-central areas and high chromium appears more common in the north-central and northeast areas. Nickel and arsenic were also encountered but in lower relative concentration levels at several locations.

Off-site the most common metal contaminants in soil are zinc, lead, nickel and chromium which typically occur in concentrations of less than 100 times the background. Zinc is the most commonly detected metal. Lead is most common west of the property, and chromium as well as lead are common northeast of the site. Most of the high metal levels in the off-site soils occur at or within 4 feet of the surface.

The ground water above 30 feet depth on-site is generally high in the same metals as the soil with the exception of lead which appears to be less mobile than zinc, chromium, cadmium and nickel. Highest metals concentration occurs in the north central area between wells 11, 17 and Mill Creek as shown in Figure A-3. This area is the site of the solids ponds and location of former lagoons (see Figure 11). The metals in this area are more soluble because of the relatively low pH of the shallow ground water shown in wells 10, 11 and 14 (see Appendix A - Shallow Ground Water - Other Chemical Parameters). Under low pH the metals become more mobile and migration with the local ground water flow system may occur.

The ground water flow direction is from the mound in the center of the site (see Figure 8) primarily to Mill Creek on the west and somewhat to the drainage ditches on the east, north and south. The metals concentration in the Creek and ditch sediments is high where the local ground water flows into these drainage courses. The metals contamination in the Creek and ditch sediments is presented in Figure A-5. The figure shows a migration of the metals downstream that may have occurred with transport of the bedload or as solute in the surface water. Chromium and cadmium have moved the furthest downstream.

On-site soils data below 30 feet depth indicate there is no significant metals contamination in this deeper zone. Although the water analyses have not been completed on ground water samples from the deep on-site wells (MB series) it is unlikely the water will show significant metals contamination at these depths. This conclusion is based on the deep on-site soil data and ground water samples from 10 deep off-site wells. Only two showed metal concentrations exceeding drinking water standards. These were wells 31 and 36 which had lead concentrations of 0.06 and 0.07 mg/1, respectively, only slightly higher than the 0.05 mg/1 standard.

Organic Chemicals

Volatile and base-neutral extractible organic compound groups are the most common soil organic contaminants on-site. Acid extractibles are also found throughout the site while pesticides occur in only a few localized areas. The contaminated soil is generally above a depth of 15 feet based on data that is concentrated in this depth zone. Limited soil testing below depths of 15 feet (MB-01, MB-02, MB-03) indicates the contamination decreases significantly with depth. However one well, MB-01, does show a trace of volatiles contamination between 75 and 100 feet in depth.

As with the metals, the area of the solids pond and waste lagoons in the center of the site generally shows the highest concentration levels of the organic chemical contaminants. Figures A-2 and A-4 in Appendix A present the organics cotamination in the soil and the ground water, respectively.

Ground water on-site is contaminated primarily with volatiles and acid extractibles. The base-neutral extractibles and pesticides do not appear as ground water contamination. A plume of organics in the ground water occurs in the north central site near the lagoons and solids pond with smaller areas in the south central and northeast site.

Figure A-6 shows the organics contamination in the Creek and ditch sediment. The major contamination can be seen in the northwest where the site abuts Mill Creek. Here, high volatile concentrations occur in the Creek sediment. In the north and northeast ditches, high levels of base neutral extractibles occur. The base-neutrals may be related to spillage as they do not appear in the ground water in this area.

Shallow soil west of Mill creek shows volatile contamination, primarily trichloroethene, to a depth of approximately 30 feet. The volatiles in the soil are more likely related to a source west of the Creek than from the on-site operations. The concentration level of the trichloroethene ranges from 0.3 mg/kg to 93.5 mg/kg, the highest occurring in SB-14 at a depth of 4 feet.

The deep off-site soils (below 30 feet) tested for organic chemicals show a few anomalous occurrences of high volatile chemical concentrations. Acetone and methylene chloride noted in the soil from many of the deep off-site wells may be related to field or laboratory contamination as this appears to be common in the chemical data. The occurrence of Trans 1, 2 Dichloroethene in the soil at a depth of 60 feet in Well 35 and 4-Methyl-2-Pentanone at 40 feet in Well 37 is more difficult to explain but is also suspect. With the upward flow gradient of the deeper ground water, contamination at these depths is unlikely.

The above relationships represent the general occurrence of the highly contaminated areas and the apparently anomalous occurrences of contaminants in the deep soil and ground water. There are other locations on-site that show high concentrations of contaminants of other priority and non-priority pollutants. We have described only a portion of the on-site contamination. Data by EPA and CH2M Hill provide more information on the specific contaminants and their location.

HYDROGEOLOGIC FACTORS AFFECTING POLLUTION MIGRATION AND POTENTIAL POLLUTION PATHWAYS

Pollution migration from the site is affected by geologic, hydrogeologic and chemical factors.

- Geologic Factors:
  - Regional geologic setting
  - Site stratigraphy

- Hydrogeologic Factors:
  - Recharge conditions
  - Ground water flow directions
  - Vertical hydraulic gradients
  - Variations in hydraulic conductivity
  - Surface water drainage courses

- Chemical Factors:
  - Mobility of contaminants especially with regard to pH conditions

Pollution can leave the site by surface and subsurface pathways. During storm events the infiltration capacity of site soils can be exceeded which will cause surface water runoff. Past practices likely allowed runoff to contact the waste and transport pollution down slope towards Mill Creek, the drainage ditches or other areas. This may have been a contributing cause of soil contamination to the area immediately north of the site. Remedial activities which have recently been accomplished on-site likely prevent runoff from moving off-site.

A water surplus is available to transport contaminants to the water table once they have entered the subsurface. Continuing recharge from either natural or man-induced sources causes contaminants to migrate downward.

A fluctuating water table may also cause contaminant migration. As the water table rises, water potentially comes in contact with contaminated soil which can mobilize additional contamination.

The available data indicates that major ground water contamination is restricted to shallow ground water (less than 40 feet deep) immediately beneath the site. Contaminant migration generally has been controlled by:

- o The presence of stratified low hydraulic conductivity soils at depths less than 40 feet.
- o Locations of surface water drainage courses.
- o A ground water mound that has formed beneath the site.
- o Local and shallow downward vertical hydraulic gradients.
- o Regional upward hydraulic gradients.

Contaminant migration appears to have generally occurred from beneath the site to Mill Creek and to a lesser extent the east drainage ditches. Initially beneath the site, strong downward gradients caused downward contaminant migration. However, the downward migration is impeded by low hydraulic conductivity layers, and decreasing downward gradients with depth and proximity to site boundaries. The drainage courses appear to act as ground water divides with ground water discharging into the drainage course rather than migrating off-site beneath the drainage course.

Changing pH conditions will also effect the mobility of the metals. Highest metal concentrations were detected in areas having relatively low pH. As the metals migrate pH will likely rise making the metals less soluble and less mobile.

Significant ground water contamination has not been detected off-site or on-site at depths greater than approximately 40 feet because of the hydrogeologic conditions of the area. Contaminants have migrated into Mill Creek as indicated by the increase in sediment chemical concentrations along a stretch of the Creek situated along the northeast site boundary (Figure A-5 and A-6).

HART-CROWSER & ASSOCIATES, INC.

LORI J. HERMAN
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MATTHEW G. DALTON
Senior Associate Hydrogeologist

LJH/MGD:sek

Table 1 Monitoring Well Data

Well Number	Well Depth in Feet	Screened Interval Depth in Feet		Hydraulic (1) Conductivity in ft/day	Ground Water Elevation in Feet for Date Indicated				
		Top	Bottom		11/82 (2)	5/83 (2)	10/83 (3)	5/84 (4)	7/84 (5)
1S	12	9	12	-	13.55	15.19	12.59	14.52	13.75
1D	30	27	30	-	12.86	14.40	12.47	14.84	13.78
2	15	8.5	11.5	-	14.37	15.65	13.14	14.06	13.48
3	12	8.5	11.5	-	18.35	19.41	18.38	18.19	17.94
4	15	11.5	14.5	-	12.37	13.76	11.95	12.33	11.77
5	15	8.5	11.5	-	15.17	16.62	14.46	16.13	14.54
6	15	8.5	11.5	-	14.19	15.79	13.37	14.52	13.90
7	15	8.5	11.5	-	14.59	16.26	13.75	14.71	14.31
8	16	13	16	-	13.39	15.28		15.04	14.25
9	15	11.5	14.5	-	11.35	12.21		11.64	10.88
10	15	11.5	14.5	-	12.09	12.5	13.25	Dry	Dry
11S	12	9	12	-	14.83	16.53	14.06	16.31	15.41
11D	30	26	29	1-5	12.94	14.97	12.57	15.39	13.97
12	15	7.5	10.5	-	14.10	15.72	Destroyed		
13	9	2.5	5.5	-	11.91	13.70		12.58	11.69
14	15	11.5	14.5	-			14.55	15.55	14.55
15	16	13	16	-	15.29	17.24			
15a	16	13	16	-					
16	15	11.5	14.5	-	13.73	13.69			
17S	15	12	15	-	16.39	18.20	15.86	19.96	18.40
17D	30	27	30	-	12.72	14.57	12.77	15.14	13.91
18	16	13	16	-	15.86	18.25	15.84	17.37	16.65
19	12	2.5	5.5	-	14.35			14.10	12.69
20	15	11.5	14.5	-	15.88	17.23	14.13	17.79	16.62
21	15	11.5	14.5	-	12.80	15.24	12.80	15.85	13.68
22S	15	12	15	-	13.9	15.68	Destroyed		
22D	30	23.5	26.5	-	13.77	14.72	Destroyed		
23	16	12	15	-	14.05	16.30	15.38	17.86	16.61
24	15	11.5	14.5	-	13.34	16.17	13.26	16.45	15.24

Table 1 Monitoring Well Data

Sheet 2 of

Well Number	Well Depth in Feet	Screened Interval Depth in Feet		Hydraulic (1) Conductivity in ft/day	Ground Water Elevation in Feet for Date Indicated				
		Top	Bottom		11/82 (2)	5/83 (2)	10/83 (3)	5/84 (4)	7/84 (5)
25S	16	13	16	-	13.81	16.03	13.57	Destroyed	
25D	30	23	26	-	13.85	15.89	13.70	Destroyed	
25c	12	9.5	12	-					
26	15.5	12.5	15.5	-	14.48	16.13	Destroyed		
27	12	8.5	11.5	-	14.51	15.13	Unable to Read		
28	12	8.5	11.5	-		12.46		11.55	10.88
29	12	8.5	11.5	-		15.01		14.45	13.43
30	15	11.5	14.5	-					
31S	140	45	55	-			11.39	15.57	14.01
31D	140	130	140	5-10			13.83	16.97	13.66
32S	30	18	28	-				14.92	13.88
32D	156.5	96	106	-			14.15	18.37	15.89
33S	145.5	28	38	-			13.93	15.45	15.70
33D	145.5	55	65	10-50			15.54	18.01	16.80
34S	181.5	52	62	-			12.43	15.32	14.25
34D	181.5	124	134	0.1-1.0			13.36	17.29	16.08
35	140	55	75	-			13.77	16.88	15.57
36	100	74	94	10-100			13.12	16.43	14.01
37	100	75	95	10-50			13.95	17.16	15.89
38	120	35	55	10-50			12.29	14.99	13.89
39	96	20	40	1			13.63	16.99	15.64
40	100	20	40	2-20			13.39	17.00	15.53
41	135	75	95	-			13.40	16.62	15.31
42	100	50	70	-			13.27	16.61	15.24
43	100	15	35	1-2			13.36	17.01	14.37
44	100	15	35	0.5-2			15.20	18.64	16.14
DB-01	365	140	150						18.03
PB-01		14	16						15.38
PB-02		14	16						13.89

Table 1 Monitoring Well Data

Sheet 3 of :

Well Number	Well Depth in Feet	Screened Interval Depth in Feet		Hydraulic ① Conductivity in ft/day	Ground Water Elevation in Feet for Date Indicated				
		Top	Bottom		11/82 ②	5/83 ②	10/83 ③	5/84 ④	7/84 ⑤
PB-03		14	16						12.71
PB-04		14	16						19.96
PB-05		13	18						11.56
PB-06		12	14						16.37
PB-07		12	14						16.93
PB-08		14	16						18.26
MB-01	100	75	95						⑥15.32
MB-02	60	35	55						15.45
MB-03	100	8	10						19.11
		15	17						15.01
		22	24						16.71
		29	31						16.51
		36	38						15.91
		43	45						15.61
		55	57						16.51
		67	69						16.71
		79	81						16.81
		91	93						16.41

① Hydraulic conductivity estimated from pump test recovery data and/or slug test data.
- means no test conducted or results uninterpretable.

② EPA Investigation for Soil and Water Contamination at Western Processing, King County, Washington, September to November, 1982, Table 1.

