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Expanded Site Inspection of the Central Chemical - Hagerstown Site
MD-302

September 1993

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1.0 Introduction

1.1 Authorization

This Expanded Site Inspection was performed by the Maryland Department of the Environment, Waste Management Administration (MDE/WAS), Environmental Response and Restoration Program (ERRP), Site Assessment Division under Cooperative Agreement Number V-99004-01-0 with the U.S. Environmental Protection Agency (EPA).

1.2 Scope of Work

The MDE/WAS ERRP Site Assessment Division was contracted to perform an Expanded Site Inspection (ESI) of the Central Chemical - Hagerstown site (MD-302). The purpose of the ESI is to assess the actual and potential release of hazardous waste from the site by way of groundwater, surface water, soil exposure, and air pathways. The populations and sensitive environments which may be impacted are discussed. The scope of the ESI included reviewing the available file information, a target survey, site reconnaissance, and sampling under the U.S. EPA Contract Laboratory Program (CLP).

1.3 Executive Summary and Conclusions

The site is located in Hagerstown, Washington County, Maryland. Central Chemical blended and produced pesticides and fertilizers at the site from the 1930's and continued pesticide operations until the 1960's and fertilizer operations until the 1980's. Central Chemical is not actively operating at this location, and considerable space is leased for warehouse, auto-rebuilding, and other purposes.

When it was in operation at the site, Central Chemical blended pesticides with inert materials and then packaged and stored the blended products on site. The building which housed the pesticide blending operation was destroyed by fire in 1965. State records indicate that some pesticide blending was conducted in another building at the site after 1965, but this practice had discontinued by 1968. Pesticide operations were eventually transferred to another Central Chemical location in Elkton, Maryland.

Fertilizer manufacturing operations continued at the site until 1984. Materials handled during that time period include potash, phosphate, and ammonium sulfate. Records from 1968-70 indicate that the principal operation in the fertilizer manufacturing at the time involved blending ammonia solutions with other materials to produce fertilizers. The product was then dried, packaged, and stored at the site.

A small dump was observed at the site in 1970 by Maryland Department of Water Resources personnel. The 1970 inspection discovered bags marked "Omite" in stagnant water in the dump area.

A 1976 study of the Antietam Creek, conducted by the U.S. Geological Survey, indicated that sediments in the drainage basin associated with Hagerstown had been impacted by lead and some pesticides, notably DDT. Maryland Water Resources Administration officials investigated the situation, and they concluded that the Central Chemical site might be a significant source of the contaminants detected in the creek.

A Complaint and Order was issued to Central Chemical Corporation by the Maryland Water Resources Administration in 1977. The company was ordered to provide for a hydrologic study, to contain or remove contaminants in the ground, and to prevent discharges to waters of the State. The company opted to contain the contaminants through vegetative stabilization, and a Notice of Compliance was issued in December 1979 by the State.

During the excavation of a trench for a sewer line in March 1987, workers uncovered what appeared to be buried materials in the north section of the property, known as the quarry (dump) area. Soil samples taken at the time revealed pesticides, naphthalene, and volatile organic compounds. Subsequent investigation indicated that two locations at the site, the quarry (dump) area and a sinkhole area, are suspected to have been used by Central Chemical to deposit wastes, including pesticides and other potentially hazardous materials.

Following this incident, the Maryland Department of the Environment's Hazardous and Solid Waste Management Administration (now the Waste Management Administration) directed Central Chemical to conduct an environmental evaluation of the site. The ensuing investigation, which was closely regulated by the State, included soil sampling and monitoring well installation and sampling. The State continued to direct investigation efforts until recently, when Central Chemical announced that budgetary constraints restricted further efforts in this matter.

In March 1992 the U.S. EPA conducted a removal assessment of the site. Samples were collected from the monitoring wells, shallow soil, and interior building surfaces at the site. The U.S. EPA personnel determined that a removal action was not warranted in light of the evidence gathered at the time.

Sampling was conducted for this Expanded Site Inspection by personnel of the MDE/WAS ERRP Site Assessment Division on May 24 and 25, 1993. The effort, which was conducted in accordance with the U.S. EPA Contract Laboratory Program (CLP), included sampling of the soil, groundwater, and surface water associated with the site. These samples confirmed the presence of pesticides and organic constituents in the soil and groundwater at the site. In addition, sediment sampling revealed evidence of migration of pesticides from the site. Furthermore, DDT, DDD, and DDE were detected in a wipe sample collected from a storm drain on Mitchell Avenue next to the site. Thus, ESI sampling indicates that the pesticides DDD, DDE, and DDT are migrating from the site to the Antietam Creek in concentrations significantly above the local background levels.

2.0 Site Description

The Central Chemical - Hagerstown site is located on Mitchell Avenue in Hagerstown, Washington County, Maryland (Figures 1 and 2). Coordinates for the site, which is located on the Hagerstown, MD-PA quadrangle, are 39° 39′ 23" N latitude and 77° 43′ 21" W longitude.[1] The Maryland Grid coordinates for the site are 596,400 feet east by 665,033 ft north.

The site may be reached from Baltimore by proceeding west on Interstate 70 for approximately 60 miles from the Baltimore Beltway (Interstate 695). Take U.S. Highway 40 West for about 5 miles to the intersection with U.S. Highway 11 North. Turn Right (north) onto U.S. Hwy 11 North and continue for about 0.8 miles to Mitchell Avenue. Turn left onto Mitchell Avenue and continue for about 0.2 miles, and the site is on the right side.

The Central Chemical property consists of 19.022 acres.[2] Several buildings are currently located on-site, including the former fertilizer plant, warehouses, and several smaller structures (Figure 3). The foundation of the former Pesticide Plant (destroyed by fire in 1965) remains on site. A fence currently encloses the property, and two gates are located along Mitchell Avenue for access to the site.

Central Chemical is not active at the site, and it leases space to other parties.[3,30,72] At this time, tenants are using the site for paper recycling, firewood cutting, antique auto renovation, storage, and auto repair. Most of the activities associated with these operations are described by Central Chemical as part-time, and an estimated 5 to 10 persons are on site each day.

Two locations at the site are suspected to be former waste disposal areas: the dump area (or quarry area) and a sinkhole area (Figure 3, Photos 1 and 2). These areas are currently covered with soil and vegetated. Seven monitoring wells, which were installed by Roy F. Weston, Inc. in the late 1980s, are located on site (Figure 4 and Section 5).[4]

North of the site is Brighton manor subdivision, which is currently under development. An excavation for a sewer in this north section of the site revealed the suspected dump area currently under investigation (Section 2.1). An electrical substation, owned by the City of Hagerstown, is located just northeast of the property (Figure 3). Further east of the site property is a strip mall, located adjacent to Highway 11, which includes a supermarket, drug store, and other shops. Mitchell Avenue borders the southeast perimeter of the site, and the Maryland Metals building (currently vacant) is on the east side of this street. A stormwater drain is located on Mitchell Avenue (Section 3.2). The site is bordered on the southwest by Penn-Central Railroad, beyond which are residential areas.

2.1 Operational History

The Hagerstown Central Chemical Corporation site was constructed sometime in the early 1930's.[4,31] From that time until the mid 1960's, the plant functioned as a blender of agricultural pesticides and fertilizers. Records indicate that the pesticide blending operations included the use of DDT, Sevin, TDE, Daconil (tetrachloroisophthalonitrile), Guthion, and Omite, which were blended with inert materials like clay.[5,12,8] The raw pesticides, which were manufactured at other locations, were blended with other materials at the site.[5,30] The grinding and blending was accomplished using air and hammer mills and wetting agents, followed by dry packaging of the material.[5]

The pesticide operations building was destroyed by fire in 1965. State records indicate that some pesticide blending continued in another building at the site following the 1965 fire.[5] However, by 1968 the pesticide operations had been transferred to the Elkton Central Chemical location.[13]

Fertilizer manufacturing continued at the site until 1984. Records from 1968-70 indicate that the principal operation in the fertilizer manufacturing at the time involved blending ammonia solutions with other materials to produce fertilizers.[6,7] The product was then dried, packaged, and stored at the site. State records indicate that Central Chemical ceased operation at the site in 1984.

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A small dump was found outside the plant area in 1970 by Maryland Department of Water Resources personnel.[8] At the time of discovery, the dump contained standing septic water and bags marked as the pesticide Omite, a mite-killing insecticide. The same inspection reported "...suspicious dust in a ditch outside the plant, leading to a storm drain. It smells like insecticide." Records indicate that the Washington County Health Department directed that the dump area be covered with two feet of soil.[43]

Samples were collected from Antietam Creek in June 1976.[9] These samples indicated that DDT and lead were migrating to Antietam Creek from the Hagerstown area (Section 5.1). As part of the effort to locate the source of the DDT, soil samples were collected from the site and vicinity in August and October 1976.[10,11] These samples revealed DDT concentrations from 0.2 to 1,646.4 ppm, lead from 14.8 to 395.0 ppm, and arsenic from 2.2 to 300.0 ppm (Section 5.1). Environmental concerns were addressed by the State through Consent Order C-O-77-432, with subsequent ammendments, issued during the period 1977-1978 (Section 2.2). As the result of these actions, Central Chemical contracted to have the quarry and sinkhole areas covered with clay and soil.[4] This action included vegetative stabilization (seeding and mulching of the site) in order to reduce migration of soils from the site.[54,55,56,57]

In March 1987, during the development of an adjacent property, workers uncovered what appeared to be buried wastes during the excavation of a trench for a sewer line.[4,53,66] This excavation was adjacent to the quarry area on the Central Chemical property. Samples taken at the time revealed pesticides, naphthalene, and volatile organic compounds.

Soon after the 1987 incident, the Maryland Department of Environment (MDE) began negotiating a Consent Order with Central Chemical.[59] While not signing an agreement, Central Chemical contracted Roy F. Weston, Inc. to conduct an environmental assessment of the site in 1988-1989.[4] The Work Plan for the Weston Study was submitted to MDE for approval prior to site activities, and the study was completed by 1989 (Section 5.1).[4]

Mr. Robert Boone, Regional Inspector for the Maryland Department of the Environment, Hazardous and Solid Waste Management Administration (HSWMA) (now the Waste Management Administration, WAS), Hazardous Waste Program, conducted an interview with Earl Melvin Faith on January 20, 1989.[32,45] Mr. Faith informed Mr. Boone that he was employed as a supervisor overseeing warehouse operations at Central Chemical Corporation during the 1950's until 1965.[33,45] Mr. David Swartz, current president of Central Chemical, confirmed that Mr. Faith was a former employee of Central Chemical.[30]

Mr. Faith informed Mr. Boone that as raw materials became defunct and were banned by the government, he was directed to bury the materials either in an old stone quarry which held approximately 15 feet of water (for soluble waste) or to bury the materials in 40 x 5 feet deep trenches throughout areas east/northeast from the former quarry (for insoluble wastes). Mr. Faith said that such disposal was acceptable practice at the time, and he further stated that he was responsible for the disposal of the following wastes (Note: The following areas are both understood to be in the area identified as the dump (quarry) area on Figure 3):

Quarry (now abandoned)

Bags of crystallized copper sulfate, bags of powdered chlordane, bags of powdered sulfur, bags of powdered arsenic, and other soluble wastes.

Earthen trenches

Bags of unusable lime and sulfur, several thousand gallons of chlordane, hundreds of tons of DDT in fiber 55 gallon fiber drums, 50-60 tons of Para Screen (used to mix with insecticides) in 55 gallon fiber drums, cyanide gas canisters, sulfuric acid canisters, muriatic acid canisters, Sevin, and 70-80 55 gallon drums of 2-4,5T.

On February 22, 1989, Alan Williams and Laura Myers-Paligo, both of MDE, interviewed Mr. Faith again. Mr. Faith verified his previous testimony to Mr. Boone, and he added that he had buried Dyrene and large quantities of raw DDT. He stated that he was aware of only one time that waste was hauled to a county landfill.[34]

In March 1992 the U.S. EPA conducted a removal assessment of the site.[58] Samples were collected from three of the existing monitoring wells, eight shallow soil locations, and two wipe samples from interior building surfaces. The U.S. EPA personnel determined that a removal action was not warranted in light of the evidence gathered at the time.

2.2 Permitting and Regulatory Actions

In the early 1960's, the State and Washington County Health Departments were notified of complaints by local residents that pesticide odors were migrating from the plant.[12] Air samples collected by the State on October 18, 1962 revealed 7.5 mg/m^3 of Guthion. This concentration was deemed not to pose a hazard at the time by the State Health Department.

Following transfer of pesticide operations to a new location in Elkton, Cecil County, Maryland in 1968, Central Chemical filed an application for registration of the Hagerstown site as a Fertilizer Manufacturing Plant with the Maryland Department of Health on December 6, 1968.[6]

Records indicate that the Washington County Health Department ordered that a small dump area, discovered in 1970, be covered with two feet of soil.[8,43]

State and County Health Departments were notified of complaints by local residents concerning emissions of dust and smoke from the Number 2 stack at the site in 1970.[7] These emissions were due to oil-burning dryers, which were used in the fertilizer manufacturing operations. (The Number 1 stack emitted waste material from the ammoniator used in the fertilizer manufacturing, and records described it as usually non-visible).

In response to these Air Quality concerns, Central Chemical signed a Plan for Compliance with the State on April 30, 1971.[14] The Plan stated that Central Chemical would be in compliance with State Air Regulations by December 31, 1971. This compliance included the installation of vibrating bag filters and an economic study of the fertilizer granulator in order to determine whether to cease operation or install emission control equipment. State records indicate that the Plan for Compliance was complete by February 14, 1972.[15] These records indicate that Central Chemical opted to cease operation of the fertilizer granulator.