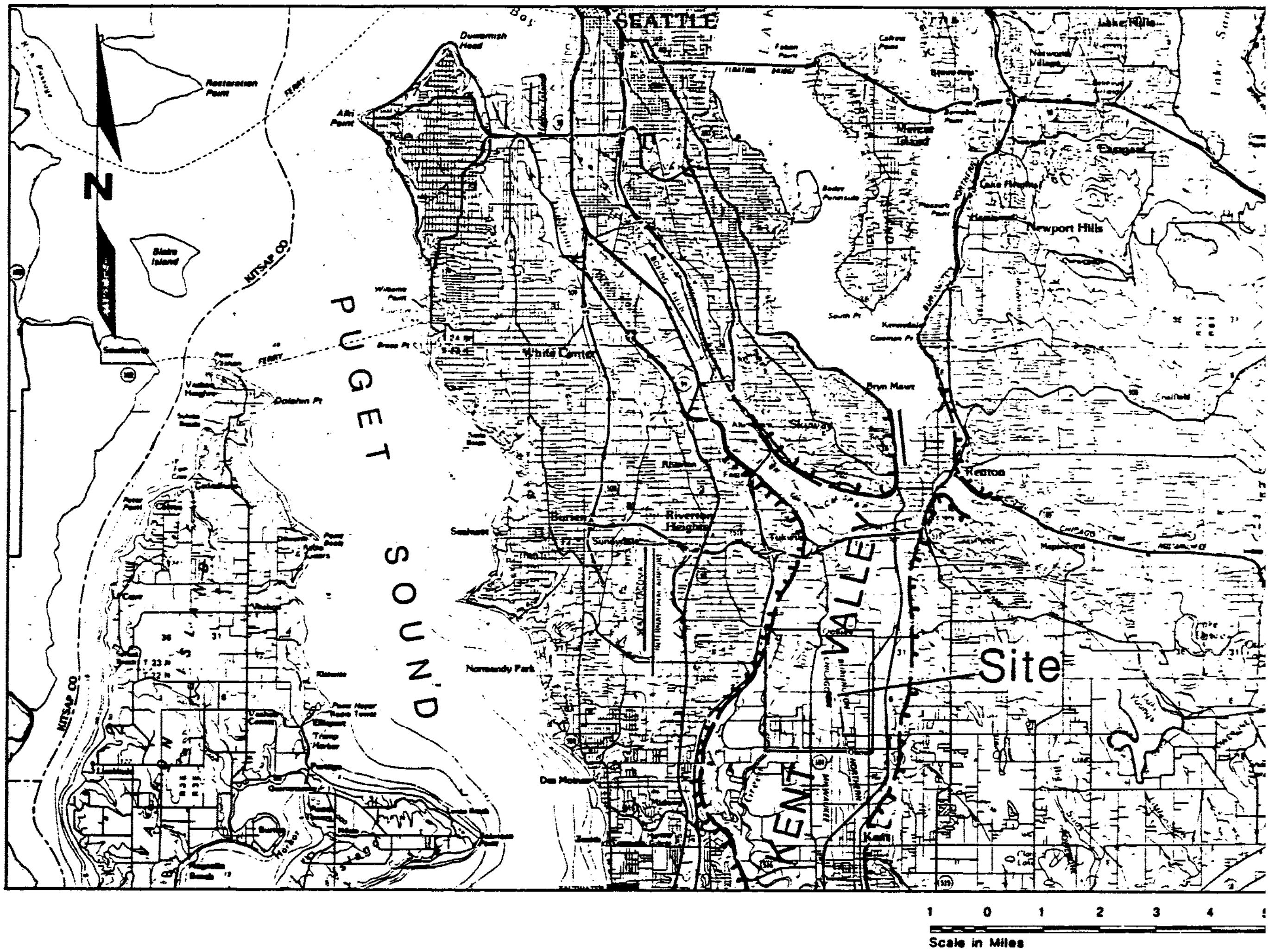
③ Western Processing Alternatives Assessment Study, 1983 Data, Table 2. Water levels measured between 10/24 and 10/27.

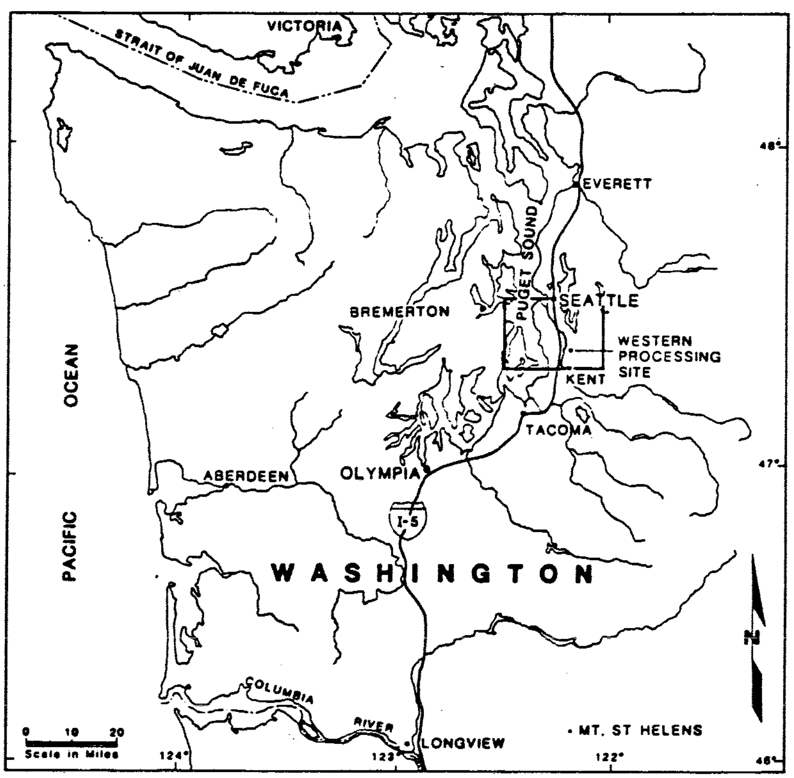
④ Ecology and Environment, Inc. Memorandum dated May 30, 1984, Subj: Monthly field monitoring of REM/FIT Wells. Water levels measured 5/14 - 5/15.

⑤ Ecology and Environment, Inc. Monthly field monitoring data for July, 1984. Water levels measured 7/11 - 7/13.

⑥ Field notes taken from MB borings at Western Processing site. Water levels measured 6/7/84 in MB-03 and 6/12/84 in MB-01 and MB-02.

Project Setting and Site Location Map





Kent Valley Boundary

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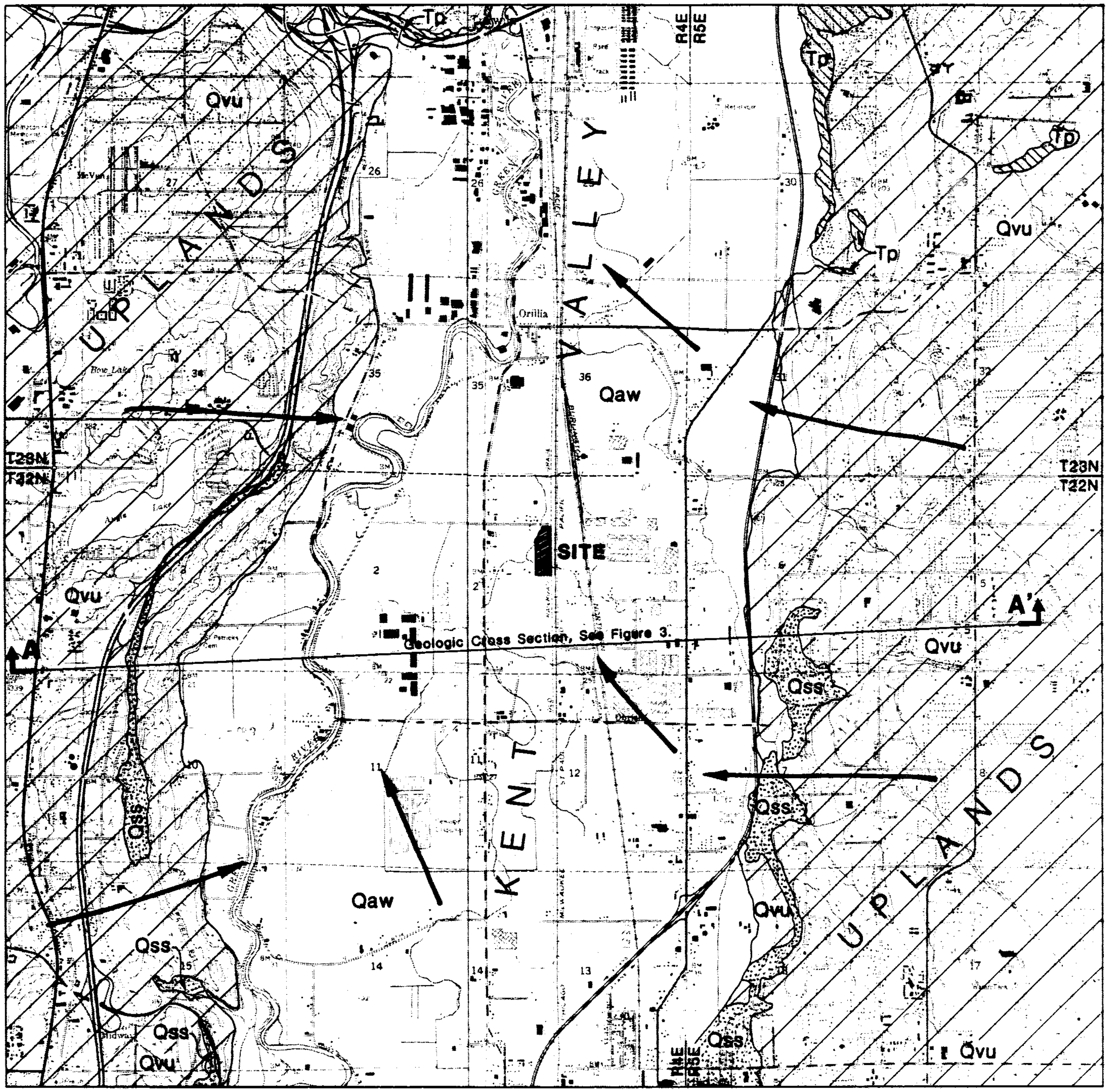
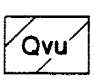
Figure 1

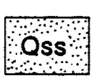
Regional Surficial Geologic Map



Recent White River and Older White River/Green River Alluvial Deposits
Valley deposits consisting predominantly of interbedded Sand, Silt, Peat and Clay near the Western Processing Site. Includes coarse Sand and Gravel river channel deposits in other areas of the valley.



Vashon Undifferentiated Glacial Deposits
Surficial glacial sequence on the uplands consisting of Till and Outwash Deposits of Sand and Gravel with interbedded Silt and Clay, may include non-glacial deposits near base.



Salmon Springs Glacial Deposits
Deeper glacial sequence in uplands consisting of Sand and Gravel with interbedded Silt, Clay, Till and some non-glacial sediments. Outcrops along flanks of the valley.

Bedrock of Puget Group
Consists of interbedded Sandstone, Shale and Coal occurring at depth in the uplands on the eastern side of the valley and outcropping near the city of Renton.

Regional Ground Water Flow Direction Trends

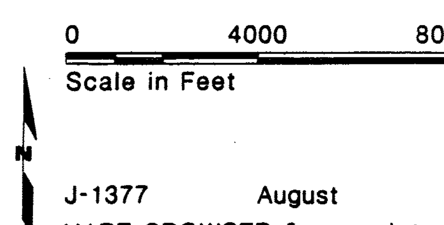


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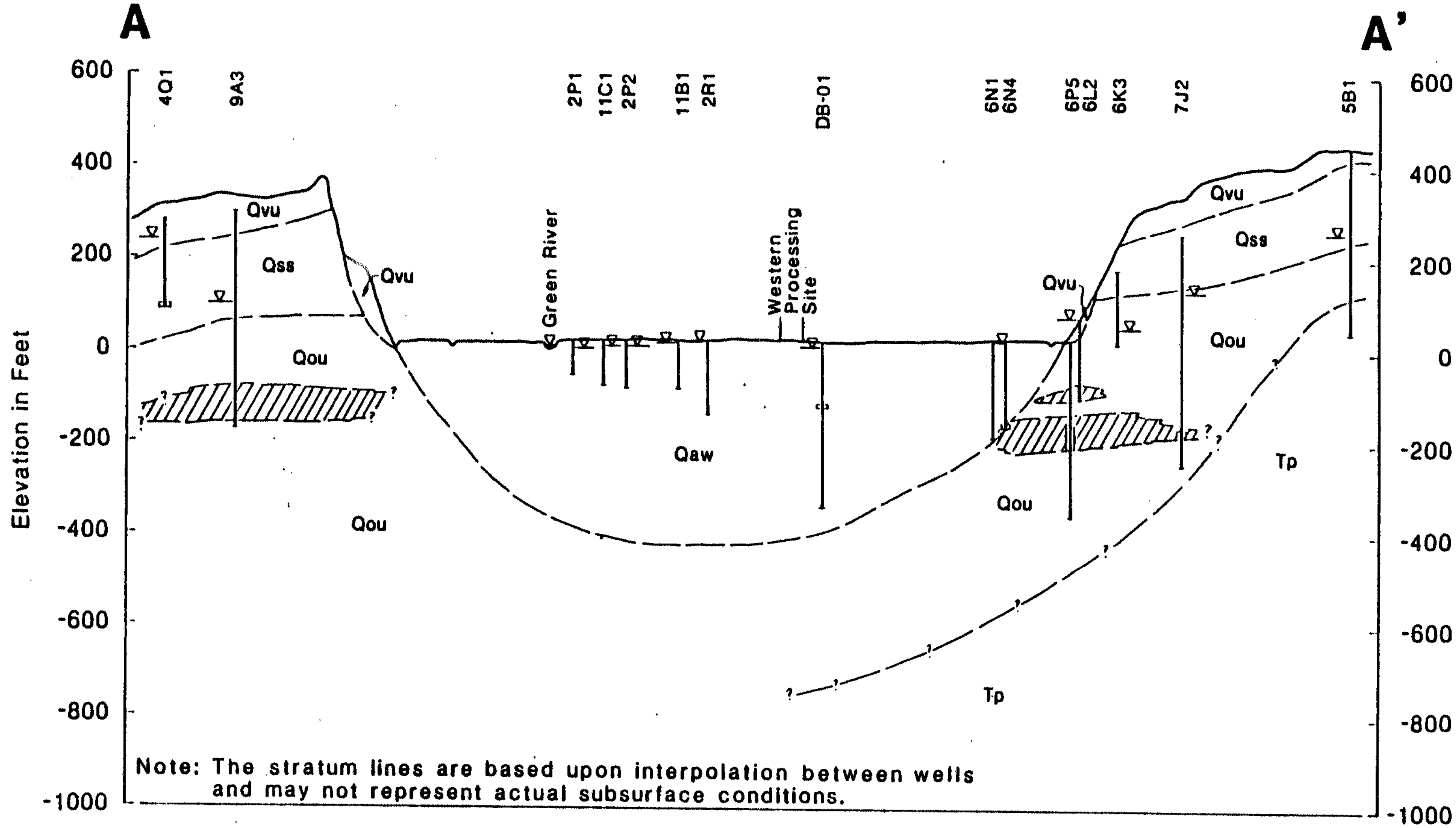
Figure 2

Regional Geologic Cross Section A-A'



Qaw	**Recent White River and Older White River/Green River Alluvial Deposits** Valley deposits consisting predominantly of interbedded Sand, Silt, Peat and Clay near the Western Processing Site. Include coarse Sand and Gravel channel deposits in other areas of the valley.
Qvu	**Vashon Undifferentiated Glacial Deposits** Surficial glacial sequence in the uplands consisting of Till and Outwash deposits of Sand and Gravel with interbedded Silt and Clay, may include non-glacial deposit.
Qss	**Salmon Springs Glacial Deposits** Deeper glacial sequence in the uplands consisting of Sand and Gravel with interbedded Silt, Clay, Till and some non-glacial sediments. Outcrops along flanks of the valley.
Qou	**Older Undifferentiated Glacial and Interglacial Deposits** Deeper unconsolidated deposits in the uplands consisting of Sand and Gravel with interbedded Silt, Clay and Till.
Tp	**Bedrock of the Puget Group** Consists of interbedded Sandstone, Shale and Coal occurring at depth in the uplands on the eastern side of the valley and outcropping near the city of Renton.

4O1 Well Number
Well Location
Water Level
Screen Section
Aquifer Zone

Horizontal Scale in Feet
0 4000 8000
0 400 800
Vertical Scale in Feet
Vertical Exaggeration x 10

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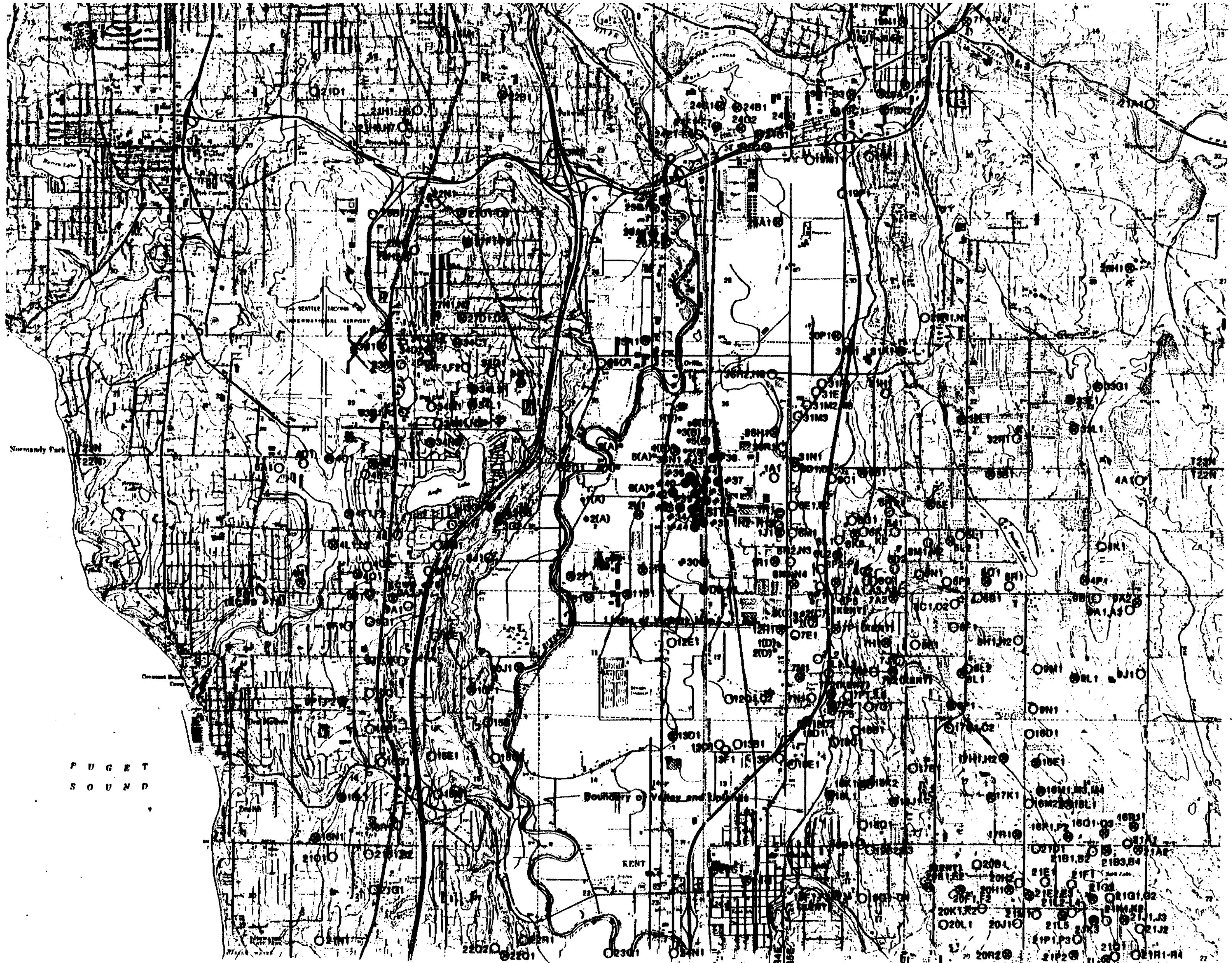
Figure 3



Well Location and Number

#33 ● Monitoring Well Constructed for Western Processing Study

30P1⊗ Well from W.S. Bulletin or DOE Water Well Records with Geologic Log

31F1 ○ Well from W.S. Bulletin

1(A) • Soil Boring Location and Number (Reference)

(A) Dames & Moore, 1970

(B) Dames & Moore, 1962

(C) Pittsburg Testing Laboratory, 1968

(D) Shannon & Wilson, 1972

O Gaging Station

The well numbering system used for Water Supply Bulletin 28 and Department of Ecology well records is based on the rectangular grid system used for subdivision of public land. The first number indicates the geographic location by section within the appropriate Township and Range. This is followed by a letter which denotes the 40-acre subdivision (A thru R) of the section according to the following diagram. The last number is a series number used to distinguish each well within a subdivision.

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

0 4000 8000
Scale in Feet

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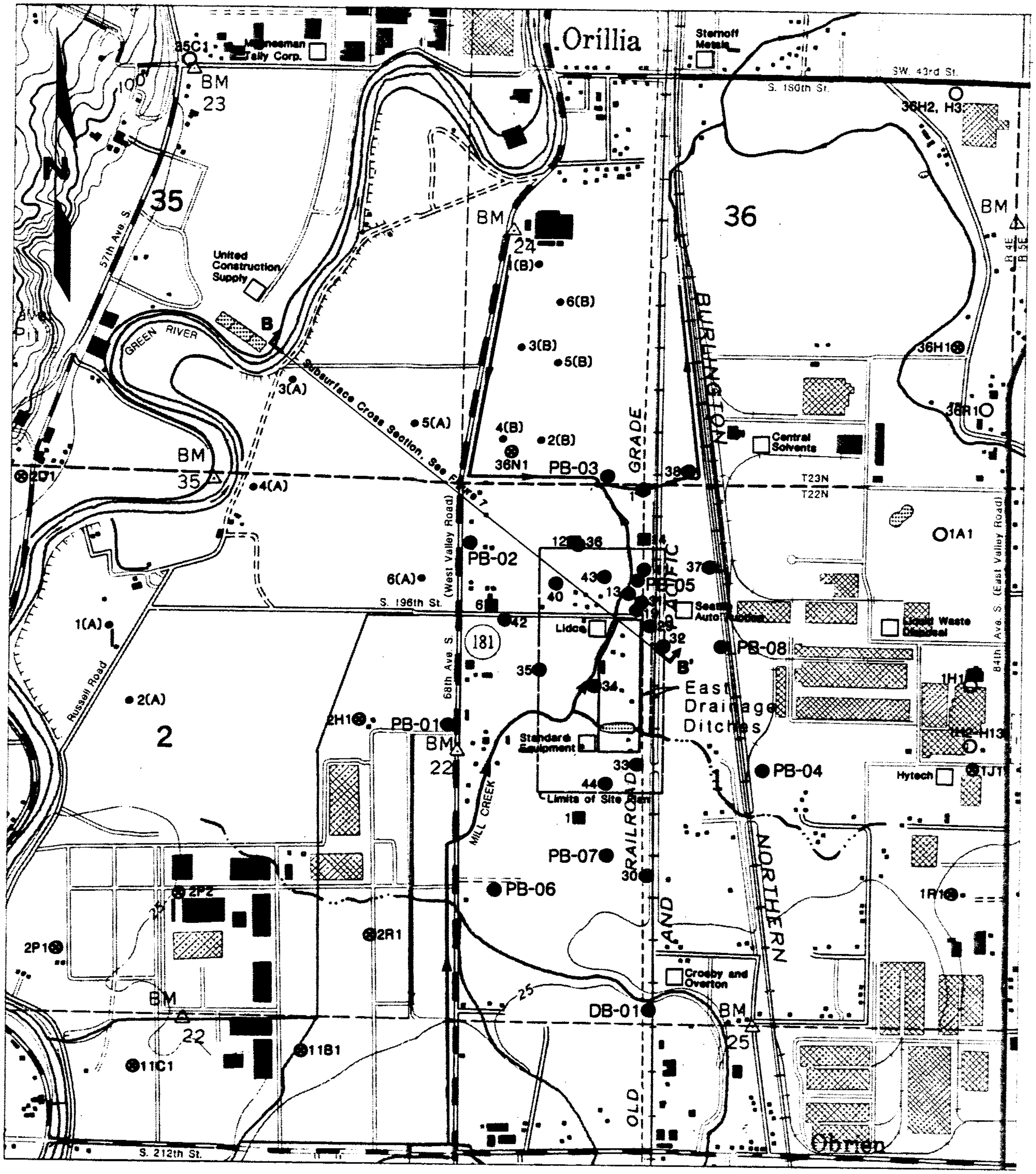
Figure 4

Vicinity Well Location Map



Locations and Numbers

2R1	○⊗	Domestic Wells
6(A)	•	Boring
33	●	Monitoring Well
6	■	Surface Soil Sample
1	⬢	Staff Gage

See Figures 4 and 6 for explanation of well numbering and data sources.

□ General Locale of Potential Secondary Sources

0 1500 3000

Scale in Feet

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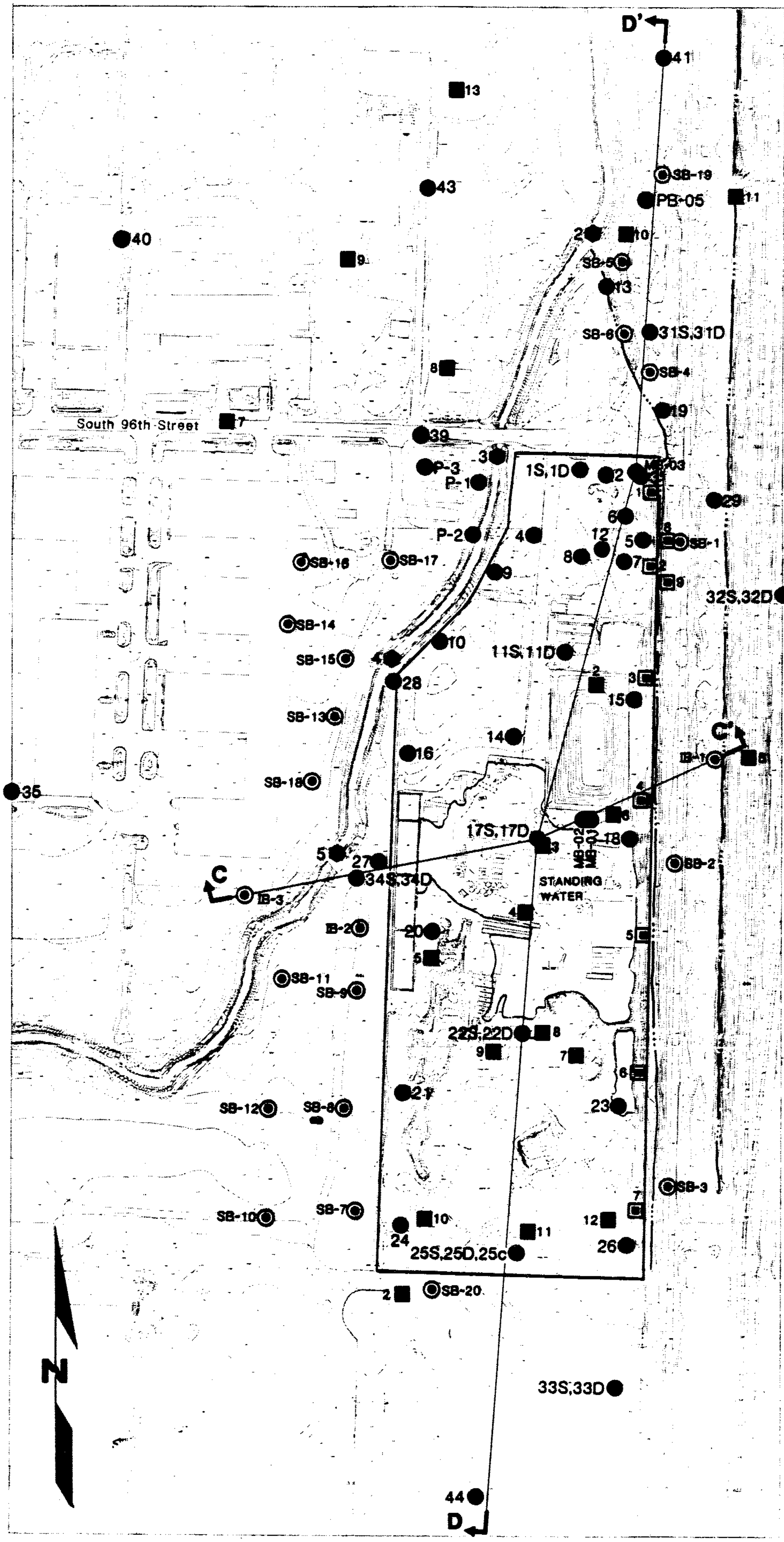
Figure 5