Following the discovery of elevated concentrations of pesticides and heavy metals at the site in 1976 (Section 5.1), a Complaint and Order (C-0-77-432) was issued to Central Chemical Corporation by the Maryland Water Resources Administration (WRA) in 1977.[10] This action directed Central Chemical to submit a hydrologic investigation of the site (Baker & Wibberly Study, Section 5.2). Through Supplemental Orders C-0-77-432 A, B and C, the State continued to direct investigation and stabilization of the site by Central Chemical to prevent further migration of contaminated soils (Section 2.1).[54,55,56] The State issued a Notice of Compliance on December 14, 1979.[57]

Following the discovery of the on-site dump area in 1987 (Section 2.1), the MDE began negotiating a Consent Order with Central Chemical.[59,60] To date, Central Chemical has not signed the currently proposed Consent Order with the State.

Central Chemical was issued Site Complaint SC-0-92-185 on May 22, 1992.[61] Central Chemical was cited for improper storage of materials, including two 5-gallon containers, which reportedly contained prohibited pesticides.

Federal, State, amnd local officials began requesting that Central Chemical install a fence around the quarry (dump) area in 1992.[62,63,64,65] Central Chemical agreed to construct the fence in July 1992. The fence was completed by October, 1992.[70]

3.0 Environmental Setting

3.1 Water Supply

Sources of potable water for the site vicinity include the Hagerstown/Williamsport Municipal System, private wells, and cisterns. The principal source of potable water is the Hagerstown/Williamsport Municipal System.[18] This system, which serves a total of approximately 75,000 persons, draws water from an intake located on the Potomac River northwest of Williamsport, Maryland. The intake for the Hagerstown/Williamsport Municipal System is not associated with the surface water downstream from the site. This municipal water is treated at the Richard Wilson Filtration Plant (in Williamsport) prior to distribution.

Private wells serve approximately 1,011 persons living within four miles of the site.[46] This estimate is based upon records of private wells drilled since 1969. A survey of the area conducted for the ESI in 1993 was successful in identifying private wells north of the site in the 2 - 4 mile rings, east of the site in the 2 - 4 mile rings, southeast of the site in the 3 - 4 mile ring, none south of the site within four miles, and west of the site in the 2 - 4 mile rings. A significant number of homes use cisterns, which capture and store rain water, but as mentioned above, the most significant source is the municipal system. No municipal wells are located within four miles of the site.[18]

The distribution of private wells within four miles of the site is estimated to be:[18,46]

Distance ring from site (miles)	Population served by wells
0 - 1/4	0
1/4 - 1/2	0
1/2 - 1	0
1 - 2	0
2 - 3	416
3- 4	595
Total:	1,011

3.2 Surface Water

Most of the drainage from the site enters a storm drain on Mitchell Avenue (Figure 9, Photo 14).[35] Runoff flows southward from the drain through the underground stormwater system for approximately one mile, where it discharges from a box culvert into an open stream near Walnut Street and City Park (Photo 7). This open stream is unnamed on the U.S.G.S. topographic maps, but it is locally known as Marsh Run, and it will be referred to as Marsh Run 2.[32,35] (U.S.G.S. maps designate another stream in the vicinity of Hagerstown as Marsh Run, therefore this distinction is necessary.[1]) A sample (SW-4/SED-4, Figure 13) was collected from this location during the ESI sampling condcuted in May 1993 (Section 6).

The flow rate of Marsh Run 2 depends upon the amount of water received by the stormwater system, which varies seasonally. The stream was observed to be flowing during site visits conducted in February and May of 1993, and the flow rate is estimated to have been less than 10 cubic feet per second (cfs) on both occasions. This stream cannot be considered a fishery or recreational stream.

In City Park, a spring-fed stream from the Hager House, an historic landmark, feeds Marsh Run 2. Another tributary runs along the Penn Central Railroad track adjacent to City Park, and this location was sampled during the ESI (SED-5). A spring-fed pond also contributes to the flow of Marsh Run 2 near City Park as it makes its way to Memorial Boulevard.

As Marsh Run 2 makes it way through the city, it flows through segments of earthen ditches and cement-lined conduits, and several storm drains and tributaries contribute to its flow along this pathway (Figures 9 and 13). Marsh Run 2 follows Memorial Boulevard southeast past South Potomac Street, the former location of a greenhouse.[30] The current president of Central Chemical has identified this greenhouse as a potential source of pesticide contaminants in the Hagerstown area. Marsh Run 2 continues eastward along Memorial Boulevard to Eastern Boulevard, where a sample was collected from a significant tributary (SW-6/SED-6, Photo 9 and 10). This tributary was cement-lined, but sediments were deposited in it to a depth of 1/2 - 2 inches.

Marsh Run 2 then turns south and flows around a vacant power plant (Maryland Electric, Light, and Power, MELP; Photo 13). A sample (SW-2/SED-2) was collected just upstream from this location during the ESI. Marsh Run 2 then discharges into the Antietam Creek a distance of approximately 1.8 miles downstream from the box culvert.[35] This point of discharge of Marsh Run 2 into the Antietam Creek is designated as the probable point of entry (ppe) of surface water discharge from the site. A sample (SW-3/SED-3, Photos 11 and 12) was collected during the ESI from Antietam Creek just downstream from the confluence with Marsh Run 2.

The Antietam Creek flows south for several miles before converging with the Potomac River (Figure 5).[1] This creek is estimated to flow between 100 - 1,000 cfs. This estimate is based upon gaging station data, which records an annual average flow of 120 cfs upstream from the site near Waynesboro, Pennsylvania, and an average annual flow of 276 cfs downstream from the site near Sharpsburg, Maryland.[51]

The Antietam Creek is used for fishing and recreational purposes. A boy was observed fishing from the creek during the ESI, and there was evidence of old fishing hooks, soda and beer cans, etc., along the creek (Photo 12).

The wetlands identified along the surface water pathway are designated as open water riverine by the U.S. Department of the Interior.[47] Figure 16 illustrates the wetlands located in the site vicinity.

There are no municipal surface water intakes located on Antietam Creek within 15 miles downstream from the point of convergence with Marsh Run 2.[18] The Antietam Creek enters the Antietam National Battlefield a distance of approximately 17 miles downstream from the ppe.[52]

3.3 Soils

The site rests upon a soil type classified as the Hagerstown silt loam which is a deep, well-drained, mature, red-to-orange soil which develops during the weathering of limestones.[19] Analyses of this material show the mechanical composition to be 10% clay, 10% sand and 80% silt with an organic content adequate to support a variety of crops. Soils thicknesses vary considerably from 0 to 40 feet thick over bedrock, depending on the slope of the terrain. In this particular area, slopes are between 0 and 15%.

The surface of the Hagerstown silt loam often has a friable or crumbly character which affects the rate of water percolation. These surface permeabilities generally range from 0.06 to 0.6 inches per hour which is sufficient to prevent flooding except during unusually heavy rainfalls.

Hagerstown soils are capable of supporting a large variety of commercial agricultural and wood crops with only a moderate need for expensive fertilizers. The fine particle size of the soil makes it susceptible to erosion but, with properly designed farming techniques, erosion is easily controlled.

3.4 Geology

The site is located in the Great Valley (or Hagerstown Valley) of the Valley and Ridge physiographic province.[20] The Valley and Ridge physiographic province is a series of anticlinal and synclinal ridges and valleys. The province is separated into 2 topographically and geologically distinct zones: the Great Valley and the Allegheny Ridge area. The Great Valley is approximately 18 miles wide and averages 500 to 600 feet in elevation. The broad, flat valley is underlain by a thick series of limestones and shales. The Allegheny Ridge area extends westward from the Great Valley to the Allegheny Front near Frostburg. The parallel ridges of erosion-resistant sandstone are aligned in a northeast-southwest direction. Intervening valleys are composed of weaker shale and limestone beds.

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There are three formations that produce water within a 4-mile radius of the site. These are: the Conococheague limestone, the Stonehenge limestone, and the Rockdale Run Formation (Figure 10). The Conococheague limestone is the formation that the site is located on.

The Conococheague limestone, of Cambrian age, is thought to be between 2000 and 2600 feet thick. The formation is described as an argillaceous, laminated, dark slate blue limestone with interbedded dolomites in the basal sandy portion.[17]

Transmissivity values of the Conococheague range between 2,200 to 19,000 gallons per day per foot (gpd/ft). Well depths are reported to be between 40 and 500 feet deep and yield from 15 to 235 gallons per minute (gpm) of water. The well that is located on site is completed in this formation. This well was reported to be 318 feet deep and originally yielded 45 gpm in 1950 when it was used for industrial purposes by the Central Chemical Corporation. Hydraulic conductivities are variable in karst terrains, but locally range from 2.24×10^{-2} to 2.5×10^{-3} cm/sec in this formation.[17]

Overlying the Conococheague limestone is the Ordivician-aged Stonehenge limestone. This formation, a member of the Beekmantown Group, is approximately 500 to 800 feet thick and is composed of a massively bedded clayey limestone which grades upward into thin conglomerate beds. Transmissivities of this formation range from 2,000 to 200,000 gpd/ft. Well depths in the Stonehenge range from 70 to 910 feet and yield from 1.5 to 600 gpm. Hydraulic conductivities range from 2.2×10^{-1} to 2.198×10^{-3} cm/sec, according to pumping tests conducted in this aquifer.[17]

The third formation present is the Rockdale Run Formation, which is of Ordivician age. Like the underlying Stonehenge limestone, this formation is also a member of the Beekmantown Group. It is made up of alternating limestones and dolomites, and reaches a maximum thickness of 2250 feet. The basal section of this formation consists of a cryptozoon chert, approximately 100 to 200 feet thick, overlain by stromatolitic silty limestones and dolomites. Transmissivity ranges from 10 to 127,000 gpd/ft. Well depths range from 19 to 230 feet. Yields from these wells range from 1 to 30 gpm. Hydraulic conductivity ranges from 9.85 x 10^{-6} to 1.25 x 10^{-1} cm/sec, depending on whether they are measured in fractured zones or in competent bedrock.[17]

3.5 Groundwater

Geologic structure is an extremely important factor governing groundwater occurrence and availability in the region the site is located in because joints, faults, and bedding plane partings provide the framework for relatively rapid permeability.[21] Groundwater is continuously in motion, flowing laterally under the influence of gravity from areas of high hydraulic potential and discharging as springs and seeps in areas of low hydraulic potential. The rate of movement in carbonate aquifers is in some places greater than in many other rock types because cavernous openings provide large conduits through which water can move fairly rapidly. Studies show, on the basis of dye tracings, that the groundwater can move as much as 4,000 feet in 2 to 6 days. This is in comparison to other rock types in which groundwater moves a few inches or feet per day.[21]

Joints are planes of separation between rock masses where little or no displacement has occurred. Joints never occur alone, but are found in a series of parallel planes called joint sets. In the Hagerstown Valley there are three to six joint sets, 2 or 3 which are generally dominant. The joint set parallel to the strike of the bedding is nearly always present and seems to be most important in controlling solution channel development. This conclusion is in agreement with data relating to cavern passage orientation. Another set of joints striking approximately perpendicular to the strike of the bedding is generally present. Other sets of joints are present in varying degrees of development at most localities. Surface expression of this network is most easily observed as trellis and rectangular drainage patterns, but can also be seen through the use of air photometry in fracture trace analyses.[21]

A filled and regraded sinkhole is present at the site near the south entrance (Figure 3). The quarry (dump) area that was present in the northern portion of the site may have originally been a sinkhole, or acted as a sinkhole after quarrying operations reached the groundwater. It seems unlikely that widespread sinkholes can develop unless they are connected to an underground conduit system in which water is free to flow to a spring outlet at a lower level.[22] The drainways from many sinkholes connect directly with underlying conduit systems. They are often attractive sites for waste disposal, where corrosion and decay provide a source of contamination for long periods of time. Some sinkholes flood, and all take surface runoff from small catchments surrounding the sink. The pondings and injections of fresh water continually leach the accumulated debris in the sink and carry the leachate into the groundwater system.[23] Sinkholes are a nuisance and potential hazard to farmers and other property owners, and the sinkholes are usually filled. Sinkholes are natural points of recharge and water recharged through them receives little if any filtering.[21]

Hazardous chemical waste sites may permit substances to transport directly into the underlying conduit system due to the possibility of soil piping beneath the site. Leachate from the waste can enter the subsurface either directly through solution openings or by percolation through soils. Steel drums containing chemical wastes corrode after a few years in most environments and release their contents to whatever transport processes are available.[23]

Most metals of concern are not highly mobile if brought into equilibrium with karst groundwater. Acid wastewaters are quickly neutralized by reaction with limestone. However, the beneficial effect of carbonate water chemistry is offset by the open conduit flow paths. Leachates may enter cave streams where they flow on a chemically inert bed of quartz sand and clay minerals. Rapid flow in the conduit system may transport metals for long distances before reactions come to equilibrium.[23]

The hydrochemistry of hazardous chemical waste disposal sites in karst terrains is almost unknown. Chlorinated hydrocarbons and other more complex organic molecules are often poorly soluble in water, and so could be carried as a separate phase for considerable distances with little dispersion along conduit drainage paths. Adsorption on clastic sediments, oxidation, or other reactions with karst groundwater, and rates of dilution and dispersion are all of interest. Likewise, there are few data on the effects of chemical contamination on aquatic organisms in underground streams.[23]

During an investigation conducted by Roy F. Weston, Inc., 7 monitoring wells were installed (Section 5.3.4, Figure 4, and Appendix A).[4] Of these wells, MW-1 was completed in a cavern and MW-2 was completed in a mud-filled void. Voids were encountered during drilling at varying depths in MW-2, MW-4, and MW-7. A water-bearing fracture was encountered at 47 feet below surface in MW-3. Table 5F summarizes the specifications of these wells. Depth to groundwater in these wells was measured to be 25 to 67 feet below the surface.

A Ground-Penetrating Radar (GPR) survey and an EM-31 survey conducted by Weston were able to give an estimate of the quarry depth and volume (Sections 5.3.2 and 5.3.3).[4] However, in other areas of the site, the data had interferences and anomalies that Weston could not confidently analyze. A resistivity survey conducted by an experienced consulting firm may be helpful in order to clarify some of the unidentified anomalies. It may also define solution cavity orientation under the site, which is important as it would define groundwater flow directions.