Site Well Location Map



Monitoring Well Location and Number

● 1 thru 30	Shallow (<15') Wells EPA, Installed October 1982 (1, 11, 17, 22 and 25 • Dual Installation S (Shallow and D(Deep <30'))
● 31 thru 34	Off-Site S (Shallow) and D(Deep) Wells EPA, Installed May 1983
● 35 thru 44	Off-Site Wells CH_2M Hill, Installed Aug.-Sept. 1983
● MB-01,-02	On-Site Deep Wells CH_2M H Installed May 1984
● MB-03	MP System Monitoring Well West Bay, Installed May 19
● PB-01 thru PB-08	Off-Site Shallow Wells CH_2M Hill, Installed July 19
● P-1 thru P-3	Off-Site Shallow Piezomete EPA, Installed July 1984

Boring Location and Number

◎ SB-1 thru SB-20	Shallow Borings CH_2M Hill, Installed May/June 1984
◎ IB-01 thru IB-03	Intermediate Borings CH_2M Hill, Installed May/June 1984
● DB-01	Deep Boring CH_2M Hill, Installed June 1984

Soil Sampling Location and Number

■ 2 thru 12	On-Site Surface Soil Samples EPA, Reported May 1983
■ 1, 2 and 5 thru 14	Off-Site Surface Soil Samples CH_2M Hill, Reported April 1984
▣ 1 thru 9	Berm Auger Soil Samples EPA, Reported May 1983
⬢ 1 thru 5	Mill Creek Staff Gage Location and Number
C C'	Cross Section Location and Designation See Figure 7

Notes:

1. All sampling locations approximate as scaled from EPA documents listed in Data Sources.
2. For locations falling outside of this limited area see Figure 5, Vicinity Well Location Map
3. For more detailed information about monitoring wells see Table 1, Monitoring Well Data.

0 250 500

Scale in Feet

J-1377 August 1984

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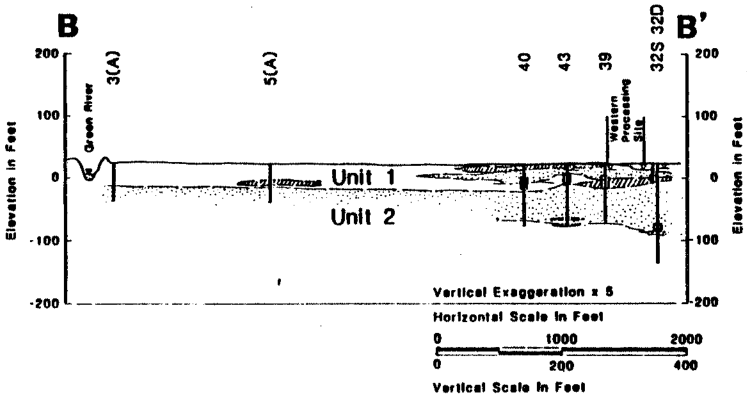
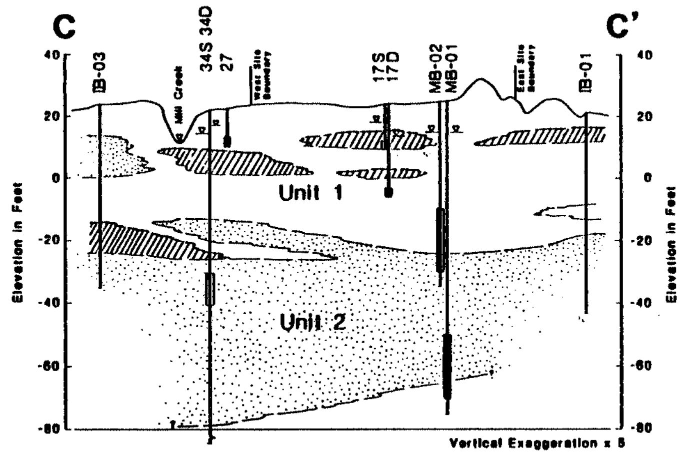
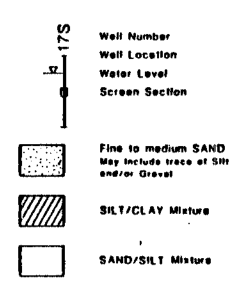
Figure 6

Vicinity Subsurface Cross Section B-B'

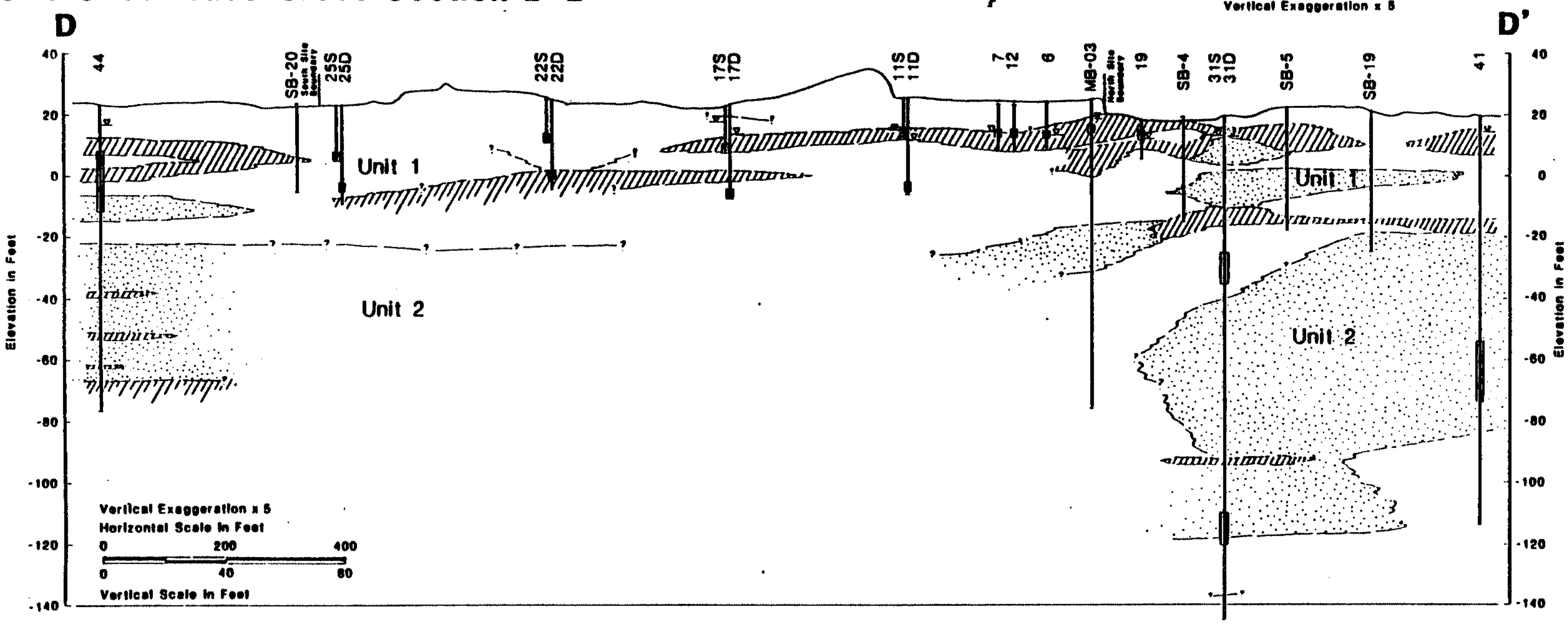


Site Subsurface Cross Section C-C'





Site Subsurface Cross Section D-D'



Notes:

1. The stratum lines are based upon interpolation between widely spaced borings and wells and may not represent actual subsurface conditions.
2. Refer to Figure 5 for Cross Section B-B' location and to Figure 6 for Cross Sections C-C' and D-D' locations.
3. See Page 11 for explanation of Unit 1 and Unit 2 designations.

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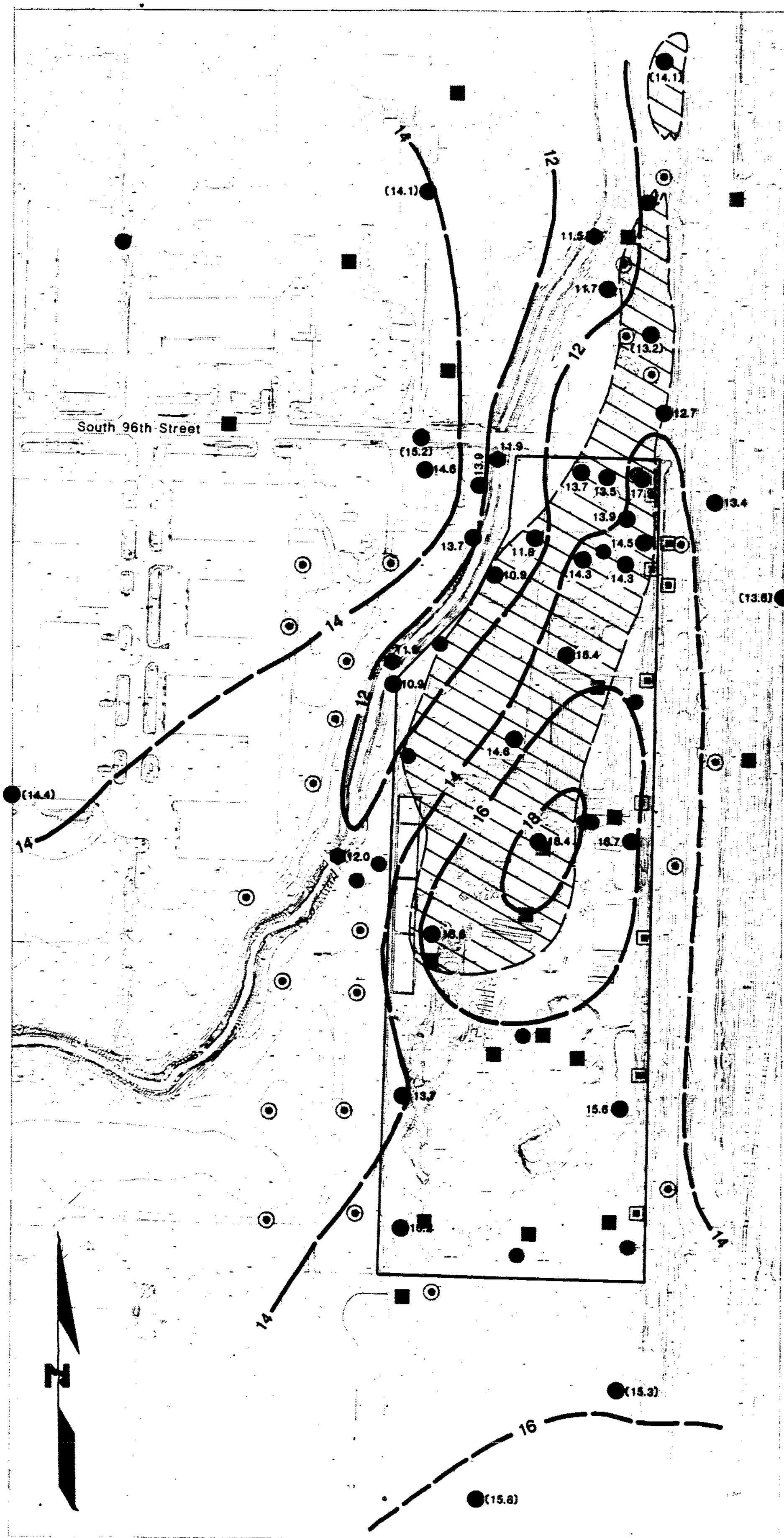
Figure 7

Site Ground Water Elevation Contour Map

Using Data from Wells less than 40 feet Deep



Measuring Point

- ● Monitoring Well
- ⬢ Staff Gage

See Figure 6 for details.

Approximate extent of shallow, silty CLAY layer (Less than 15 feet in depth)

●15.4 Water Level Elevation in Feet

●(13.6) Water Level Elevation in Feet (Corrected for Upward Gradien

14 Water Level Elevation Contour in Feet

Notes:

1. Spot elevations and elevation contours based on water levels reported by E & E from measurements taken 7/10-13/84.
2. Wells >20 feet deep corrected for an average upward gradient of 0.02 feet/foot

0 250 500

Scale in Feet

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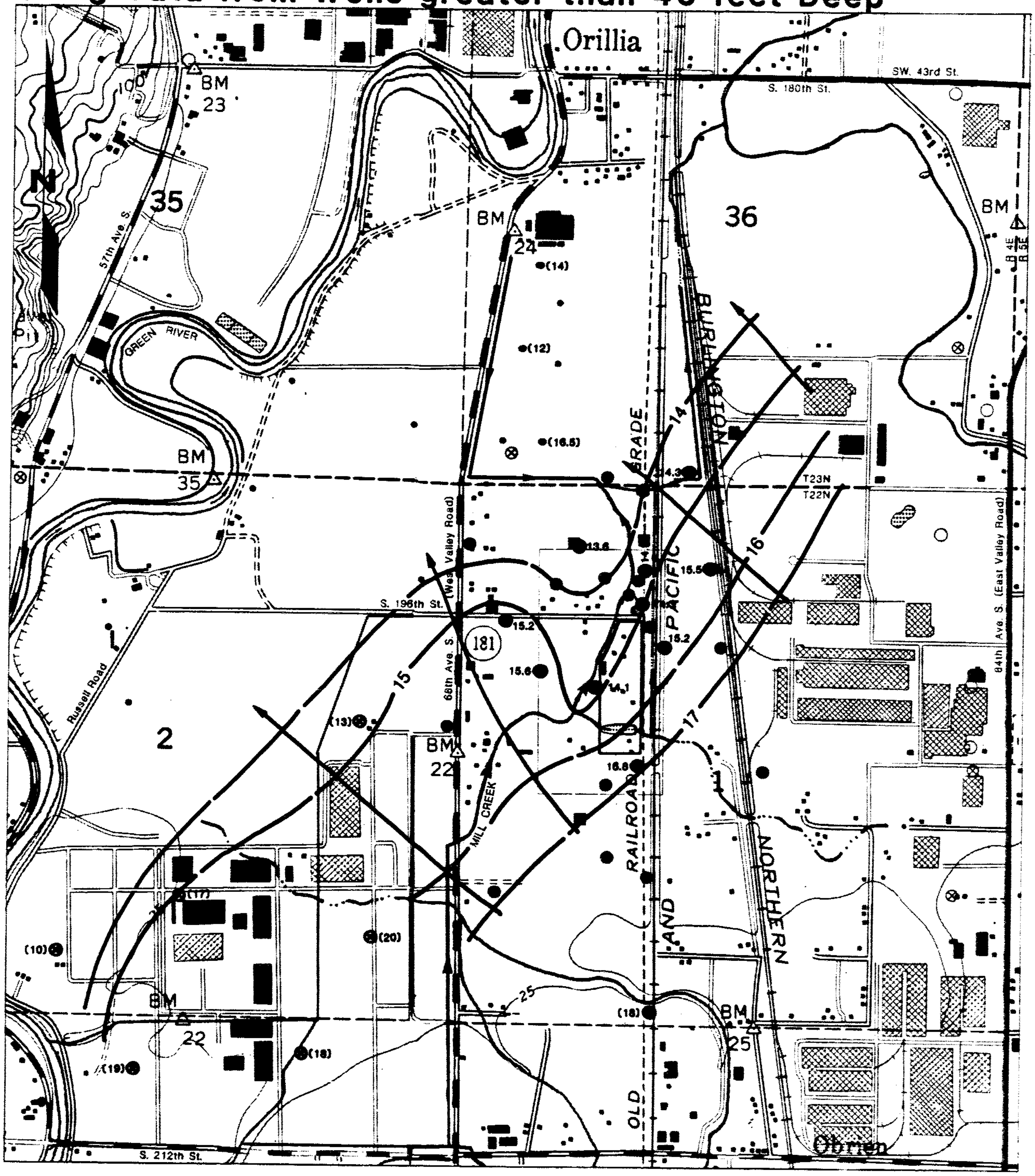
Figure 8

Regional Ground Water Elevation Contour Map
Using Data from Wells greater than 40 feet Deep



Measuring Point

- Boring
- Domestic Well
- Monitoring Well

See Figures 4 and 6 for details.

16.8 ● Water Level Elevation in Feet

(18) ● Water Level Elevation in Feet (Corrected for Upward Gradient)

14 — Water Level Elevation Contour in Feet

— Ground Water Flow Direction

Notes:

1. Spot elevations and elevation contours based on water levels reported by E & E from measurements taken 7/10-13/84.
2. Wells >75 feet deep corrected for an average upward gradient of 0.02 feet/foot.

0 1500 3000

Scale in Feet

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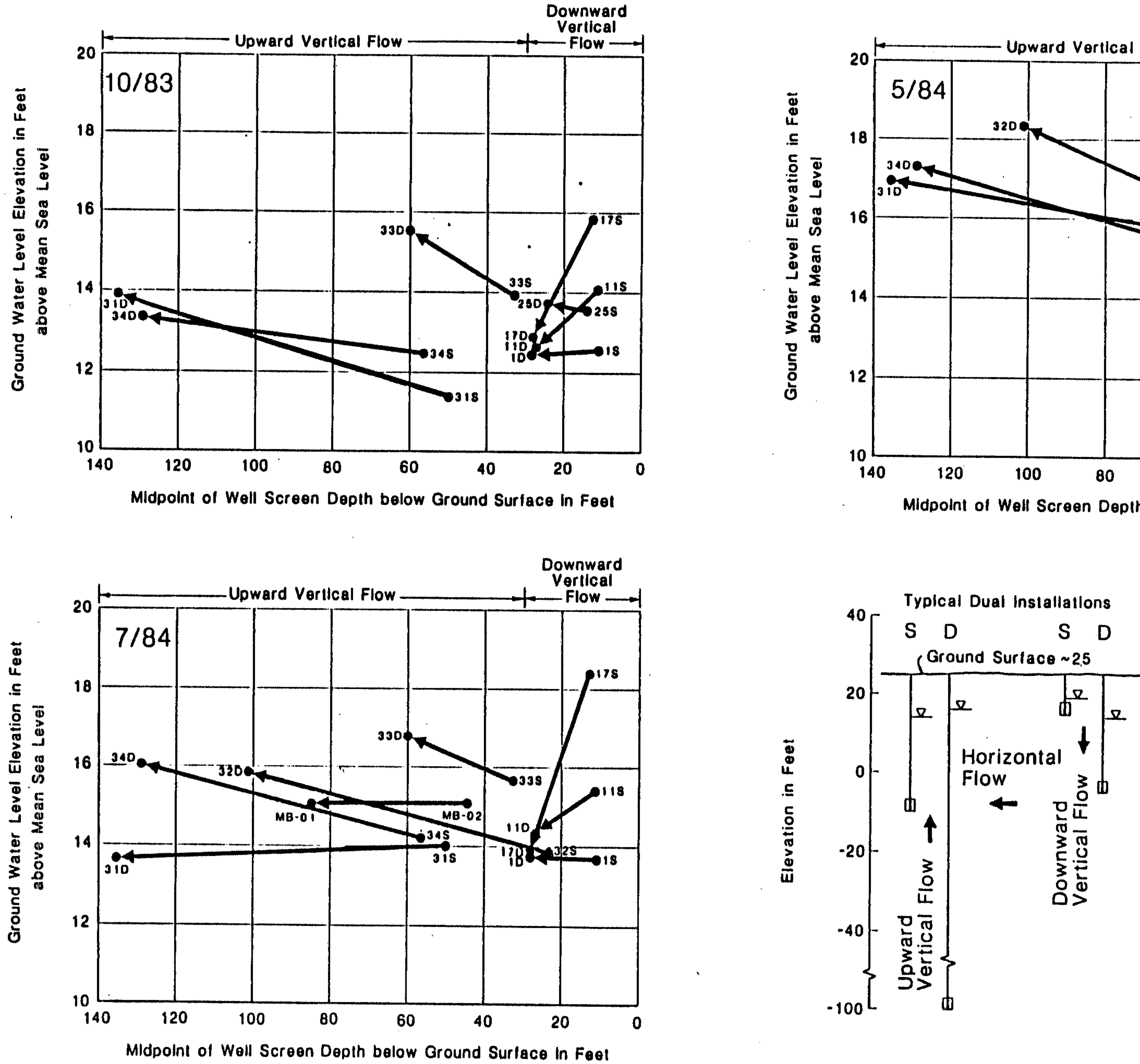
Figure 9

Vertical Gradient Diagram



Note

1. Data derived from EPA documents listed in Data Sources.

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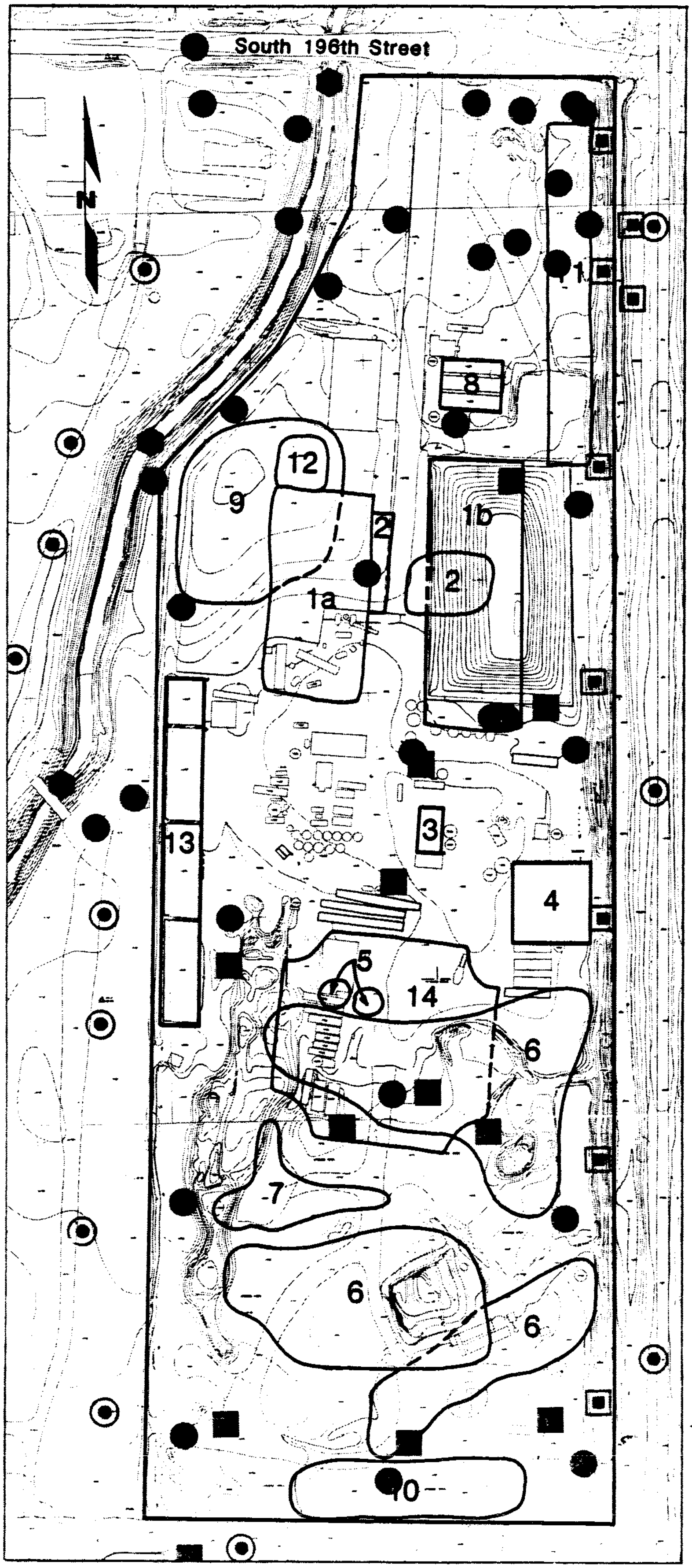
Figure 10

Summary of Waste Handling Features



1. **Storage Lagoons**
   a. Acidic, Caustic and Cyanide Wastes
   b. Acidic Wastes, Methylene Chloride and Phenols
2. **55-Gallon Drum Storage**
3. **Solvent Recovery Plant and Storage Area**
   Halogenated and non-halogenated Solvents Distillation
4. **Fertilizer Plant**
   Heavy metals extraction from shrimp exoskeletons. Cadmium, Chromium, Copper, Iron and Zinc stored in this area
5. **Bulk Storage Tanks**
6. **Scrap Metal, Foundry Sand and Construction Debris**
7. **Chromic Hydroxide Sludge Ponds**
8. **Bulk Storage Tanks**
   Solvents, Naptha and Petroleum Products
9. **Solids Ponds**
   Heavy Metals from Electroplating and Pickle Liquor Wastes
10. **Flue Dust Piles.**
11. **Waste Water Lagoons**
    Chromium, Oil
12. **55-Gallon Drum Storage Area**
    Cyanides and Ketons
    Acids or Caustics and Formaldehyde
    Acids and Ethylamine
    Acids and Caustics and Chlorinated Organics
13. **Cooling Water Lagoons**
    Stored surface water drainage pumped from sump
14. **Possible Missile Storage Area during U.S. Army Occupation**

0 150 300

Scale in Feet

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Figure 11

APPENDIX A
CONTAMINATED MEDIA DATA AND EVALUATION METHODS

The contaminated media which we evaluated included soil, ground water, and creek/ditch sediment. The available data are grouped and discussed in three categories for each media:

- o Priority Pollutant Metals (As, Cd, Cr, Ni, Pb, Zn),
- o Priority Pollutant Organic Chemicals (volatiles, acid extractibles, base-neutral extractibles), and
- o Other Chemical Parameters (Non-priority metals and organics, PCB's, Pesticides, Conductivity, chloride, Total Dissolved Solids (TDS), and pH).