Surface drainage on the site and groundwater flow under site appears to be to the east. There are indications that groundwater flow may turn to the south soon after leaving the site. Figure 11 shows water level contours in the Hagerstown Valley area around the site. This would indicate that groundwater probably flows to the east towards Antietam Creek, but may also flow to the south towards the Potomac River.

3.6 Meteorology

The average net annual precipitation is estimated to be 7 inches per year. This value is based upon a mean annual precipitation of 39 inches and an average annual open-water evaporation of 32 inches.[48,49] The 2-year 24-hour precipitation is estimated to be 3.1 inches.[50]

3.7 Nearby Land Use and Population Distribution

The total population living within four miles of the site is estimated to be 62,707 persons. This population is distributed as follows:

Distance of ring from site (miles)	Population
0 - 1/4	3
1/4 - 1/2	4,932
1/2 - 1	15,017
1 - 2	26,649
2 - 3	11,440
3 - 4	4,666
Total:	62,707

This estimate is based upon topographic mapping of the site area and census data.[1,44] The number of dwellings within each distance ring were counted, and these values were multiplied by the average of 2.6 persons per dwelling for Washington County.[44] However, the latest topographic maps available dated to 1971. In order to account for the increase in the population of Washington County since that time, the population values were then multiplied by the ratio of the population of Washington County in the 1990 census (121,393) to that of the 1970 census (103,829). In addition, the number of persons in the urban areas (which are shaded on the topographic maps and do not include designations for the individual dwellings) was apportioned to each distance ring based upon the 1990 census data for the populations of

Hagerstown (35,445), Halfway (8,873), and Funkstown (1,136). This resulted in the values reported above.

The site is located within the City of Hagerstown, and the land around the site is used for commercial and residential purposes. The land within four miles of the site is used for residential, commercial, and agricultural purposes.

4.0 Waste Description

Two locations at the site are suspected to have been used as waste disposal areas, the dump area (or quarry area) and a sinkhole area (Figure 3). These areas are currently covered with soil and vegetated. Actual dimensions of any areas formerly used for waste disposal are difficult to determine at this time, but estimates of these areas may be made. The suspected dump area in the former quarry area covers approximately 0.44 to 3.1 acres, and the sinkhole area is estimated to cover 1/4 to 1/2 acre.

During the excavation of a trench for a sewer line in March 1987, it was revealed that the quarry area appeared to contain buried materials. This area corresponds to a dump which was observed by Maryland Department of Water Resources personnel in 1970 (Section 2.1). Samples taken following the 1987 incident revealed the presence of pesticides, naphthalene, and volatile organic compounds. ESI sampling conducted in May 1993 confirmed the presence of elevated concentrations of pesticides, lead, and mercury.

Testimony of a former employee of Central Chemical, Mr. Earl Melvin Faith, alleges that both the quarry and sinkhole areas were formerly used as disposal areas by Central Chemical. Mr. Faith was employed as a supervisor overseeing warehouse operations at Central Chemical Corporation from the 1950's until 1965. He was interviewed by Maryland Department of the Environment (MDE) Regional Inspector Robert Boone on January 20, 1989.

Mr. Faith informed Mr. Boone that as raw materials became defunct and were banned by the government, he was directed to bury the materials either in an old stone quarry which held approximately 15 feet of water (for soluble waste) or to bury the materials in 40 x 5 feet deep trenches throughout areas east/northeast from the former quarry (for insoluble wastes). Mr. Faith said that such disposal was acceptable practice at the time, and he further stated that he was responsible for the disposal of the following wastes:

Quarry (now abandoned)

Bags of crystallized copper sulfate, bags of powdered chlordane, bags of powdered sulfur, bags of powdered arsenic, and other soluble wastes.

Earthen trenches

Bags of unusable lime and sulfur, several thousand gallons of chlordane, hundreds of tons of DDT in fiber 55 gallon fiber drums, 50-60 tons of Para Screen (used to mix with insecticides) in 55 gallon fiber drums, cyanide gas canisters, sulfuric acid canisters, muriatic acid canisters, Sevin, and 70-80 55 gallon drums of 2-4,5T.

A subsequent interview of Mr. Faith was conducted by MDE personnel on February 22, 1989. During this interview, Mr. Faith repeated the allegations mentioned above, and he also said that he had buried "Dyrene". On this occasion, Mr. Faith stated that he had also buried large quantities of raw DDT in bags and that he was aware of only one time when the waste had been hauled to a county landfill.

5.0 Previous Study

5.1 State of Maryland Sampling

State records indicate that the State began monitoring the site for DDT contamination in 1976, following discovery of DDT in sediments of the Antietam Creek during a study of the Antietam Creek watershed conducted by the U.S. Geological Survey.

Samples from the Antietam Creek and two of its tributaries were sampled on June 22, 1976.[9] A total of eleven sediment samples were collected: one from the unnamed tributary downstream from the site, nine along Antietam Creek, and one from Marsh Run (Figure 5 and Table 5A). Elevated levels of DDT (2.06 ppm) and lead (1070 ppm) were detected in the unnamed tributary sample, which is downstream of surface water drainage from the Central Chemical site (Section 3.2).

Table 5A Previous Sediment Sampling - July 13, 1976

Sample	arsenic	cadmium	chromium	lead	mercury	Chlordane	DDD	DDE	DDT	Dieldrin	PCB 1254
ANT 0366	2.05	< 1	27.0	68	0.5	0.015	0.002	< 0.000	0.002	< 1.0	< 0.01
ANT 0291	2.12	< 1	11.0	8	< 0.1	< 0.01	< 0.000	< 0.000	0.001	< 1.0	< 0.01
ANT 0277	1.9	<1.0	22.0	53	0.5	< 0.01	0.001	0.001	0.003	< 1.0	< 0.01
ANT 0251	5.07	2.0	34.0	54	1.5	< 0.01	0.001	0.001	0.002	< 1.0	< 0.01
ANT 0241	3.96	5.0	50.0	255	0.2	< 0.01	0.074	0.011	0.417	< 1.0	< 0.01
ANT 0229	5.07	2.0	29.0	96	0.3	< 0.01	0.01	0.003	0.104	< 1.0	< 0.01
ANT 0203	3.09	1.0	31.0	47	0.3	< 0.01	0.068	0.007	0.138	< 1.0	< 0.01
ANT 0134	3.39	5.0	41.0	114	0.3	< 0.01	0.011	0.003	0.047	< 1.0	< 0.01
ANT 0044	4.09	1.0	30.0	36	0.5	< 0.01	0.005	0.001	0.003	< 1.0	< 0.01
UAK 0001	4.89	2.0	35.0	1070	1.5	< 0.01	0.205	0.018	2.059	< 1.0	< 0.01
MRS 0000	1.03	8.0	80.0	5	0.6	< 0.01	< 0.000	< 0.000	0.001	< 1.0	< 0.01

Units in parts per million (ppm)

Soil samples were collected from the site and vicinity on August 3, 1976 by personnel from the Maryland Water Resource Administration (WRA).[10] Four samples were collected from four drainage areas associated with the site. The available documentation does not include a map locating the samples, but location descriptions are available. Table 5B presents the information regarding sample locations and analytical results. These samples demonstrated elevated levels of DDT associated with the site.

Table 5B Previous Soil Sampling - August 3, 1976

Sample	Location	DDT	arsenic	lead
1	Chemical plant drainage ditch located at west side edge of pesticide chemical loading dock.	1.9	53.8	188
2	Chemical plant drainage ditch west of paper storage shed before entering Penn Central Railroad drainage ditch.	6,535	16.2	100
3	Penn Central Railroad drain inlet pipe receiving west side drainage of chemical plant.	6,932	34.0	124
4	Mitchell Ave storm drain below drainage from chemical plant (NE of railroad overpass).	46.7	16.5	139

Units in mg/kg (ppm).

Additional soil samples were collected in the vicinity of the site by WRA personnel in October 1976.[10,11] These samples were collected from seven locations at various depths using a split-spoon apparatus. The analyses revealed DDT concentrations from 0.2 to 1,646.4 ppm, lead from 14.8 to 395.0 ppm, and arsenic from 2.2 to 300.0 ppm. Sample location descriptions and analytical results are presented in Table 5C.

Table 5C Previous Soil Sampling - October 28 and 29, 1976

Sample	Location	Depth collected (feet)	DDT	arsenic	lead
1A	Lowest area in southeast corner of property.	0.5	176	20.9	395
1B		2 to 3	25.1	11.7	201
1C		8 to 9	471	8.1	32.2
2A	Inside fence line on western side of property, near liquid storage area.	0.5	119.5	16.3	93.5
3A	Outside of property fence line on southeast corner, near shipping area.	0 to 1	653.6	180.0	97.3
3B		1 to 2	300.3	300.0	197
4A	Outside of property fence on western side, near the grinding and dust packing area.	0 to 1	85.1	38.0	31.0
5A	At northern corner, which is the highest point of the property.	0 to 1.5	70.7	17.7	114.5
5B		2.5 to 3.5	0.3	5.7	14.8

Sample	Location	Depth collected (feet)	DDT	arsenic	lead
6A	Outside of property fence line, at the edge of abandoned Central Chemical dump containing rubble from the pesticide building which was destroyed by fire in 1965.	1 to 2	1,646	39.3	90.8
6B		3 to 4	34.7	3.7	15.0
6C		8 to 9	1.5	3.8	18.7
7A	Along edge of Mitchell Avenue, south of Central Chemical plant building.	0 to 1	27.3	ni	89.1
7B		1 to 2	16.9	ni	79.3
7C	At point where the surface drainage enters public storm drains.	2 to 3.5	ni	2.2	15.8

Units in mg/kg (ppm).
ni = no information in record

5.2 Baker & Wibberly Study

Baker & Wibberly (B&W) conducted a study of the site in April 1977. Central Chemical contracted B&W to conduct this assessment to comply with the State of Maryland Water Resources Administration's Supplemental Order C-0-77-432A.[16] This hydrologic assessment included the collection of soil borings, groundwater, and ponded surface water from the site and vicinity. (There is currently no evidence of monitoring wells identified in this study.) These samples were analyzed for DDT, arsenic, and lead constituents.

Soil borings were drilled at 33 locations, and 62 samples were collected from various depths within these locations. In addition, groundwater was sampled from two monitoring wells established by B&W. An aqueous sample was collected from an abandoned quarry located 1,200 feet southeast and hydrologically downgradient from the site. Figure 6 depicts the locations of the soil borings and monitoring wells installed by B&W, and Table 5D presents the results of this study.[4,16] The location of the ponded surface water sample is not depicted in the references.

B&W concluded that "the underlying clay strata has retained the lead, arsenic and DDT".[16] As a result of this study, and a Consent Agreement with the State of Maryland, Central Chemical closed its refuse dump located to the northeast of the former pesticide manufacturing plant in 1978.

ORIGINAL

Table 5D Baker & Wibberly Study (1977) Soil Borings

SOIL ANALYSES
SHOWN IN PARTS PER MILLION

BORING	DEPTH OF SAMPLE			
A-1	0' to 1.5'	4.5' to 6.0'	8.0' to 9.5'	11.0' to 12.0'
Total Lead	68.6	35.0	7.5	10.7
Total Arsenic	41.0	71.1	77.5	13.2
D.D.T.	117.2	0.41	*0.05	0.33
A-3	0' to 2.0'	4.5' to 6.0'	8.0' to 9.5'	11.0' to 12.0'
Total Lead	1020.0	17.8	8.9	22.9
Total Arsenic	22.8	63.3	20.7	21.4
D.D.T.	55.2	0.19	0.80	*0.05
A-5	0' to 2'	4.5' to 6.0'	8.0' to 9.5'	11.0' to 12.0'
Total Lead	317.7	15.0	18.5	16.7
Total Arsenic	12.4	17.5	19.7	12.4
D.D.T.	273.2	3.17	0.56	20.2
A-7	0' to 2.0'	4.5' to 6.0'	8.0' to 9.5'	11.0' to 12.0'
Total Lead	41.0	16.3	10.4	9.0
Total Arsenic	13.3	11.6	9.8	12.1
D.D.T.	2.72	0.29	*0.05	0.49
B-2	0' to 2.0'	4.5' to 6.0'	8.0' to 9.5'	11.0' to 12.0'
Total Lead	16.4	72.7	4.4	10.8
Total Arsenic	20.3	306.0	12.7	12.9
D.D.T.	1.26	*0.05	0.22	0.15
B-5	0' to 2'	4.5' to 6.0'	10' to 11.5'	
Total Lead	20.7	16.0	12.1	
Total Arsenic	15.1	13.7	11.0	
D.D.T.	38.2	0.21	0.26	
B-7 +80	0' to 2.0'	4.5' to 6.0'	8.0' to 9.5'	11.0' to 12.0'
Total Lead	75.0	31.2	12.5	4.6
Total Arsenic	20.4	15.7	12.7	3.9
D.D.T.	392.9	14.5	28.0	0.27

* Less than

Table 5D Baker & Wibberly Study (continued)
Soil Borings

C-2	0' to 1.5'
Total Lead	8.7
Total Arsenic	13.6
D.D.T.	1.55

C-3	0' to 1.5'
Total Lead	20.7
Total Arsenic	16.4
D.D.T.	3.15

C-3A 15' N.W. of C-3	4.5' to 6.0'	8.0' to 9.5'	11.0' to 12.0'
Total Lead	15.9	17.9	88.8
Total Arsenic	17.1	11.9	156.0
D.D.T.	4.8	0.28	0.83

C-4	0' to 2'	4.5' to 6.0'	8.0' to 9.5'	11.0' to 12.0'
Total Lead	61.0	39.0	10.6	16.9
Total Arsenic	23.6	13.8	12.0	9.4
D.D.T.	160.0	17.1	5.26	16.0