Data sources included the results of laboratory analyses summarized in:

- o Investigation of Soil and Water Contaminations at Western Processing, Parts 1 and 2: May, 1983 prepared by EPA Region X.
- o Alternatives Assessment Study, 1983 Data: April, 1984 prepared by EPA Region X.
- o Close Support Lab, Field Data: July, 1984, CH2M Hill.

Soil - Priority Pollutant Metals

Figure A-1 presents the distribution of on and off-site priority pollutant metals in the soil. The figure shows the number of times, within a general range, the evaluated sample exceeds background. For our analysis, the highest sample concentration of each metal was divided by a background concentration. Background levels are based on average metal concentrations from the deep off-site boreholes (Wells 35 to 44) (EPA, 1984, Table B-1) either rounded to the nearest whole number (As, Cd, Pb) or the nearest ten (Cr, Ni, Zn). Very low and undetected values were not included in the averaging. The background concentrations used for each metal are listed in Table A-1.

Table A-1 - Background Concentrations for Priority Pollutant Metals in Soil

Metal	As	Cd	Cr	Ni	Pb	Zn
Background Concentration Level in mg/kg (ppm)	2	1	10	10	2	20

Soil - Priority Pollutant Organic Chemicals

Figure A-2 presents organic chemical contamination distribution in on-site and off-site soils. Organic chemical concentrations in mg/l (ppm) are displayed at soil sampling locations for three general categories - volatiles, acid extractibles and base-neutral extractibles. The concentration values were determined using the highest sample concentration level for each compound encountered at each location. The total value reported represents a sum of the compounds for each of the three groups.

The off-site soil boring data from the Close Support Lab (July 1984) were tested only for bis(2-Ethylhexyl) Phthalate from the base-neutral extractible group. Although significant levels of this compound were detected in many of the soil samples they are not included on the figure because the compound can be a laboratory and/or field contaminant, and the lack of other base-neutral testing leaves the actual contamination of these soils in question. Likewise where methylene chloride (also a common laboratory contaminant) was the only volatile detected, the soils in that boring were not considered contaminated.

Soil - Other Chemical Parameters

Other priority and non-priority metals were analyzed for on-site contamination. Table A-2 lists those wells which have high concentrations of specific metals relative to a background level. Since off-site background values were not available for these parameters, we considered the borehole with the least contamination as background. The values in Table A-2 are the number of times each metal exceeds the background concentration. The table indicates specific locations where other analyzed metals have relatively higher concentration.

Other priority and non-priority organic compounds were analyzed in the on-site soils. The non-priority organic chemical data is presented in Appendix B, Section 6, of the Investigation of Soil and Water Contamination at Western Processing (EPA, May, 1983).

Table A-2 - Relative Contamination of Other Metals in the On-Site Soils

Metal Ion	Assumed Background Concentration in mg/kg	Contaminated Well Number	Concentration in Excess of Background	Notes
Aluminum (Al)	1500	8, 18 15, 21	3x-5x 12x	All other wells at 1x-2x background level.
Barium (Ba)	30	3,5,7,11, 15,22,23	5x	All other wells at 1x-2x background level
Cobalt (Co)	101	15	1x	Detected at well 15 only.
Copper (Cu)	50	5,7 15	10x 100x	All other wells at 1x-5x background level.
Iron (Fe)	500	15	20x	All other wells at 10x background level.
Manganese (Mn)	10	3,5,21, 22,23	100x	All other wells at background level
Antimony (Sb)	20	16 22	1x 5x	
Selenium (Se)	2	22	15x	
Mercury (Hg)	.03	14,16,18	1x	
Tin (Sn)	3	3,7 2,21	1x 2x-3x	
Cyanide (CN)	5	5,11 22	2x 20x	

Note:
Beryllium(Be), Boron(B), Vanadium(V), Silver(Ag) and Thallium(Tl) were below detection limits.

Table A-3 presents the concentrations of the priority pollutant pesticides and PCB's detected in the on-site soil samples. The available data indicate the off-site soils were not analyzed for these organic groups.

Table A-3 - Concentration of Pesticides and PCB's in On-Site Soils

Pesticides

Well No.	Concentration in mg/kg (ppm)
6	6.2
17	.138
25	.129
28	.145

PCB's

Well No.	Concentration in mg/kg (ppm)
3	.939
5	1.070
6	3.516
7	.058
9	1.510
10	1.142
14	.407
15	25.0
21	1.87
23	2.59
25	0.11

Shallow Ground Water - Priority Pollutant Metals

The ground water data available on-site was obtained (to date) from wells completed above a depth of 30 feet. Off-site ground water data was collected from well completions ranging from shallow depths of less than 15 feet to wells as deep as 150 feet. Shallow ground water data is considered to be from those wells completed less than 40 feet in depth because several of the off-site wells are screened between 20 and 40 feet depth.

Figure A-3 shows the general metals contamination of shallow ground water for priority pollutant metals. Areas on-site where the ground water contamination of any particular metal was greater than 10 mg/l are depicted on Figure A-3. Actual concentration levels of the six analyzed metals are presented in Table A-4 where the metal concentration was above the drinking water standard (also shown on the table) for that particular metal.

Table A-4 - Concentration of Metals in Ground Water that Exceed Drinking Water Standards

Well Number	Metal Concentration in mg/l (ppm) As	Cd	Cr	Ni	Pb	Zn
Washington State Drinking Water Standard	.05	.01	.05	.013	.05	5
1S	--	.04	.070	.110	--	B
1D	--	--	--	--	--	B
2	--	.025	--	.200	--	B
3	.60	.094	2.2	3.60	3.3	5.9
4	--	--	--	.160	--	B
5	--	--	.40	25.0	--	B
6	--	.085	B	1.10	--	B
7	--	.120	.260	.680	--	B
8	--	.175	B	.570	--	B
9	--	.130	B	.140	--	B
10	B	60	17	280	.620	400
11S	B	4.8	1.4	77	1.6	350
11D	B	3.9	.770	69	1.1	375
12	--	.210	.057	.620	--	8.4
13	--	--	--	.390	.730	--
14	B	12	65	76	.072	380
15	--	.011	.170	.360	--	B
16	B	.580	.600	2.5	.470	64
17S	B	4.5	32	26	1.6	360
17D	--	.800	.680	3.2	.210	160
18	--	.240	--	.530	.110	510
19	--	.290	B	.860	--	100
20	--	.100	.052	.470	.280	11
21	--	--	.160	.320	--	B
22S	--	.018	.078	.130	.250	2.0
22D	B	.077	B	.280	--	30
23	B	--	.400	.064	.430	B
24	--	--	--	--	--	--
25S	--	--	--	--	--	B
25D	--	--	--	--	--	B
26	--	B	--	.049	--	34
27	B	.320	--	6.4	--	94
28	B	5.6	6.1	77	B	510
29	--	.076	B	.960	--	350
30	--	--	--	.210	B	B

\- Concentration below detection limit
B Concentration below Drinking Water Standards

Note 1. Metal concentrations for Wells 31 through 44 were all below Drinking Water Standards except Wells 31 and 36 which had Lead concentrations of .061 and .070 respectively.

2. Data taken from EPA documents listed in Data Sources.

Shallow Ground Water - Priority Pollutant Organic Chemicals

Figure A-4 shows the location of shallow wells sampled for 4 organic compound groups - volatiles, acid extractibles, base-neutral extractibles, and pesticides. Total detected concentrations (sum for each group) in mg/l are plotted at the well locations. Note pesticides were detected only in Well 28.

Shallow Ground Water - Other Chemical Parameters

Other testing for non-priority metals and organics was performed on the on-site well water samples. The other metals data and the non-priority organics data is presented in Appendix B of the Investigation of Soil and Water Contamination at Western Processing (EPA, May, 1983) in Sections 4 and 6 respectively.

The shallow water was also tested for chloride, conductivity, total dissolved solids (TDS) and pH. The data for Wells 1-30 are presented in Tables 3 and 4, of the Investigation of Soil and Water Contamination at Western Processing (EPA, May, 1983). Conductivity and pH profiles were performed at 10 foot intervals in most of the off-site wells 35-44 and are presented in Table 3 of the Alternatives Assessment Study (EPA, April, 1984).

The data showed the conductivity of the on-site shallow water to range from 35 micromhos (Well 2) to greater than 7,500 micromhos (Wells 3, 5, 6, 10, 11D, 14, and 17S) while the shallow off-site water conductivity ranged from 110 to 320 micromhos. The pH ranged between 6 and 7.5 in the wells tested with the exception of the on-site Well 3 which was 13 and Wells 10, 11S, 11D, 14, 16, 17B, and 22B (also on-site) which were between 4 and 6. The chloride and TDS which were measured in Wells 1-30 only, ranged from 11 mg/l (Well 24) to 5968 mg/l (Well 10) and from 144 mg/l (Well 30) to 33074 mg/l (Well 10), respectively.

Deep Ground Water - Priority Pollutant Metals

Data on the water quality of the deep ground water system (wells completed below 40 feet) is from off-site wells. Three wells were installed on-site in July, 1984 in the deep ground water system (MB-01, MB-02 and MB-03), however, water quality data is not yet available.

Of the ten sampled deep wells off-site only two showed metal concentrations above the drinking water standards. These were wells 31 and 36 which had a lead (Pb) concentration of 0.06 and 0.07 mg/l, respectively, only slightly higher than the 0.05 mg/l standard for Pb.

Deep Ground Water - Priority Pollutant Organic Chemicals

Four of the ten deep wells off-site indicate one organic contaminant in the water tested. These include Wells 34 and 35 which showed a concentration of Trans 1,2 Dichloroethene at 0.086 mg/l and 0.260 mg/l, respectively. Well 41 showed Acetone at 0.058 mg/l which may be a field contaminant and Well 36 indicated 0.015 mg/l of Hexanone.

Deep Ground Water - Other Chemical Parameters

There were no other metals or organics tested that were detected in the deep ground water. However, conductivity and pH measurements were made on samples taken at 10 foot intervals during drilling of Wells 35-44. The data is presented in Table 3 of the Alternatives Assessment Study (EPA, April, 1984) and shows the conductivity to increase with depth from a low of 50 micromhos at 70 feet in Well 40 to a high of over 2,000 micromhos in Well 38 at 120 feet and in Well 41 at 130 feet. The pH ranged between 6.0 and 7.8.

Creek and Ditch Sediment Priority Pollutant Metals

Figure A-5 shows the location of the creek and ditch sampling for metals and indicates the extent of metals contamination in the sediment for the priority pollutant metals tested. The background metal concentration levels used are presented on the figure. These were based on an average of the metal concentration levels for five upstream sampling locations (10, 11, 12, 13, and 14). Total metals are plotted for those locations where one or more of the metal concentrations were greater than 2x the background level. When a metal was greater than 10x the background level that metal is noted in parenthesis adjacent to the total metals value. Table A-5 presents those locations where one or more metals were above the assumed background level.

Table A-5 - Creek and Ditch Sediment Sampling Locations which Indicate Metal Concentrations above the Background Level

Metal Concentration in mg/kg (ppm)

Sampling Location No.	As	Cd	Cr	Ni	Pb	Zn
Background	6	0.5	10	8	25	90
1	17	2.7	37	12	190	684
2	11	5.6	17	12	1300	31100
3	--	1.4	--	--	--	878
4A	7.5	0.8	11	--	--	167
4B	7.0	--	--	--	--	118
5	12	4.6	793	16	430	1,670
6	--	--	--	--	--	1,470
7	--	68	23	28	--	3,630
8	24	18	2,620	48	240	3,710
9	150	86	309	120	1,300	5,420
10	7.0	--	12	--	38	91.5
12	--	--	--	--	42	--
15	--	1.5	15	--	26	155
16	--	15	1,620	108	31	1,120
17A	9.0	4	308	--	100	168
17B	8.5	4	398	12	100	215
18	8	--	16	12	--	--
19	6.5	0.7	--	12	--	91.5
20	--	7.9	51	12	--	248
21	--	10	128	16	--	280
23	--	16	1,560	116	--	1,130
24	--	30	57	44	--	890
25	--	1.3	--	12	--	91.5
26	--	8.8	90	16	29	430
27A	--	1.0	18	12	--	102
27B	--	0.65	22	--	--	95.5
29	--	1.6	11.5	--	--	--
30	--	3.1	64.5	14	--	146

Creek and Ditch Sediment - Priority Pollutant Organic Chemicals

Figure A-6 shows the location of the creek and ditch sampling for organics and indicates the areas where particular organic groups were detected. Table A-6 lists the actual organics detected at each sampling location. Background concentration levels for most of the organics are considered to be undetected. Only methylene chloride - a laboratory extractant, and bis(2-Ethylhexyl) Phthalate - a laboratory and field contaminant common where poly vinyl chloride (PVC) is used were not considered as organic contaminants when they occurred as the only detected organic compound.