D-3	0' to 1.5'
Total Lead	9.7
Total Arsenic	12.2
D.D.T.	0.96

D-4	0' to 2.0'	5.0' to 6.5'	8.0' to 9.5'
Total Lead	266.0	24.9	17.4
Total Arsenic	33.3	21.1	16.2
D.D.T.	124.0	178.0	27.3

D-6	0.5' to 2'	4.5' to 6.0'
Total Lead	48.3	17.5
Total Arsenic	12.1	63.3
D.D.T.	2.15	1.89

D-6 + 25 25' West of D-6	8.0' to 9.5'	11.0' to 12.0'
Total Lead	78.0	12.4
Total Arsenic	15.3	10.5
D.D.T.	7.65	5.26

Table 5D **Baker & Wibberly Study (continued)**
Aqueous Samples

WATER ANALYSES

Location	Monitoring Well A-5	
	Water Level 18 feet below ground level	
	Total Lead	Less than 0.05 parts per million
	Total Arsenic	Less than 0.02 parts per million
	D.D.T.	0.33 parts per billion (0.00033 parts per million)
Location	Abandoned Quarry	
	Total Lead	Less than 0.05 parts per million
	Total Arsenic	Less than 0.02 parts per million
	D.D.T.	0.36 parts per billion (0.00036 parts per million)
Location	E-7A, Water Level 10 feet below ground level	
	Total Lead	Less than 0.05 parts per million
	Total Arsenic	1.97 parts per million
	D.D.T.	2.20 parts per billion (0.0022 parts per million)

Table 5D

Baker & Wibberly Study (continued)
Soil Borings

D-7	0' to 2.0'
Total Lead	254.0
Total Arsenic	9.2
D.D.T.	100.0

D-7A - 30' N.W. of D-7	4.5' to 6.0'	8.0' to 9.5'	11.0' to 12.0'
Total Lead	16.7	12.5	13.7
Total Arsenic	8.4	16.5	16.8
D.D.T.	0.95	0.72	3.08

D-8	0' to 2.0'
Total Lead	83.5
Total Arsenic	6.2
D.D.T.	15.5

E-3	0' to 2.0'
Total Lead	42.2
Total Arsenic	7.2
D.D.T.	1.75

E-7-A - 30' N.W. of E-7	5.0' to 7.5'	15.0' to 20.0'	Auger Sample
Total Lead	102.0	31.9	
Total Arsenic	26.1	35.0	
D.D.T.	22	1404.	

E-8	0' to 1.5'	4.5' to 6.0'
Total Lead	39.0	53.0
Total Arsenic	9.0	17.5
D.D.T.	17.5	122.5

F-5	0' to 2.0'	4.5' to 6.0'	8.0' to 9.5'
Total Lead	10.9	28.7	54.0
Total Arsenic	11.0	20.9	4.9
D.D.T.	25.0	0.70	0.82

G-4	0.5' to 2.0'	4.5' to 6.0'	8.0' to 9.5'	11.0' to 12.0'
Total Lead	47.0	11.3	27.2	14.4
Total Arsenic	10.0	19.2	12.7	19.9
D.D.T.	5.32	1.08	7.2	2.75

5.3 Roy F. Weston Study

During excavation in 1987 for a sewer line (for an adjoining property) in the quarry area, evidence of buried waste was unearthed.[4] MDE personnel collected soil samples which revealed pesticides, naphthalene and chlorinated organic compounds. MDE directed Central Chemical to conduct an environmental site evaluation, and Central Chemical hired Roy F. Weston, Inc. to perform the evaluation.

Weston conducted the site evaluation in 1988-89, and they published the results in 1989 as the "Phase I Environmental Assessment".[4] This evaluation focused on two areas of the site: the former dump (quarry) area and the filled sinkhole area (Figure 3). The work conducted for this assessment included the collection of soil borings from six locations, the installation and sampling of seven monitoring wells, and EM-31 and GPR geophysical surveys.

5.3.1 Soil Borings

In October 1988, six borings were drilled at the site by Weston. An MDE observer noted that workers were forced to stop boring operations on several occasions when the odor of chemical compounds became too strong.[53] Borings were drilled as deep as 36 feet in order to visually characterize the material beneath the surface, and the report descriptions include black material, yellow powder, black and gray waste material, green seams, black and gray silt and clay, brown sand and silt and white powder.[4]

While the soil borings penetrated as deep as 36 feet, the soil samples were collected from depths of 6 to 12 feet (Table 5E and Figure 6). The Weston report indicates that soil was collected from one sample interval in five of the six locations (BH-1 through BH-5), and that two intervals were collected from the sixth location (BH-6). These samples were analyzed for volatile and semi-volatile organic compounds, pesticides, herbicides, and total metals. In addition, EP Toxicity characterization of these soil samples was conducted (all samples

Table 5E Weston Study (1989) Soil Borings

Soil Sampling Results
October 25-28, 1988

	BH-1-4	BH-2-7	BH-3-5	BH-4-3	BH-5-7	BH-6-4	BH-6-5	BH-2(water)**	BH-5(water)
SAMPLE DEPTH (ft)	*6-8*	*12-14*	*8-10*	*4-6*	*14-16*	*10-12*	*12-14*	*36*	*32.5*
HEAD SPACE (ppm)	6.2-20	150->1000	12-35	0	6-400	78-95	40-85	NA	NA
VOLATILES (ppm)									
chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
bromomethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
vinyl chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
acrolein	ND	ND	ND	ND	ND	ND	ND	ND	ND
acrilonitril	ND	ND	ND	ND	ND	ND	ND	ND	ND
dichlorodifluoromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
trichlorofluoromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
methylene chloride	ND	ND	ND	ND	ND	ND	ND	ND	*0.05
acetone	ND	ND	0.11	ND	ND	ND	ND	ND	*0.026
1.1-dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroform	0.013	ND	ND	0.002	ND	ND	ND	0.012	ND
1,2-dichlororthane	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-butanone (MEK)	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND	ND
bromodichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND
trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND
dibromochloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
tetrachloroethene	*0.008	ND	ND	0.007	ND	ND	ND	ND	ND
benzene	0.017	ND	0.005	ND	ND	ND	ND	ND	0.036
trans-1,3-dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-chloroethylvinyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND
bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-methyl-2-pentanone (MIBK)	ND	ND	ND	ND	ND	ND	ND	ND	ND
toluene	0.011	ND	0.031	0.003	ND	ND	ND	ND	ND
chlorobenzene	1.1	4.6	0.1	0.041	0.034	0.034	0.72	0.74	0.49
m-xylene	0.033	9.2	0.11	ND	0.005	ND	0.45	0.019	ND
o&p-xylene	0.038	7.5	0.15	ND	0.009	ND	0.11	ND	ND
1,3-dichlorobenzene	0.066	12	0.017	0.006	ND	0.014	0.79	0.027	0.021
1,2-dichlorobenzene	1.1	81	0.079	0.034	0.015	0.058	3.3	0.27	0.9
1,4-dichlorobenzene	1.2	180	0.34	0.046	0.045	0.26	22	0.63	0.34
ethylbenzene	*0.008	ND	0.053	ND	ND	ND	ND	0.046	0.097

** Water samples from BH-2 and BH-5 contained 30 to 40 % solids, therefore the data are not defensible.

* indicates a result below exact quantification

ORIGINAL

Table 5E Weston Study (continued)
Soil Borings

	BH-1-4	BH-2-7	BH-3-5	BH-4-3	BH-5-7	BH-6-4	BH-6-5
SAMPLE DEPTH (ft)	6-8	12-14	8-10	4-6	14-16	10-12	12-14
SEMI-VOLATILES (ppm)							
phenol	ND	ND	ND	ND	ND	ND	ND
bis(2-chloroethyl)ether	ND	ND	ND	ND	ND	ND	ND
2-chlorophenol	ND	ND	ND	ND	ND	ND	ND
1,3-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
1,4-dichlorobenzene	*0.82	66	0.87	47	4.5	*0.16	*4
1,2-dichlorobenzene	*1.2	ND	ND	ND	1.4	ND	ND
bis(2-chloroisopropyl)ether	ND	ND	ND	ND	ND	ND	ND
4-methylphenol	ND	ND	ND	ND	ND	ND	ND
N-nitroso-Di-n-propylamine	ND	ND	ND	ND	ND	ND	ND
hexachloroethane	ND	ND	ND	ND	ND	ND	ND
nitrobenzene	ND	ND	ND	ND	ND	ND	ND
isophorone	ND	ND	ND	ND	ND	ND	ND
2-nitrophenol	ND	ND	ND	ND	ND	ND	ND
2,4-dimethylphenol	ND	ND	ND	ND	ND	ND	ND
bis(2-chloroethoxy)methane	ND	ND	ND	ND	ND	ND	ND
2,4-dichlorophenol	ND	ND	ND	ND	ND	ND	ND
acenaphthene	ND	ND	*0.31	ND	ND	ND	ND
fluorene	ND	ND	*0.35	ND	ND	ND	ND
1,2,4-trichlorobenzene	40	210	*0.42	ND	2.8	6.1	12
naphthalene	ND	*3.7	ND	ND	0.87	ND	ND
hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND
4-chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND
hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND
2,4,6-trichlorophenol	ND	ND	ND	ND	ND	ND	ND
2-chloronapthalene	ND	ND	ND	ND	ND	ND	ND
dimethylphthalate	ND	ND	ND	ND	ND	ND	ND
acenaphthalene	ND	ND	ND	ND	ND	ND	ND
2,4-dinitrophenol	ND	ND	ND	ND	ND	ND	ND
4-nitrophenol	ND	ND	ND	ND	ND	ND	ND
2,4-dinotrotoluene	ND	ND	ND	ND	ND	ND	ND
diethylphthalate	ND	ND	ND	ND	ND	ND	ND
4-chlorophenyl-phenylether	ND	ND	ND	ND	ND	ND	ND
4,6-dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND
n-nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND
4-bromophenyl-phenylether	ND	ND	ND	ND	ND	ND	ND
hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND
2,6-dinitrotoluene	ND	ND	ND	ND	ND	ND	ND
pentachlorophenol	ND	ND	ND	ND	*0.83	ND	ND
phenanthrene	ND	*8.4	1.7	ND	0.5	ND	*1.2
fluoranthene	ND	*3	1	ND	*0.2	ND	ND
benzo(b)fluoranthene	ND	ND	ND	ND	*0.056	ND	ND
benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND
benzo(a)pyrene	ND	ND	ND	ND	*0.091	ND	ND
pyrene	ND	ND	ND	ND	*0.18	ND	ND
butylbenzylphthalate	ND	ND	ND	ND	ND	ND	ND
3,3'-dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND
benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND
chrysene	ND	ND	ND	ND	*0.15	ND	ND
anthracene	ND	ND	*0.3	ND	*0.061	ND	ND
bis(2-ethylhexyl)phthalate	ND	*5.9	ND	ND	ND	*0.75	*1.4
di-n-octyl phthalate	ND	ND	ND	ND	ND	ND	ND
di-n-butylphthalate	*11	*2.6	*0.22	ND	ND	*0.88	*1.4
indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	*0.067	ND	ND
dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND
benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND
n-nitrosodimethylamine	ND	ND	ND	ND	ND	ND	ND
benzidene	ND	ND	ND	ND	ND	ND	ND

Table 5E Weston Study (continued)
Soil Borings

SAMPLE DEPTH (ft)	BH-1-4 6-8	BH-2-7 12-14	BH-3-5 8-10	BH-4-3 4-6	BH-5-7 14-16	BH-6-4 10-12	BH-6-5 12-14
PESTICIDES (PP) (ppm)							
Alpha-BHC	110	ND	ND	ND	ND	ND	ND
Beta-BHC	ND	ND	*790	ND	ND	ND	ND
Delta-BHC	260	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	390	130	840	*57	*140	*1200
Endrin	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	*140	2100	*12	22000	*32	*120	*370
Endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	6700	31000	130	76000	390	1900	*5400
Methoxychlor	ND	ND	ND	ND	ND	ND	ND
Endrin aldehyde	ND	ND	ND	ND	ND	ND	ND
alpha-Chlordane	ND	ND	ND	ND	ND	ND	ND
gamma-Chlordane	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND
Arochlor-1016	ND	ND	ND	ND	ND	ND	ND
Arochlor-1221	ND	ND	ND	ND	ND	ND	ND
Arochlor-1232	ND	ND	ND	ND	ND	ND	ND
Arochlor-1242	ND	ND	ND	ND	ND	ND	ND
Arochlor-1248	ND	ND	ND	ND	ND	ND	ND
Arochlor-1254	ND	ND	ND	ND	ND	ND	ND
Arochlor-1260	ND	ND	ND	ND	ND	ND	ND
HERBICIDES (EP TOX) (ppm)							
2,4-D	ND	ND	ND	ND	ND	ND	ND
2,4,5-TP	ND	ND	ND	ND	ND	ND	ND
2,4,5-T	ND	ND	ND	ND	ND	ND	ND
PESTICIDES (EP TOX)** (ppm)							
gamma-BHC	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND
Methoxyclor	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND
4,4-DDT	ND	ND	ND	ND	ND	ND	ND

** 4,4-DDT, since it is not part of the EP Tox target list, required a specific search of the chromatogram. No peak was found at a retention time for 4,4-DDT or any of its isomers.

Table 5E Weston Study (continued)
Soil Borings

	BH-1-4	BH-2-7	BH-3-5	BH-4-3	BH-5-7	BH-6-4	BH-6-5
SAMPLE DEPTH (ft)	6-8	12-14	8-10	4-6	14-16	10-12	12-14
INORGANICS (PP) (ppm)							
silver	ND	ND	ND	ND	ND	ND	ND
antimony	ND	ND	ND	2.0	ND	ND	ND
arsenic	9.2	171.0	313.0	191.0	5.8	58.9	137.0
beryllium	ND	ND	2.3	ND	ND	ND	ND
cadmium	ND	ND	ND	1.1	ND	ND	ND
chromium	10.5	46.6	32.2	31.1	10.6	7.7	17.3
copper	181.0	297.0	23.4	319.0	20.6	126.0	258.0
mercury	ND	ND	ND	ND	ND	ND	ND
nickel	ND	ND	30.0	39.1	10.7	12.2	21.8
lead	50.8	ND	14.2	14.3	18.2	ND	ND
selenium	ND	ND	ND	ND	ND	ND	ND
thallium	ND	ND	ND	ND	ND	ND	ND
zinc	62.1	392.0	102.0	655.0	52.7	169.0	646.0
INORGANICS (EP TOX) (ppm)							
silver	ND	ND	ND	ND	ND	ND	ND
arsenic	ND	ND	ND	ND	ND	ND	ND
barium	ND	ND	ND	ND	ND	ND	ND
cadmium	ND	ND	ND	ND	ND	ND	ND
chromium	ND	ND	ND	ND	ND	ND	ND
mercury	ND	ND	ND	ND	ND	ND	ND
lead	ND	ND	ND	ND	ND	ND	ND
selenium	ND	ND	ND	ND	ND	ND	0.209

were below regulatory levels). Aqueous fractions were collected from two of these boring locations, BH-2 and BH-5, and analyzed for volatile organic compounds. Table 5E presents the results of these analyses. Samples revealed several volatile compounds, semivolatile compounds, and pesticides.

5.3.2 Ground Penetrating Radar Study (GPR)

Weston used the GPR survey to estimate depth to bedrock, and the results are shown in Figure 7. Only two traverses were provided with the Weston report included in the report, but to properly evaluate the results, all the data must be presented.[4]

5.3.3 Electromagnetic Survey (EM-31)

EM-31 with a penetration of approximately 18 feet was run over the dump and the sinkhole.[4] The quadrature phase measures conductance and may be interpreted to depict a plume where ionic species are present. The in-phase measures the response of the instrument to metal and may be used to delineate buried metallic objects.

Within the dump there appears to be a plume of conductive material (Figure 8). The plume is defined within the shaded area. Background conductance at this site appears to be 10 mmhos/m. The area within the dump has conductance from 30 to 110 mmhos/m according to the study. This may indicate that ionic substances may be present. The Weston report interprets "..these increased conductivities most likely reflect the thickening, more saturated and fine-grained unconsolidated materials within (the dump)..".

While materials saturated with water are likely to be more conductive than background, another factor may account for these results. Boring samples collected form the quarry area in October 1988 revealed arsenic up to 313 ppm, chromium up to 46.6 ppm, copper up to 319 ppm, lead up to 50.8 ppm, nickel up to 39.1 ppm and zinc up to 646 ppm. The elevated presence of these metals in the soil could be contributing to the conductivity values in the quarry area.

While the electrical transmission lines seem to have interfered with the GPR over the sinkhole, according to the Weston Report (the traverses were not provided), there was only "minimal affect on the EM-31". Background conductivity values in the sinkhole were 1 to 20 mmhos/m. Elevated values at the boundaries of the study area were attributed to cultural features such as the platform scale and the utility pole. The magnetic anomaly just south of the sinkhole is associated with a steel drainage culvert. Therefore it appears that no plumes or magnetic anomalies are present in the sinkhole based upon the available data.

5.3.4 Monitoring Well Installation and Sampling

In April of 1989, Weston installed seven monitoring wells at the site.[4] Well locations were selected based upon the assumption that the groundwater was flowing to the southeast, and the wells were located near fracture traces identified by Weston from aerial photographs. The locations of these wells are indicated in Figure 4, the well specifications are given in Table 5F, and the well logs are included in Appendix A.

In situ permeability tests were run on three wells: MW-2, 3 and 5. Tests could not be performed on wells 6 and 7 because of slumping in the wells. Also, MW-1 and MW-4 were not tested because they were completed in caverns. The variation in permeability among the three wells was from 2.56 to 1042 feet/year. This variability can be attributed to the fractures and solution cavities that develop as a result of fluid migration, even within a small area.

Table 5F On-Site Monitoring Wells

Well Designation	Well Depth (ft)	Casing			Open Hole Interval Depth (ft)	Depth to Water[1] (ft)
		Material	Depth (ft)	Diameter (in)		
MW-1	17.5 to open cavern, which is 43.5 ft	steel	26	6	26 to 43.5	35 (Weston, 1989)
MW-2	82	steel	42	6	42 to 82	67 (Weston, 1989) 27.1 (MDE, 1993)
MW-3	50	steel	about 35	6	35 to 50	25 (Weston, 1989) 24.9 (MDE, 1993)
MW-4	42	steel	about 22	6	22 to 42	No water (Weston, 1989)
MW-5	59	steel	about 20	6	20 to 59	35 (Weston, 1989) 26.4 (MDE, 1993)
MW-6	65	steel	about 13	6	13 to 65	23 (Weston, 1989)
MW-7	100	steel	about 15	6	15 to 100	28 (Weston, 1989)

Note

1. Depth to groundwater measurements taken by Weston in 1989 study and by Maryland Department of the Environment (MDE) Site Assessment Division for ESI in 1993.

Six of the seven wells were sampled in May 1989 for volatile organic compounds, pesticides, and total metals. MW-4 could not be sampled because of insufficient water. Table 5G presents the results of these analyses.

The pH in the monitoring wells varied from 6.2 to 6.7, which Weston interpreted to indicate that infiltrated rainwater was reaching equilibrium with the CO_3 ion in the carbonate rock.

However, according to a report by Slaughter and Darling, the on-site well (Wa-Bi-19) was measured for pH and the pH was 3.0.[17] Well Wa-Bi-19 is 318 feet deep with casing to 38 feet. The report concluded that there was chemical contamination of groundwater at the site. In addition to the anomalous pH, the total iron was 35 ppm as compared to 0.0 - 1.8, which is normally found in the Conococheague limestone. Sulfate was 2,560 ppm, which compares with a normal value of 8.4 - 60 ppm for that lithology.

Table 5G Weston Study (1989)
Monitoring Wells

Groundwater Sampling Results
May 17-18, 1989

MONITOR WELL	MW-1	MW-2	MW-3	MW-5	MW-5(D)	MW-6	MW-7
VOLATILES (ppm)							
chloromethane	ND	ND	ND	ND	ND	ND	ND
bromomethane	ND	ND	ND	ND	ND	ND	ND
vinyl chloride	ND	ND	ND	ND	ND	ND	ND
chloroethane	ND	ND	ND	ND	ND	ND	ND
acrolein	ND	ND	ND	ND	ND	ND	ND
acrilonitril	ND	ND	ND	ND	ND	ND	ND
dichlorodifluoromethane	ND	ND	ND	ND	ND	ND	ND
trichlorofluoromethane	ND	ND	ND	ND	ND	ND	ND
methylene chloride	ND	ND	ND	ND	ND	ND	ND
acetone	ND	ND	ND	ND	ND	ND	ND
1.1-dichloroethane	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	ND	ND	ND	ND	ND	ND	ND
trans-1,2-dichloroethene	ND	ND	ND	ND	ND	ND	ND
chloroform	ND	ND	ND	ND	ND	ND	0.0086
1,2-dichlorethane	ND	ND	ND	ND	ND	ND	ND
2-butanone (MEK)	ND	ND	ND	ND	ND	ND	ND
1,1,1-trichloroethane	ND	ND	ND	ND	ND	ND	ND
carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND
bromodichloroethane	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-tetrachloroethane	ND	ND	ND	ND	ND	ND	ND
1,2-dichloropropane	ND	ND	ND	ND	ND	ND	ND
trichloroethene	ND	ND	ND	ND	ND	ND	ND
dibromochloroethane	ND	ND	ND	ND	ND	ND	ND
1,1,2-trichloroethane	ND	ND	ND	ND	ND	ND	ND
tetrachloroethene	ND	ND	ND	ND	ND	ND	ND
benzene	ND	0.016	0.0011	0.0084	0.0087	ND	ND
trans-1,3-dichloropropene	ND	ND	ND	ND	ND	ND	ND
2-chloroethylvinyl ether	ND	ND	ND	ND	ND	ND	ND
bromoform	ND	ND	ND	ND	ND	ND	ND
4-methyl-2-pentanone (MIBK)	ND	ND	ND	ND	ND	ND	ND
toluene	ND	0.0013	ND	ND	ND	ND	ND
chlorobenzene	ND	0.15	0.0088	0.074	0.08	ND	ND
total xylene	ND	0.0021	ND	0.001	0.0011	ND	ND
1,3-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
1,2-dichlorobenzene	0.0022	0.0069	0.0019	0.0058	0.0052	ND	ND
1,4-dichlorobenzene	ND	0.022	0.0061	0.012	0.013	ND	ND
ethylbenzene	ND	0.0046	ND	ND	ND	ND	ND

ORIGINAL (Red)

Table 5G Weston Study (continued)
Monitoring Wells

MONITOR WELL	MW-1	MW-2	MW-3	MW-5	MW-5(D)	MW-6	MW-7
INORGANICS (PP) (ppm)							
silver	ND	ND	ND	ND	ND	ND	ND
antimony	ND	ND	ND	ND	ND	ND	ND
arsenic	ND	ND	ND	ND	ND	ND	ND
beryllium	ND	ND	ND	ND	ND	0.0383	ND
cadmium	ND	ND	ND	ND	ND	0.005	ND
chromium	ND	ND	ND	ND	ND	ND	ND
copper	ND	0.0338	ND	0.0255	0.0271	0.0559	ND
mercury	0.00048	ND	ND	ND	ND	ND	ND
nickel	ND	ND	ND	ND	ND	0.379	ND
lead	ND	ND	ND	ND	ND	ND	ND
selenium	ND	ND	ND	ND	ND	ND	ND
thallium	ND	ND	ND	ND	ND	ND	ND
zinc	ND	0.0237	0.0208	0.0543	0.0575	0.512	0.0568
PESTICIDES (PP) (ppm)							
Alpha-BHC	0.00063*	ND	0.0039	0.012	0.023	ND	ND
Beta-BHC	0.0024	*0.0024	0.0078	ND	ND	ND	0.057
Delta-BHC	0.0024	0.0095	0.019	0.014	0.016	ND	ND
gamma-BHC (Lindane)	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND
Dieldrin	0.0056	ND	ND	ND	ND	ND	*0.003
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND
Endrin aldehyde	ND	ND	ND	ND	ND	ND	ND
alpha-Chlordane	ND	ND	ND	ND	ND	ND	ND
gamma-Chlordane	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND
Arochlor-1016	ND	ND	ND	ND	ND	ND	ND
Arochlor-1221	ND	ND	ND	ND	ND	ND	ND
Arochlor-1232	ND	ND	ND	ND	ND	ND	ND
Arochlor-1242	ND	ND	ND	ND	ND	ND	ND
Arochlor-1248	ND	ND	ND	ND	ND	ND	ND
Arochlor-1254	ND	ND	ND	ND	ND	ND	ND
Arochlor-1260	ND	ND	ND	ND	ND	ND	ND

6.0 ESI Contract Laboratory Sampling

The MDE/WAS ERRP Site Assessment Division conducted sampling of the site on May 24 and 25, 1993. Samples were collected in accordance with Standard Operating Procedures (SOP) of the Site Assessment Division, which are described in Appendix B of the MDE/WAS ERRP Quality Assurance Project Plan.[36] Samples were submitted for analysis in accordance with the U.S. EPA Contract Laboratory Program (CLP) Routine Analytic Services (RAS) under case number 20067, and were analyzed for all priority pollutants, which includes analyses for 125 organic compounds (Target Compound List, TCL) and 24 inorganic compounds (Target Analyte List, TAL).[24,25] In addition, a wipe sample was submitted for pesticide/PCB analysis under the CLP Special Analytical Services (SAS) case number 7891-C-01.[26,27]

Samples were organized into five matrices: organic aqueous, organic solid (soil and sediment), inorganic aqueous, inorganic solid, and inorganic dissolved (filtered) metals (for the monitoring wells).[26,27] Dissolved metals matrix samples were collected only for the monitoring well locations, and these samples were filtered on-site using 0.45 µm size cellulose acetate filters in a vacuum assembly. According to CLP protocol, a maximum of twenty samples are permitted per matrix, and additional samples must be separated into additional matrices.

CLP Quality Control (QC) procedures required the submittal of field duplicates, field blanks, and additional volumes for laboratory spiking (no field spikes were included).[26,27] These requirements were applied to each matrix, as defined above. The matrix spike samples were collected at specific additional volumes in order to provide the laboratories with additional sample volumes for CLP matrix spike QC procedures. The following additional volumes, including both the spike volume and the corresponding spike duplicate volume, were collected (volumes expressed as multiples of the regular sample volume of 1):

Sample Matrix	Spike Volume
Organic Aqueous	3
Organic Solid	2
Inorganic Aqueous	2
Filtered Metals	2
Inorganic Solid	1

Both a field blank and a trip blank were submitted with the samples. The blank samples consisted of deionized water provided by the Maryland Department of Health and Mental Hygiene Laboratory. The samples collected on May 24 included the field blank with the shipment to the laboratories, and the samples collected on May 25 included only a trip blank with the samples to the organic laboratory.

The water for the field blank was transported to the field in 5-gallon containers, and it was transferred (in the field the first day of the sampling collection, May 24) to the appropriate sample containers. The field blank was submitted with the samples collected on May 24 and it was analyzed for all TCL and TAL substances. The organic samples collected the following day, May 25, were shipped with a trip-blank sample. The trip blank was included only with the organic shipment and it was analyzed only for volatile organic compounds.

As mentioned above, following each day of sample collection, the samples were packaged and delivered the same day to Federal Express for shipment. The organic matrices were shipped to:

Southwest Research Institute
6220 Culebra Road
San Antonio, TX 78238

The inorganic matrices were shipped to:

IT Analytical Services
5103 Old William Penn Highway
Export, PA 15632

Because previous sampling had demonstrated that soil and groundwater at the site were impacted (Section 5), the objectives of the ESI sampling were to:

1. Confirm on site contamination with CLP data.
2. Confirm impact to groundwater with CLP data.
3. Collect information concerning the migration of hazardous constituents from the site with CLP data.