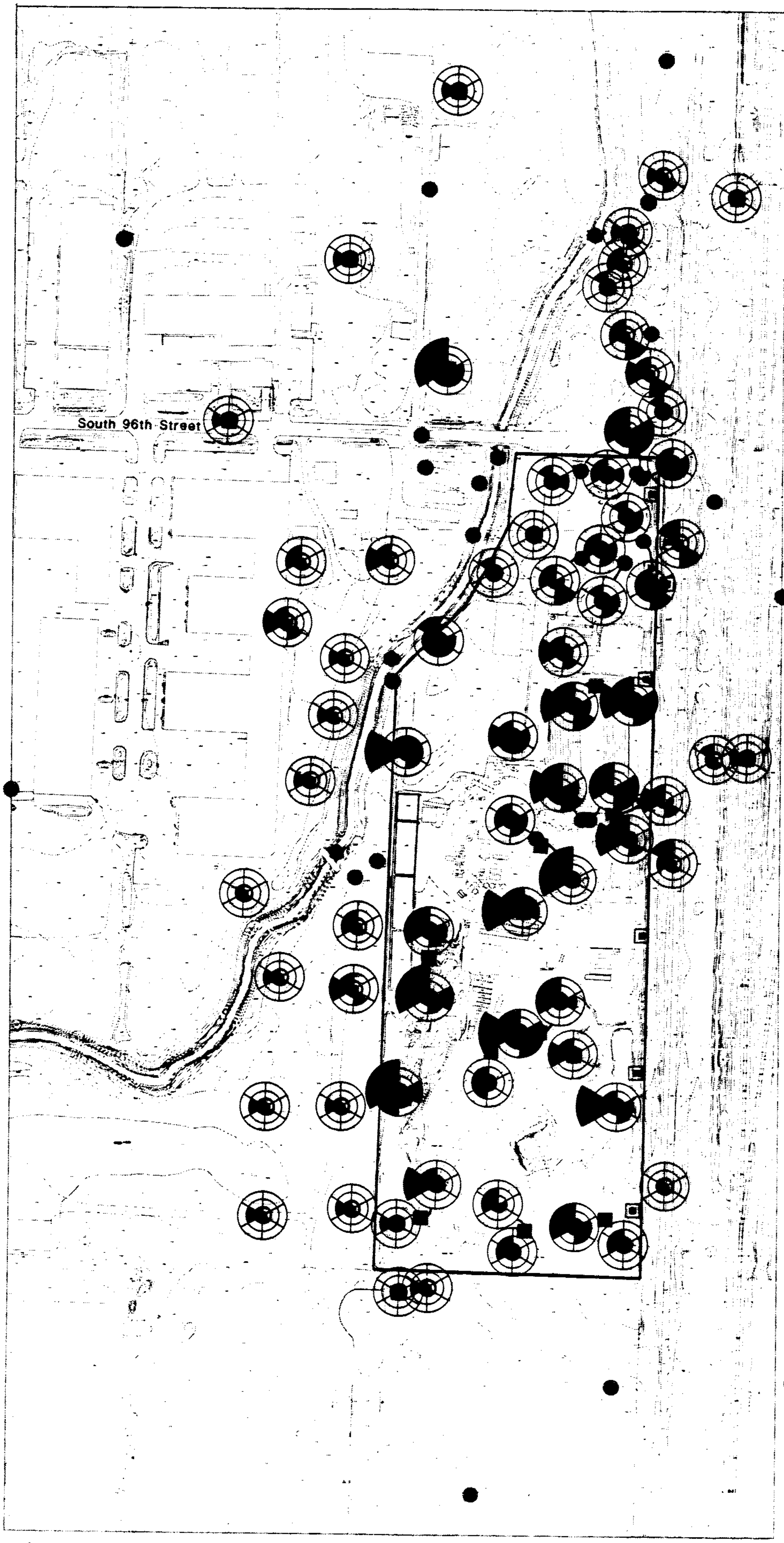
Table A-6 - Organic Contaminants in the Creek and Ditch Sediments

Sampling Location Number	Organic Compound	Concentration Level in mg/kg (ppm)
1	Methylene Chloride	.0802
2	Methylene Chloride	.0447
5	Acetone	.032
8	Acenaphthene	2.113
	Napthalene	2.703
	Phenanthrene	10.962
	Pyrene	2.589
	2-Methyl Naphthalene	10.651
	Dibenzofuran	3.275
15	Toluene	.056
	Bis(2-Ethylhexyl) Phthalate	3.564
17A	1,1,1 Trichloroethane	.0544
	Trans -1,2 Dichloroethene	.0693
	Methylene Chloride	.61
	Toluene	.261
	Trichloroethene	.908
	Total Xylenes	.0602
17B	1,2 Dichloroethane	.0495
	1,1,1 Trichloroethane	.152
	1,1 Dichloroethane	.043
	1,1 Dichloroethene	.04
	Trans 1,2, Dichloroethene	.344
	Toluene	.668
	Methylene Chloride	1.71
	Trichloroethene	1.51
	Total Xylenes	.106
28	Methylene Chloride	.0418

Creek and Ditch Sediment - Other Chemical Parameters

There are no other chemical parameters tested in the creek and ditch sediments.

Metals in Soil



Sampling Location

Data displayed at actual location except where leadered for clarity.

See Figure 6 for details.

Metal Ions* Detected in Soil Samples

<10 x Background

10 x - 100 x Background

100 x - 1000 x Background

1000 x - 10000 x Background

> 10000 x Background

Assumed Background Concentration Level in mg/kg (ppm)

As	Cd	Cr	Ni	Pb	Zn
2	1	10	10	2	20

*Analysis of Six Priority Pollutant Metals

Zinc Zn, As Arsenic, Lead Pb, Cd Cadmium, Nickel Ni, Cr Chromium

Notes

1. Data presents the highest concentration level encountered in samples taken at each location.
2. No soil samples taken from wells 27 through 34 and DB-01. All soil samples from wells 35 through 44 were less than twice the background levels for all metals tested.
3. Open segment denotes that metal not tested at that sampling location.

0 250 500

Scale in Feet

J-1377 August 1984

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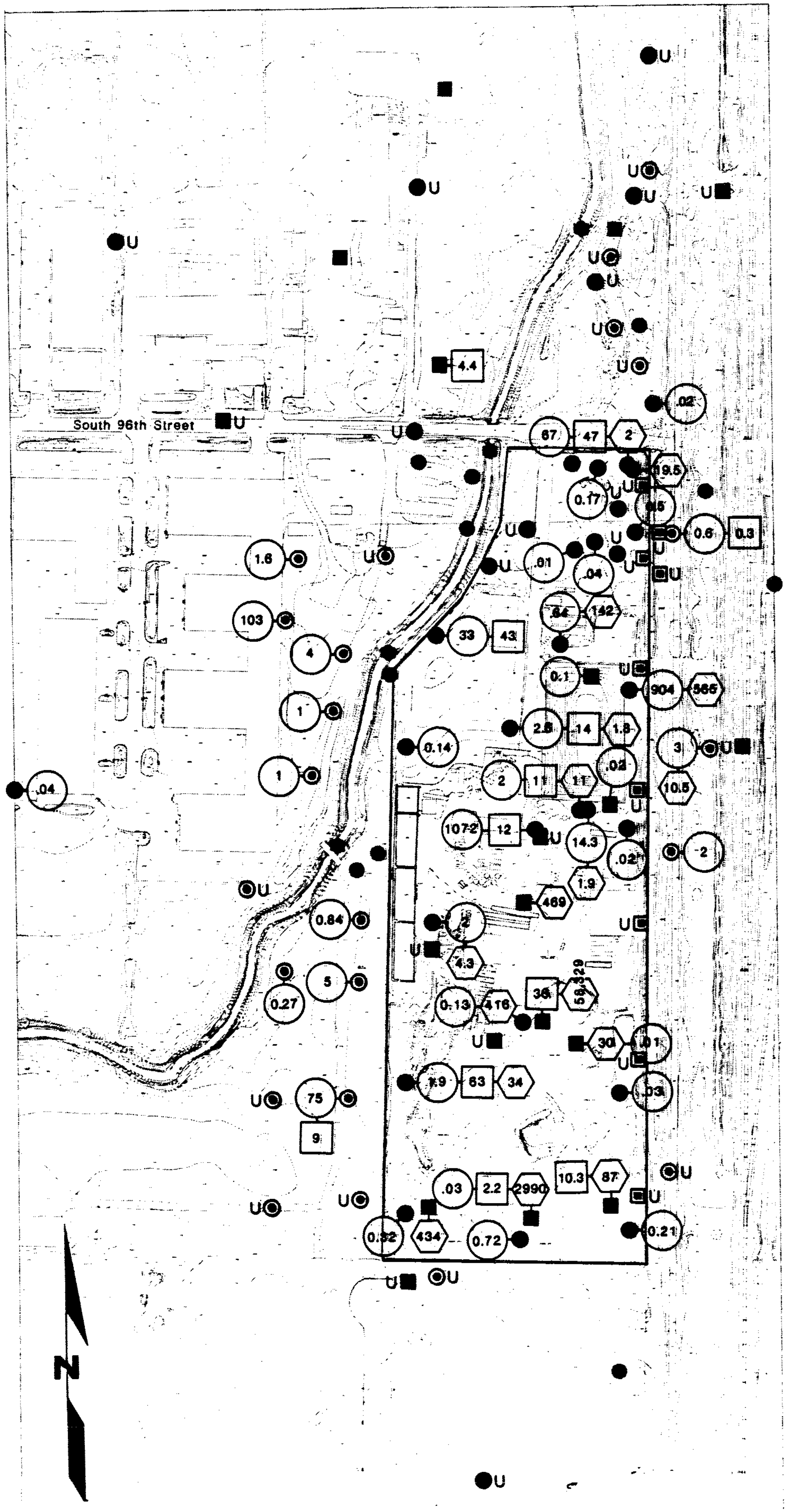
Figure A-1

Organics in Soil



Sampling Location

- ● Monitoring Well
- ◉ Boring
- ■ Surface Soil Sample
- ▣ Berm Soil Samples

See Figure 6 for details.

Organics* Detected in Soil Samples

*Total Priority Pollutant Organics Concentration in mg/kg (ppm)

- ●○ Volatiles
- ●□ Acid Extractibles
- ●⬡ Base-Neutral Extractibles
- ●U Undetected or not quantifible level for organics tested

Notes:

1. Data presents the total of the highest concentration level of organics encountered in samples taken at each location.
2. Data derived from EPA documents listed in Data Sources.

0 250 500

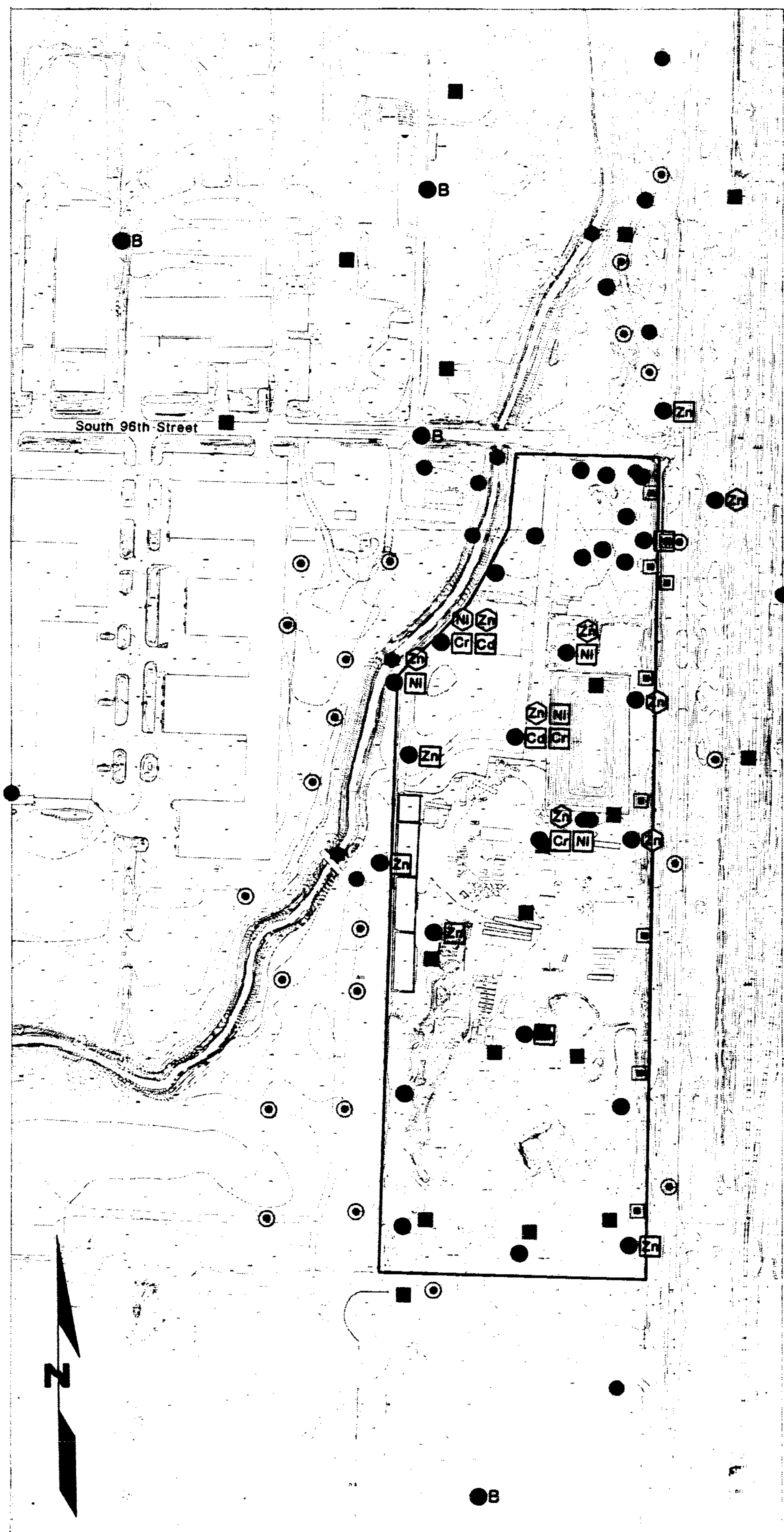
Scale in Feet

J-1377 August 198

HART-CROWSER & associates ir

Figure A-2

Metals in Shallow Ground Water



Sampling Location

● Monitoring Well

See Figure 6 for details.