Samples were collected from the soil, groundwater, and surface water associated with the site. Appropriate background samples of each medium were also collected and analyzed. In addition, wipe sampling of a storm drain which receives runoff from the site was conducted. The following table summarizes the samples collected, and Figures 12 through 15 present the sample locations.

Table 6A Sample Summary

Sample Designation	Sample Type	Sample Location	Rationale	CLP QA/QC
		Soil sampling		
Soil-1	soil	North of site.	Characterize subsurface soil background in area.	matrix spike
Soil-2	soil	On-site dump area.	Characterize subsurface soil in former waste deposition area.	
Soil-3	soil	On-site dump area.	Characterize subsurface soil in former waste deposition area.	
Soil-4	soil	On-site sinkhole area.	Characterize subsurface soil in former waste deposition area.	
Soil-8	soil	"	Duplicate of Soil-4.	duplicate
Soil-5	soil	On-site sinkhole area.	Characterize subsurface soil in former waste deposition area.	
Soil-6	soil	On-site near railroad tracks.	Characterize surface soil in on-site area.	
Soil-7	soil	On-site near railroad tracks.	Characterize surface soil in on-site area.	
		Surface water and Sediment sampling		
SW-1	aqueous	Antietam Creek upstream from site runoff.	Determine background conditions of Antietam Creek.	
SED-1	sediment	"	"	
SW-2	aqueous	Antietam Creek at point of confluence with unnamed stream (Marsh Run 2).	Determine whether release to surface water has occurred.	
SED-2	sediment	"	"	
SW-3	aqueous	Unnamed stream (Marsh Run 2).	Determine whether release to surface water has occurred.	
SED-3	sediment	"	"	
SW-4	aqueous	Point of discharge (box culvert) of Hagerstown stormwater into unnamed stream (Marsh Run 2).	Determine whether release to surface water has occurred.	
SED-4	sediment	"	"	
SW-5	na	na	Not collected because aqueous fraction wasn't available.	
SED-5	sediment	Unnamed tributary of Marsh Run 2 near City Park.	Determine background conditions of Hagerstown runoff.	
SW-6	aqueous	Tributary of Marsh Run 2 near Antietam Creek.	Determine background conditions of Hagerstown runoff.	
SED-6	sediment	"	"	

Sample Designation	Sample Type	Sample Location	Rationale	CLP QA/QC
Groundwater sampling				
RW-1	aqueous	Residential well north of Hagerstown.	Background.	matrix spike
RW-2	aqueous	Residential well southeast of Hagerstown.	Indicate impact of site on Karst aquifer.	
RW-3	aqueous	Residential well southeast of Hagerstown.	Indicate impact of site on Karst aquifer.	
RW-4	aqueous	Residential well southeast of Hagerstown.	Indicate impact of site on Karst aquifer.	
RW-5	aqueous	"	Duplicate of RW-4.	duplicate
MW-2	aqueous	On-site monitoring well.	Determine whether observed release is demonstrated.	matrix spike - dissolved metals only
MW-3	aqueous	On-site monitoring well.	Determine whether observed release is demonstrated.	
MW-D	aqueous	"	Duplicate of MW-3 for filtered metals analytical matrix only.	duplicate
MW-5	aqueous	On-site monitoring well.	Determine whether observed release is demonstrated.	
BLK-1	aqueous	NA	Field Blank.	field blank
TB-1	aqueous	NA	Trip Blank.	trip blank
Special Analytical Services (SAS) sampling				
WIPE-1	wipe	Storm drain adjacent to site on Mitchell Avenue.	Determine whether pesticides/PCBs are migrating to storm drain.	
WIPE-2	wipe	"	Duplicate of WIPE-1.	duplicate
WIPE-3	wipe	NA	Field Blank.	field blank

6.1 Sampling Results

Following analysis by the appropriate laboratories, the raw samples results were submitted to the USEPA Region III ESAT (Environmental Services Assistance Team) contractor for data validation. At this time the data validation procedure has not been completed, and this draft report is based upon the raw data results currently available. Some of the results which follow are subject to change following the completion and finalization of the data validation process.

Several substances were detected in the field and method blanks associated with this case.[37,38] The highest concentrations detected are represented in parentheses (# μg/L) in the discussion which follows. Acetone, di-n-butylphthalate, and several inorganic substances were detected in the blanks associated with this case.

Di-n-butylphthalate was detected in the aqueous method blanks (0.6 J µg/L), aqueous field blank (0.5 J µg/L), and soil method blanks (33 J µg/kg low concentration analyses, 880 J µg/kg medium concentration analyses). (Note that while all soil samples were submitted as low concentration matrices, the laboratories found it necessary to handle some of the samples as medium matrices because of the concentrations of contamination which were detected in the samples.) Acetone was detected in the aqueous trip blank (52 µg/L) and soil method blanks (17 µg/kg low only).

The raw data packages did not include any information regarding inorganic method blanks associated with this case. However, the aqueous field blanks revealed several inorganic substances in both unfiltered and filtered (dissolved metals matrix) samples. The unfiltered blank revealed barium (1.3 µg/L J), cadmium (2.5 µg/L J), calcium (79.3 µg/L J), copper (6.6 µg/L J), iron (9.8 µg/L J), lead (1.2 µg/L J), magnesium (26.6 µg/L J), sodium (24.9 µg/L), and zinc (3.9 µg/L J). The filtered blank revealed barium (0.69 µg/L J), cadmium (2.2 µg/L J), calcium (80.4 µg/L J), copper (8.4 µg/L J), iron (10.5 µg/L J), lead (1.2 µg/L J), magnesium (36.5 µg/L J), sodium (47.4 µg/L), and zinc (16.9 µg/L J).

Acetone and the phthalate esters are considered to be common laboratory contaminants.[40] These contaminants were detected in several samples, but according to CLP guidelines published by the USEPA, these common laboratory contaminants should be detected in a sample at greater than ten times the concentration in the appropriate blank in order to be considered useable data.[40] Similarly, the other substances revealed in the blanks should be detected in the sample at greater than five times the blank concentration in order to be considered useable.[40,41] Sample results which failed to meet this requirement have been designated with a "b" in the discussion which follows. Furthermore, comparisons were made between similar mediums, concentration matrices, laboratory sample delivery groups, and filtered/unfiltered handling practices as much as possible.

6.1.1 Soil Samples

Two areas at the site are suspected to have been used as disposal areas: the former quarry (dump) area and the sinkhole area (Figure 3). Wastes may have been deposited in both liquid and solid forms (Section 2.1). Furthermore, previous sampling of soil borings from these areas (Sections 5.2 and 5.3.1) demonstrated the presence of pesticides, heavy metals, and organic solvents (Tables 5D and 5E). Therefore, ESI sampling was conducted to confirm the presence of this contamination.

A total of eight soil samples were collected, six subsurface and two surficial samples (Figures 12 and 13). ESI sampling confirmed the presence of elevated levels of pesticides, notably DDT, and semivolatile organic compounds in the subsurface soils of both the quarry and sinkhole areas. Additionally, a sample from the sinkhole area revealed lead in excess of 1,000 mg/kg. The surficial samples, which were collected from the railroad track area adjacent to the site, confirmed elevated concentrations of pesticides and semivolatile organic compounds, but failed to confirm the high concentrations of lead which were seen in previous sampling (Section 5). The sample results are summarized in Table 6B (organic) and Table 6C (inorganic), which follow this page.

Subsurface samples were collected from depths of 11 to 22 inches, and they included two samples from the dump (quarry) area (Soil-2,3), two samples from the sinkhole area (Soil-4,5), and one off site background location (Soil-1). A duplicate sample, designated Soil-8, was collected at the location of Soil-4.

These samples were collected using a hand auger, trowels, shovels, and metal spatulas ("scoopulas"). The auger, trowels, and shovels were decontaminated between each sample collection in accordance with the Site Assessment SOP mentioned above. Each scoopula was used only for one sample collection and subsequently discarded.

Sample Soil-1 was collected from subsurface soil (14 - 18 inches) near the Penn Central railroad track (Figure 13). This sample location, which is about 0.2 miles north of the property boundary, is considered to be upgradient from the site and not subject to the influence of runoff which crosses the site. Thus, it was collected to characterize the background conditions of soil in the vicinity of the site. In fact, the sample did demonstrate the presence of some organic compounds, including low levels of pesticides, which may be attributed to the regional application of these substances historically. However, the on site concentrations of many pesticides and organic compounds in soil samples were significantly greater than in Soil-1, thus indicating the on site concentration of the compounds.

The sampling in the sinkhole area revealed that the limestone bedrock is located near the surface (15 to 17.5 inches). Bedrock was encountered at a depth of 15 inches in sample location Soil-4, including duplicate Soil-8 (Photo 3). Evidence of buried waste was encountered in the soil excavated for this sample, including a glass bottle-stopper and rusty bolts. Sample location Soil-5 (Photo 4) revealed the limestone at a depth of 17.5 inches, but no evidence of buried waste was encountered in this sample location.

Table 6B Soil Sampling Results - Organic Constituents

Sample depth (inches) :	background 14 - 18	18 - 22	11 - 15	duplicates 15 - 20		16 - 17.5	0 - 6	0 - 6	
Location :	Near RR track 0.2 mile NW of site	quarry area	quarry area	sinkhole area		sinkhole area	near RR track adjacent to site	near RR track adjacent to track	
	Soil-1	**Soil-2**	**Soil-3**	**Soil-4**	**Soil-8**	**Soil-5**	**Soil-6**	**Soil-7**	
Volatile Organic Compounds (µg/kg)									
acetone	-	-	-	-	b	-	-	-	✓
Semivolatile Organic Compounds (µg/kg)									
acenaphthylene	-	-	26 j	-	-	-	-	-	✓
anthracene	-	-	-	-	-	17 j	-	-	✓
benzo(a)anthracene	-	-	-	940 j	500 j	83 j	1,700 j	1,400 j	870
benzo(a)pyrene	-	-	-	890 j	-	67 j	1,400 j	1,300 j	88
benzo(b)fluoranthene	-	-	-	1,500 j	740 j	200 j	3,100 j	3,100 j	870
benzo(g,h,i)perylene	-	-	-	610 j	-	49 j	990 j	720 j	8800
benzo(k)fluoranthene	-	-	-	1,200 j	660 j	160 j	2,900 j	2,200 j	8800
bis(2-ethylhexyl)phthalate	-	-	64 j	-	-	120 j	-	-	46000
chrysene	-	-	-	1,400 j	1,000 j	130 j	3,000 j	2,600 j	8700
dibenz(a,h)anthracene	-	-	-	-	-	-	440 j	-	88
dibenzofuran	-	-	-	-	-	68 j	560 j	1,400 j	✓
diethylphthalate	-	-	-	-	2,100 j	-	700 j	-	✓
di-n-butylphthalate	b	b	b	b	b	b	b	b	
fluoranthene	-	-	28 j	990 j	800 j	130 j	2,600 j	2,100 j	3100000
indeno(1,2,3-cd)pyrene	-	-	-	740 j	-	68 j	1,200 j	950 j	870
2-methylnaphthalene	-	-	150 j	880 j	1,100 j	150 j	1,800 j	4,600 j	
naphthalene	-	-	59 j	730 j	880 j	120 j	1,300 j	3,200 j	3100000
phenanthrene	-	-	60 j	1,100 j	1,400 j	180 j	2,100 j	3,600 j	
pyrene	-	-	68 j	1,200 j	880 j	120 j	2,600 j	2,000 j	2300000
Number of tentatively identified semivolatile compounds (TICs)	18	10	20	4	6	20	8	18	

Table 6B Continued

Sample depth (inches) :	background 14 - 18	18 - 22	11 - 15	duplicates 15 - 20		16 - 17.5	0 - 6	0 - 6	
Location :	Near RR track 0.2 mile NW of site	quarry area	quarry area	sinkhole area		sinkhole area	near RR track adjacent to site	near RR track adjacent to track	
	Soil-1	Soil-2	Soil-3	Soil-4	Soil-8	Soil-5	Soil-6	Soil-7	
Pesticides/Polychlorinated Biphenyl (PCB) Compounds (µg/kg)									
aldrin	-	2,900 c	21 jp	-	-	-	-	38 jp	38
α-BHC	-	59 jp	0.82 jp	63 j	100 j	1.5 jp	30 jp	960 cp	100
β-BHC	-	3,700 c	18 j	290 jp	280 jp	1.4 jp	-	1,700 cp	350
δ-BHC	-	170 jp	-	-	-	-	-	-	
γ-BHC (lindane)	-	-	-	23 jp	51 j	-	25 j	380 j	490
α-chlordane	-	-	-	120 jp	-	-	-	330 cjp	490
γ-chlordane	0.29 j	1,100 cjp	46 p	430 jc	620 jc	3	56 jp	2,600 c	
4,4′-DDD	-	28,000 cp	230 p	6,800 pc	6,800 pc	10 p	1,700 cp	8,600 cp	2700
4,4′-DDE	7.8	49,000 c	3,200 dc	6,600 c	9,500 c	500 dc	20,000 dc	67,000 dc	1900
4,4′-DDT	6.6	390,000 dc	2,400 dc	120,000 dc	180,000 dc	590 dc	31,000 dc	240,000 dc	1900
dieldrin	-	22,000 c	510 c	530 jc	730 jc	12 p	97 j	2,900 c	40
endosulfan I	-	-	-	-	-	1.7 jp	240 p	-	47000
endosulfan II	-	-	-	-	73 jp	-	-	-	
endrin	-	140 jp	3.4 jp	71 jp	90 jp	-	-	61 jp	2300
endrin ketone	-	240 jp	1.7 j	150 jp	190 jp	1.6 j	29 jp	360 x	
heptachlor	-	-	2.3 jp	180 jp	220 jp	-	-	18 jp	140
heptachlor epoxide	-	58 jp	4.8 j	72 jp	75 jp	0.67 jp	-	130 j	70
methoxychlor	0.2 j	-	-	120 jp	-	5.7 jp	-	-	39000

Legend:

-	=	not detected above quantitation limit
b	=	detected in sample at concentration < 10 x concentration detected in associated blank sample
c	=	pesticide results confirmed by GC/MS
d	=	sample was re-extracted and re-analyzed
j	=	estimated value
p	=	sample analysis experienced some interference, may not provide useful information
x	=	special qualifier used by the laboratory

Table 6C Soil Sampling Results - Inorganic Constituents

	background			duplicates					
Sample depth (inches) :	14 - 18	18 - 22	11 - 15	15 - 20		16 - 17.5	0 - 6	0 - 6	
Location :	Near RR track 0.2 mile NE of site	quarry area	quarry area	sinkhole area		sinkhole area	Near RR track adjacent to site	Near RR track adjacent to track	
(mg/kg)	Soil-1	Soil-2	Soil-3	Soil-4	Soil-8	Soil-5	Soil-6	Soil-7	
aluminum	23,200	7,010	8,480	10,300	10,800	15,500	4,080	5,160	23000
antimony	-	-	3.8 j	10.9 j	9.1 j	-	-	3.6 j	3.1
arsenic	10	6.5	2 j	20.5	26.7	9.2	18.1	24.9	2.3
barium	64.1	108	79	232	250	52	250	88.3	550
beryllium	3.4	0.35 j	0.23 j	0.77 j	0.79 j	1.8	0.47 j	0.7 j	.15
cadmium	-	1.1 j	-	-	1.1 j	-	-	0.94 j	3.9
calcium	2,050	123,000	166,000	31,500	33,500	2,930	4,590	12,500	
chromium	32	15.5	21.7	29.2	33.9	30.8	17.2	21.2	39
cobalt	37.2	7.1 j	9.4 j	14.1	14.9	9.9 j	5.6 j	7.1 j	
copper	23.3	45.5	24.8	882	1,230	20.9	31.4	74.9	290
iron	36,000	15,500	11,200	42,400	42,600	43,900	24,900	21,900	
lead	29.3	101	13.5	1,280	1,120	20.7	41.8	133	300-400
magnesium	4,460	4,510	14,000	4,460	4,370	535 j	583 j	1,290	
manganese	697	261	209	452	494	106	59.1	151	1100
mercury	-	-	-	0.8	0.91	-	-	0.15	2.3
nickel	41.7	9.6 j	18.1	35.3	34.3	24.1	12.1	19.1	160
potassium	1,370	715 j	924 j	1,100 j	1,210	1,280 j	818 j	783 j	
selenium	0.33 j	-	-	1.2	2.1	-	1.2	1.3	39
silver	-	-	-	0.72 j	0.93 j	-	0.52 j	0.52 j	39
sodium	60.1 j	95.8 j	65.4 j	137 j	177 j	64 j	77.8 j	135 j	
thallium	0.36 j	-	-	0.45 j	0.57 j	-	0.34 j	0.54 j	
vanadium	41.8	13.8	24.7	22.8	24.9	25.3	20	18.4	55
zinc	81.6	158	31.3	278	330	22.5	188	179	2300
cyanide	-	0.51 j	-	0.25 j	0.5 j	-	0.2 j	0.67	160

Legend:

- = not detected above quantitation limit
j = estimated value

ORIGINAL (Red)

Samples collected in the quarry area did not encounter the limestone, although outcroppings were visible in the area. Evidence of buried waste was encountered in location Soil-2 (Photo 5), which was collected at a depth of 18 to 22 inches, including glass, plastic containers, and wood fragments. There was no evidence of buried waste encountered in location Soil-3 (Photo 6), which was collected from 11 to 15 inches.

The ESI samples clearly demonstrated the presence of elevated concentrations of semivolatile compounds and pesticides in the subsurface soils in both the quarry area (Soil-2 and 3) and in the sinkhole area (Soil-4/8 and 5). There was good agreement in the results of the duplicate samples collected from the sinkhole area (Soil-4/8). In addition, lead was detected at concentrations exceeding 1,000 µg/kg in the soil collected from the sinkhole area.

Two soil samples (Soil-6 and 7) were collected from shallow soil, 0 to 6 inches deep, in the area of the railroad track adjacent to the site. These samples were collected to determine whether elevated concentrations of pesticides and lead, which were detected in previous sampling, were substantiated with CLP data. These samples confirmed that concentrations of pesticides and semivolatile compounds were elevated, but elevated concentrations of lead were not established with these samples.

6.1.2 Surface Water Samples

The principal surface water target associated with this site is Antietam Creek (Figures 5 and 9). In fact, State records indicate that it was an elevation in DDT levels in the Antietam Creek which brought the site to the attention of the State in 1976 (Sections 2.1 and 5.1). Before reaching Antietam Creek, however, surface water drainage from the site must flow through a section of the Hagerstown stormwater drainage system (Figure 13). Most of the drainage from the site enters a storm drain on Mitchell Avenue.[35] It flows underground from this point for approximately one mile, where it discharges from a box culvert into an open stream (Marsh Run 2) near Walnut Street. Marsh Run

2 flows through City Park to Memorial Boulevard, and it follows Memorial Boulevard to discharge into the Antietam Creek a distance of approximately 1.8 miles downstream from the box culvert.

Several storm drains and tributaries contribute to the flow of Marsh Run 2 as it makes its way through Hagerstown to discharge into Antietam Creek, thus complicating the task of determining whether contaminants found in the Antietam Creek can be attributed to migration from the site.[35] In making this determination, only those substances which demonstrate a significant increase in concentration with respect to the Hagerstown stormwater drainage can be considered. Furthermore, these substances must correspond to materials which can be attributed to the site either because they were previously handled during site operations or have been detected in samples collected from the site. Additionally, efforts must be made to determine whether other sources of these materials are contributing to the same storm drainage flow as the site.

For the purpose of this ESI, surface water and sediment samples were collected from six locations (Figure 13). Both aqueous (SW-#) and sediment phases (SED-#) were collected from each location, with the exception of SW-5, which was not collected because of insufficient water the day of sample collection. ESI sampling revealed the presence of semivolatile organic compounds and pesticides in the sediments of all locations sampled, including the background locations. However, the samples collected from the sediments downstream from the site revealed several pesticides, principally DDD and DDT, at concentrations significantly above the background levels. The summarized results for this sampling begin on the next page with Table 6D (aqueous sampling), followed by Table 6E (sediment organic sampling) and Table 6F (sediment inorganic sampling).

Three samples were collected from areas downstream from the site: two from Marsh Run 2 and one from the Antietam Creek. These samples were collected in order to determine whether contaminants are migrating via runoff from the site. The Marsh Run 2 samples were collected at the point of discharge of the stormwater from the box culvert (SW-4/SED-4, Photo 7) and at a location upstream from a vacant power plant (Maryland Electric, Light, and Power, MELP) (SW-2/SED-2). The sample from Antietam Creek (SW-3/ SED-3, Photos 11 and 12) was collected just downstream from the confluence with Marsh Run 2, which is adjacent to the MELP power plant (Figure 13).

Three background samples were collected: two from Marsh Run 2 and one from the Antietam Creek. The Marsh Run 2 background samples were collected near City Park (SED-5, no water fraction) and near Memorial Highway (SW-6, SED-6, Photos 9 and 10). These samples were collected in order to characterize typical runoff from the Hagerstown stormwater system. The background location on Antietam Creek (SW-1/SED-1) was collected at the point where U.S Highway 40 crosses the Antietam Creek, which is upstream from the point of confluence with Marsh Run 2. This sample was collected to provide the local background in the creek.

Aqueous samples did not indicate significant impact from the site. While ß-BHC was detected in two samples downstream from the site (SW-2 and 3), this substance was similarly detected in the background aqueous sample collected near the Memorial Highway (SW-6). Inorganic constituents were detected in all aqueous samples collected, which is typically encountered since metals are ubiquitous to the environment. As discussed above, in making the determination of whether there is evidence that the substance is migrating from the site, the constituent needs to be detected in concentrations which are significantly above the background concentrations for the same constituent. Only beryllium was detected above background in samples downstream from the site (SW-2 and 3). However, the concentrations of beryllium in the samples (0.32 μg/L), which were below the contract required detection limit, failed to indicate significant impact which can be attributed to the site.

Table 6D Surface Water Sampling Results
Organic and Inorganic Constituents

Location :	background Antietam Creek	Marsh Run 2 Upstream from MELP	Antietam Creek	Marsh Run 2 Culvert Outfall	background Tributary of Marsh Run 2	background Tributary of Marsh Run 2
	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6
Organic Compounds						
Volatile Organic Compounds						
	none detected				no aqueous fraction collected	none detected
Semivolatile Organic Compounds (µg/L)						
bis(2ethylhexyl)phthalate	-	-	-	-	no aqueous fraction collected	1.0 j
di-n-butylphthalate	b	-	-	b		b
Number of semivolatile tentatively identified compounds (TICs)	-	3	2	2		9
Pesticides/Polychlorinated Biphenyl (PCB) Compounds (µg/L)						
α-BHC	-			-	no aqueous fraction collected	0.01 j
ß-BHC	-	0.027 j	0.02 j	-		0.013 j
dieldrin	-	-	-	-		0.012 jp
Inorganic Substances (µg/L)						
aluminum	193 j	80.1 j	30.3 j	64.7 j	no aqueous fraction collected	106 j
antimony	-	-	-	-		-
arsenic	1.5 j	-	-	1.2 j		5.6 j
barium	63.7 j	80.2 j	76.4 j	49.7 j		37.4 j
beryllium	-	0.32 j	0.32 j	-		-
cadmium	-	-	b	-		-
calcium	72,200	119,000	121,000	69,000		50,600
chromium	-	-	-	-		-
cobalt	-	-	-	-		-
copper	b	-	b	-		b
iron	301	116	70.8 j	86.8 j		149
lead	b	b	b	b		b
magnesium	14,800	11,300	10,600	9,230		8,240
manganese	22.6	8.8 j	8.7 j	26.7		21.2
mercury	-	-	-	-		-
nickel	-	-	-	-		-
potassium	3,880 j	3,970 j	3,820 j	3,250 j		14,200
selenium	-	-	-	-		1.2 j
silver	-	-	-	-		-
sodium	6,410	50,800	43,000	22,400		46,100
thallium	-	-	-	-		-
vanadium	-	2.4 j	3.6 j	2.0 j		3.6 j
zinc	b	b	b	b		30
cyanide	1.6 j	3.5 j	3.7 j	1.1 j		5 j

Legend:

-	=	not detected above quantitation limit
b	=	detected in sample at concentration < 10 x concentration detected in associated blank sample
j	=	estimated value

Samples revealed the presence of semivolatile organic compounds in every location sampled. In fact, semivolatile organic compounds were as prevalent in the background locations as in those collected downstream from the site. These samples indicate that the sources of these contaminants are much more widespread and cannot be attributed to the Central Chemical site.

Table 6E Sediment Sampling Results - Organic Constituents

Location :	background Antietam Creek	Marsh Run 2 Upstream from MELP	Antietam Creek	Marsh Run 2 Culvert Outfall	background Tributary of Marsh Run 2	background Tributary of Marsh Run 2
	SED-1	SED-2	SED-3[1]	SED-4	SED-5	SED-6
Volatile Organic Compounds (µg/kg)						
Number of tentatively identified volatile compounds	2	-	1	1	1	-
Semivolatile Organic Compounds (µg/kg)						
acenaphthene	-	41 j	-	89 j	93 j	-
acenaphthylene	50 j	280 j	-	18 j	920	23 j
anthracene	21 j	100 j	-	65 j	380 j	23 j
benzo(a)anthracene	230 j	1,200	1,100 j	610	4,600 d	310 j
benzo(a)pyrene	210 j	1,200	960 j	560	3,600	280 j
benzo(b)fluoranthene	310 j	2,400	1,100 j	1,000	6,100 d	570
benzo(g,h,i)perylene	130 j	480	-	270 j	1,600	200 j
benzo(k)fluoranthene	390 j	1,300	1,300 j	670	3,300	460
bis(2ethylhexyl)phthalate	-	2,000	-	380 j	120 j	870
butylbenzylphthalate	-	1,200	-	-	-	-
carbazole	-	91 j	-	220 j	190 j	48 j
chrysene	270 j	1,000	1,600 j	730	4,200 d	400 j
dibenz(a,h)anthracene	-	250 j	-	-	660	-
dibenzofuran	-	47 j	-	73 j	290 j	-
1,2-dichlorobenzene	-	-	-	-	440 j	-
1,4-dichlorobenzene	-	-	-	-	200 j	-
dimethylphthalate	-	-	-	-	35 j	-
di-n-butylphthalate	b	b	b	b	b	-
fluoranthene	320 j	2,100	2,100 j	2,100	8,700 d	770
fluorene	-	120 j	-	120 j	170 j	-
indeno(1,2,3-cd)pyrene	160 j	670	-	320 j	2,100	260 j
2-methylnaphthalene	27 j	35 j	-	33 j	870	-
naphthalene	28 j	51 j	-	31 j	590	Note 2
phenanthrene	120 j	670	860 j	1,500	2,000	380 j
pyrene	390 j	2,700 d	2,100 j	2,400	8,700 d	1,200
Number of tentatively identified semivolatile compounds	16	19	10	20	20	19

Table 6E Continued

Location :	background Antietam Creek	Marsh Run 2 Upstream from MELP	Antietam Creek	Marsh Run 2 Culvert Outfall	background Tributary of Marsh Run 2	background Tributary of Marsh Run 2
	SED-1	SED-2	SED-3[1]	SED-4	SED-5	SED-6
Pesticides/PCBs (µg/kg)						
α-BHC	-	0.17 jp	0.42 jp	0.24 jp	0.5 jp	-
β-BHC	-	0.54 jp	0.74 jp	-	-	-
δ-BHC	-	-	-	-	-	0.56 jp
γ-BHC (lindane)						
α-chlordane	-	2 p	4.4 p	2.6 p	-	1.1 jp
γ-chlordane	-	3.4	6.6	2.9	0.48 jp	3.2 p
4,4′-DDD	0.43 jp	34 p	74	59	2 jp	0.91 jp
4,4′-DDE	3.1 j	14 p	28	20	7.6	5.3
4,4′-DDT	3.6 jp	91 d	73 d	120 d	25	17
dieldrin	0.95 jp	2.7 jp	7.2 p	3.4 jp	0.25 jp	4.3 p
endosulfan II	0.22 jp	-	-	-	-	-
endrin	-	3.6 jp	9.2 p	5.5 p	50 p	2 jp
endrin ketone	-	-	-	-	-	0.49 jp
heptachlor	-	0.24 jp	0.42 jp	0.27 jp	-	0.48 jp
heptachlor epoxide	-	0.38 jp	0.73 jp	0.37 jp	1.1 jp	-

1. Note: The semivolatile analyses for SED-3 were conducted as medium concentration, whereas all other sediment scans were conducted as low concentration scans.