Metal Ions* Detected in Shallow Ground Water Sampl€

●⬡ > 100 mg/l (ppm)

●□ 10-100 mg/l (ppm)

● < 10 mg/l (ppm)

●B Off-Site Wells with Metal Concentratio below Drinking Water Standard

*Analysis of Six Priority Pollutant Metals

As	Arsenic
Cd	Cadmium
Cr	Chromium
Ni	Nickel
Pb	Lead
Zn	Zinc

Refer to Table A-4 for concentration level of specific metal ions that have low concentration levels but exceed the drinking water standard.

0 250 500

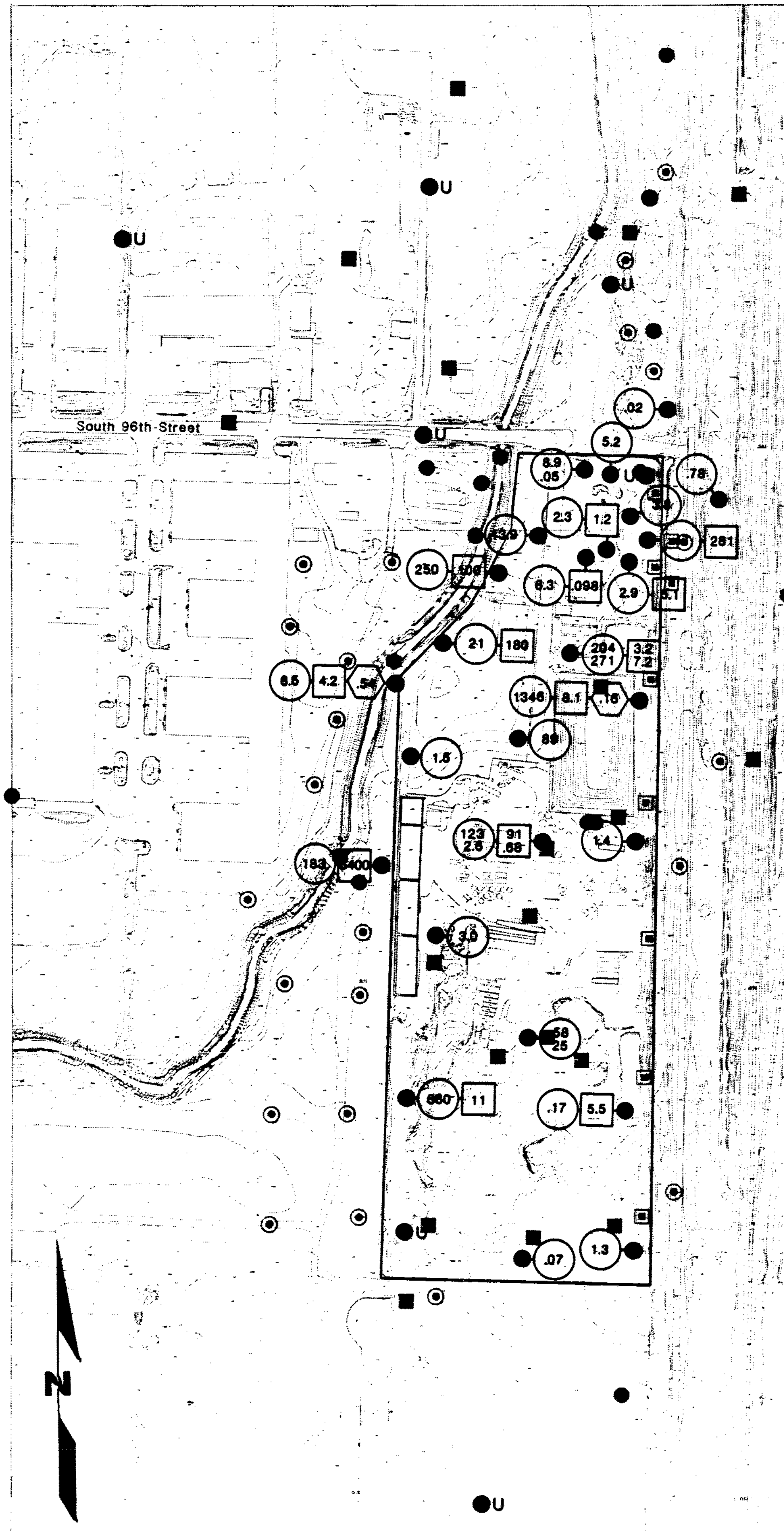
Scale in Feet

J-1377 August 198

HART-CROWSER & associates in

Figure A-3

Organics in Shallow Ground Water



Sampling Location

● Monitoring Well

See Figure 6 for details

Organics* Detected in Shallow Ground Water Samples

*Total Priority Pollutant Organics Concentration in mg/l (ppm)

Volatiles

Acid Extractibles

Base-Neutral Extractibles

●U Undetected or not quantifible level for organics tested

Notes:

1. Data presents the total concentration level of organics encountered at each sampling location.
2. Data derived from EPA documents listed in Data Sources.

0 250 500

Scale in Feet

J-1377 August 1984

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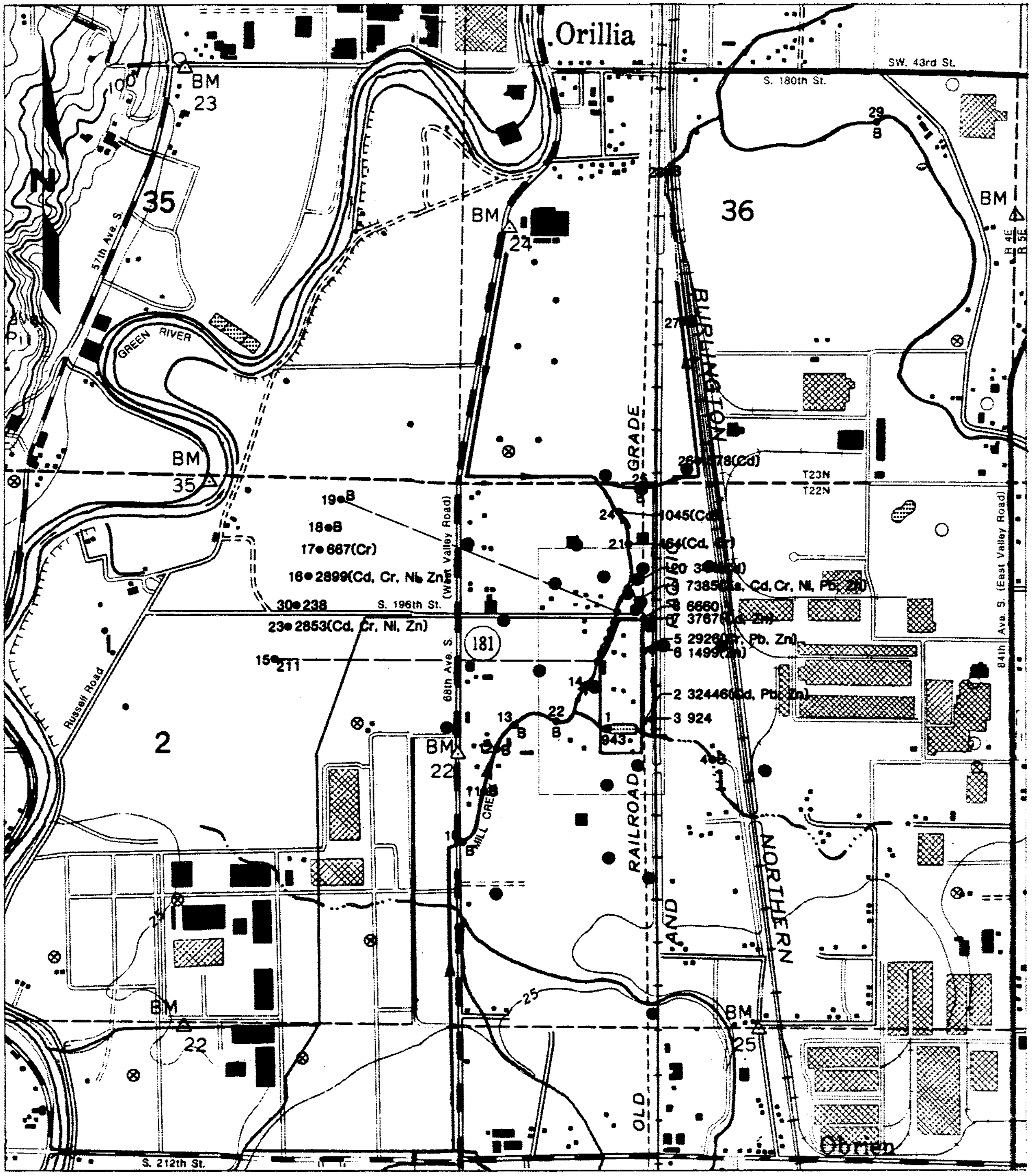
Figure A-4

Metals in Creek and Ditch Sediments



8● Creek and Ditch Sediments Sampling Location and Number

Analysis of Six Priority Pollutant Metals
Assumed Background Concentration Level in mg/kg (ppm)

As	Cd	Cr	Ni	Pb	Zn
6	0.5	10	8	25	90

2926 Total Metals Concentration in mg/kg (ppm) when one or more >2x Background Level

(Cr, Zn) Those Metals >10x Background Level

●B Sampling Location with Metal Concentration <2x Background Level

Notes:

1. Data presents the total concentration level for the six metals tested when one or more are >2x background level.
2. Data derived from EPA documents listed in Data Sources.

0 1500 3000

Scale in Feet

J-1377 August 1984

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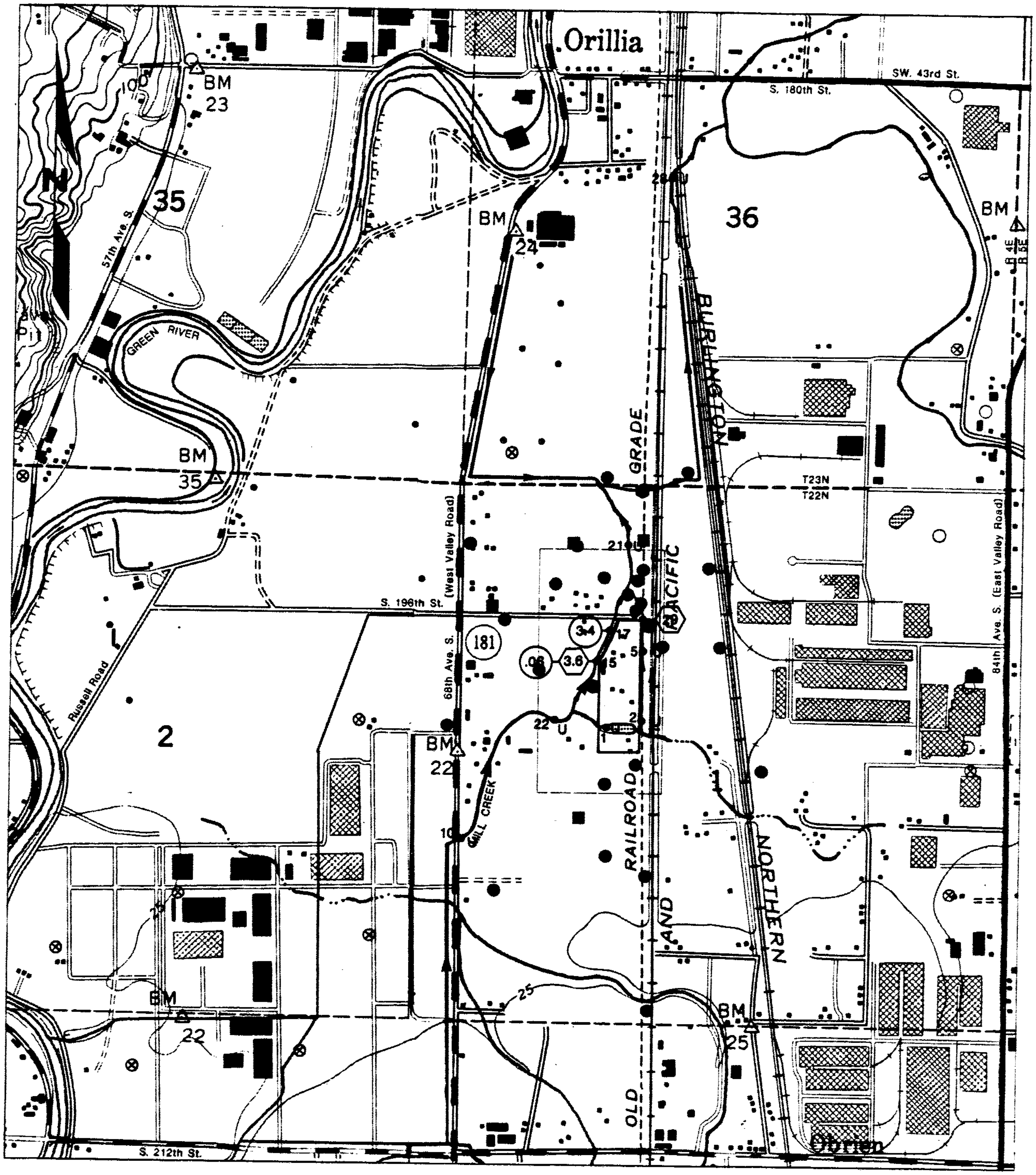
Figure A-5

Organics in Creek and Ditch Sediments



8● Creek and Ditch Sediments Sampling Location and Number

Total Priority Pollutant Organics Concentration in mg/kg (ppm)

Volatiles

Base-Neutral Extractibles

●U Undetected or not quantifible level for organics tested

Notes:

1. Data presents the total concentration level of organics encountered at each sampling location.
2. Data derived from EPA documents listed in Data Sources.

0 1500 3000

Scale in Feet

J-1377 August 1984

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Figure A-6

APPENDIX B
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