2. Naphthalene was detected in a re-extracted run at 27 j (µg/kg), but pending validated data, this value is reflected as not detected above sample quantitation limit.

Legend:

-	=	not detected above quantitation limit
b	=	detected in sample at concentration < 10 x concentration detected in associated blank sample
c	=	pesticide results confirmed by GC/MS
d	=	sample was re-extracted and re-analyzed
j	=	estimated value
p	=	sample analysis experienced some interference, may not provide useful information

ESI sampling revealed several pesticides in samples downstream from the site at concentrations significantly above the background concentrations. In fact, sampling revealed a decreasing concentration profile of DDT with respect to distance downstream from the site: SED-4 (120 µg/kg), SED-2 (91 µg/kg), and SED-3 (73 µg/kg). These values are evidence of migration of the pesticide from the site when compared to background values of 3.6 to 25 µg/kg. Furthermore, DDT, DDD, and DDE were detected in the wipe sample of the storm drain on Mitchell Avenue next to the site (see Section 6.1.4). Thus, ESI sampling indicates that the pesticides DDD, DDE, and DDT are migrating from the site to the Antietam Creek in concentrations significantly above the local background levels.

Inorganic sampling, which revealed substances in every sample, did not indicate any significant increase which could be attributed to the site. Note that previous sampling has indicated that lead may be migrating from the site, but the samples collected during the ESI failed to support this point.

Table 6F Sediment Sampling Results - Inorganic Constituents

(mg/kg)	background Antietam Creek	Marsh Run 2 Upstream from MELP	Antietam Creek	Marsh Run 2 Culvert Outfall	background Tributary of Marsh Run 2	background Tributary of Marsh Run 2
	SED-1	SED-2	SED-3	SED-4	SED-5	SED-6
aluminum	2,280	14,300	2,570	3,740	6,360	1,090
antimony	-	-	3.7 j	-	6.1 j	-
arsenic	4.4	3.5	4.7	3.8	11.5	2.1
barium	52.9 j	96.2	58.3	37.4 j	113	14.4 j
beryllium	0.21 j	0.85 j	0.29 j	0.78 j	0.63 j	0.1 j
cadmium	-	-	-	-	0.72 j	-
calcium	295,000	23,300	140,000	70,500	14,200	129,000
chromium	6.9	18.6	27.5	20	87.2	23.1
cobalt	2.7 j	10.2 j	5.6 j	16.5	12.8 j	2.2 j
copper	7.7	29.5	28.5	10	222	6.3
iron	12,500	16,000	16,000	18,500	34,100	10,300
lead	58.6	39.8	152	40.9	383	40
magnesium	17,000	4,820	8,190	11,500	3,730	34,200
manganese	131	580	328	1,200	1,090	286
mercury	-	0.71	-	-	0.15	-
nickel	6.3 j	16.2	11.2	11.1	21.1	6.5 j
potassium	306 j	1,100	241 j	269 j	562 j	180 j
selenium	-	-	-	-	1.3 j	-
silver	1.1 j	-	-	-	0.73 j	-
sodium	118 j	77.9	154 j	95.5 j	154 j	155 j
thallium	-	-	-	-	0.34 j	-
vanadium	7 j	26.1	12.8 j	23.1	19.9	10.4 j
zinc	61	68.8	155	58.2	398	85.2
cyanide	-	-	-	-	0.32 j	-

Legend:

-	=	not detected above quantitation limit
b	=	detected in sample at concentration < 5 x concentration detected in associated blank sample
d	=	sample was re-extracted and re-analyzed
j	=	estimated value
x	=	special qualifier used by the laboratory

6.1.3 Groundwater Samples

Groundwater samples were collected from three on site monitoring wells and four off site residential wells (Figures 14 and 15). In addition, four residential wells were sampled, including one sampled as a background location. Sampling confirmed the presence of organic constituents in on site groundwater, but the sampling did not indicate any impact to the residential wells sampled (Tables 6G, 6H, 6I, and 6J).

The three monitoring wells sampled, MW-2, MW-3, and MW-5 (Figure 14), are located in positions which appear to be downgradient from the two suspected disposal areas (Figure 4). These wells were installed in 1989 by Roy F. Weston, Inc., and the specifications are provided in Table 5F of Section 5.3.4. Previous sampling indicated that groundwater has been impacted by contaminants associated with the suspected former disposal areas (Section 5.3.4). Samples were collected for the ESI to confirm this release to groundwater with CLP data.

Volatile organic compounds, semivolatile organic compounds, and pesticide/PCB compounds were detected in the monitoring well samples collected from the site (Table 6G). In addition to several pesticide compounds, chlorobenzene and dichlorobenzene, which were commonly used as solvents for pesticide operations, were detected in all three monitoring wells. Several other compounds, including trichlorobenzene and chlorinated phenols, were also detected in the on site wells.

Water was purged from the wells prior to sample collection. Three times the well-water volume was considered to be adequate for purging. A duplicate of MW-3, designated MW-DUP, was collected and analyzed for the filtered (dissolved) metals matrix only.

The installation of an additional background monitoring well north of the property boundary was considered for this investigation, but this proposal was not approved for this ESI. Instead, it was determined that background conditions in this karst aquifer would be characterized based upon sampling of one residential well sample (RW-1) north of the site (Figure 15).

Table 6G Monitoring Well Sampling - Organic Constituents

	quarry area **MW-2**	quarry area **MW-3**	sinkhole area **MW-5**
Volatile Organic Compounds (µg/L)			
benzene	34	-	6 j
chlorobenzene	200	16	45
ethylbenzene	7 j	-	-
xylenes	5 j	-	-
Semivolatile Organic Compounds (µg/L)			
acenaphthene	2 j	-	-
bis(2ethylhexyl)phthalate	5 j	4 j	0.7 j
carbazole	1 j	-	0.9 j
dibenzofuran	0.9 j	-	-
1,2-dichlorobenzene	16	4 j	3 j
1,4-dichlorobenzene	25	8 j	5 j
2,4-dichlorophenol	6 j	-	2 j
di-n-butylphthalate	b	b	b
fluorene	1 j	0.6 j	-
pentachlorophenol	2,300 d	-	370 d
phenanthrene	0.6 j	-	-
phenol	-	3 j	-
1,2,4-trichlorobenzene	2 j	1 j	-
2,4,5-trichlorophenol	8 j	-	2 j
2,4,6-trichlorophenol	12	-	3 j
Number of tentatively identified semivolatile compounds (TICs)	14	13	3
Pesticide/PCB Compounds (µg/L)			
aldrin	0.23 jp	-	0.05 p
α-BHC	1.6	8.2 dc	5.8 dc
β-BHC	4.8	11 dc	5.8 dc
δ-BHC	13 dpc	20 dc	4.9 dc
γ-BHC (lindane)	0.5 p	0.84	2.3 dpc
α-chlordane	0.47 j	-	0.03 jp
γ-chlordane	0.23 jp	0.039 jp	0.064 p
4,4'-DDD	0.14 j	0.078 j	0.02 jp
4,4'-DDE	0.053 jp	-	0.06 jp
4,4'-DDT	-	-	0.12 p
dieldrin	-	0.29 jp	0.2
endosulfan I	0.28 jp	-	0.021 jp
endosulfan II	-	-	0.042 jp
endrin	0.073 jp	0.076 jp	0.057 jp
endrin aldehyde	-	0.07 jp	0.023 jp
endrin ketone	-	-	0.058 jp
heptachlor	0.13 jp	-	0.046 jp
heptachlor epoxide	-	-	0.035 jp
methoxychlor	-	-	0.028 jp

3.9

Legend:

----	=	not detected above quantitation limit
b	=	detected in sample at concentration < 10 x concentration detected in associated blank sample
c	=	pesticide results confirmed by GC/MS
d	=	sample was re-extracted and re-analyzed
j	=	estimated value
p	=	sample analysis experienced some interference, may not provide useful information

(Note that three monitoring wells were installed by R.E. Wright Associates, Inc. on May 24-25, 1990.[29] These wells were installed on the property adjacent to the northern boundary of the site, the Brighton Manor residential development. The wells were located adjacent to areas of known contamination. The well installed farthest from the site boundary (W-3) showed no contamination when sampling was conducted. W-3 would be the best choice for a background well because the groundwater is believed to be flowing south and southeast. However, W-3 may have been destroyed during a development phase of Brighton Manor. W-1 and W-2 showed trace contamination that is believed to be attributable to Central Chemical. As such, these two monitoring wells are not considered to be adequate for background purposes.)

Monitoring wells were also sampled for inorganic constituents (Table 6H) and dissolved metals (Table 6I). These results revealed several substances at concentrations exceeding the background (RW-1, table 6J), including aluminum, arsenic, beryllium, cobalt, iron, manganese, nickel, zinc, and cyanide. Note that lead, which was detected in the soil of the sinkhole area at greater than 1,000 µg/kg (Soil-4/8, Section 6.1.1), was not revealed in significant concentration in the monitoring well sample associated with that area (MW-5).

Table 6H Monitoring Well Sampling - Inorganic Constituents

	quarry area	quarry area	sinkhole area
(µg/L)	**MW-2**	**MW-3**	**MW-5**
aluminum	230	401	2,170
antimony	-	-	-
arsenic	-	1.8 j	2.2 j
barium	17.8 j	25.5 j	20.9 j
beryllium	0.87 j	-	2 j
cadmium	-	-	-
calcium	569,000	178,000	374,000
chromium	-	-	-
cobalt	-	6.9 j	4.4 j
copper	-	b	-
iron	20,000	62,600	5,420
lead	-	b	b
magnesium	59,500	13,700	39,400
manganese	9,150	1,780	1,010
mercury	-	-	-
nickel	-	11.9 j	16.5 j
potassium	13,700	19,400	24,200
selenium	-	-	-
silver	-	-	-
sodium	73,700	32,600	24,100
thallium	-	-	-
vanadium	3 j	-	4.4 j
zinc	5.6 j	20.1	20.6
cyanide	-	-	3.3 j

Legend:

-	=	not detected above quantitation limit
b	=	detected in sample at concentration < 5 x concentration detected in associated blank sample
j	=	estimated value

Table 6I Monitoring Well Sampling - Dissolved Metals

	quarry area	quarry area		sinkhole area
(µg/L)	MW-2	MW-3	MW-D	MW-5
aluminum	83.1 j	-	-	1,800
antimony	-	-	-	-
arsenic	-	2.4 j	2.3 j	2.1 j
barium	17.1 j	20.1 j	20.9 j	17.2 j
beryllium	0.66 j	-	-	1.9 j
cadmium	-	-	-	-
calcium	555,000	173,000	191,000	371,000
chromium	-	-	-	-
cobalt	-	2.8 j	-	4.8 j
copper	-	-	-	-
iron	12,300	9,460	10,900	b
lead	-	-	-	-
magnesium	58,400	13,200	14,600	39,100
manganese	8,830	1,480	1,660	1,000
mercury	-	-	-	-
nickel	5.8 j	-	-	13.5 j
potassium	13,700	22,200	19,300	24,100
selenium	-	-	-	-
silver	-	-	-	-
sodium	72,300	35,700	32,400	23,900
thallium	-	-	-	-
vanadium	3.2 j	2.4 j	-	4.7 j
zinc	b	b	b	b
cyanide	-	-	-	-

Legend:

- = not detected above quantitation limit
b = detected in sample at concentration < 5 x concentration detected in associated blank sample
j = estimated value

Four residential wells were sampled, including the background sample (RW-1) (Figure 15). The other three residential wells (RW-2,3,4) are located southeast of the site, and they were sampled in order to determine whether groundwater from the site may be impacting residential wells. A duplicate of RW-4, designated RW-5, was collected for this ESI. During the presampling field activity well surveys were conducted to determine the current locations of potable water wells, and the nearest wells associated with downgradient conditions were determined to be located in the area sampled, which is southeast of Hagerstown. The majority of Hagerstown is served with municipal water drawn from an intake on the Potomac River (Section 3.1). In addition, many residents in the Hagerstown area rely upon cisterns and delivered water.

Table 6J Residential Well Sampling
Organic and Inorganic Constituents

Location :	background NE of site	SE of site	SE of site	duplicate SE of site	
	RW-1	RW-2	RW-3	RW-4	RW-5
Organic Compounds					
Volatile Organic Compounds (µg/L)					
	none detected				
Semivolatile Organic Compounds (µg/L)					
di-n-butylphthalate	-	-	-	b	b
di-n-octylphthalate	-	1 j	-	-	0.9 j
Number of tentatively identified semivolatile compounds (TICs)	1	1	9	1	1
Pesticide/PCB Compounds (µg/L)					
endrin aldehyde	-	-	-	-	0.013 jp
Inorganic Substances (µg/L)					
aluminum	-	12.9 j	33.3 j	-	-
antimony	12.8 j	-	-	-	-
arsenic		-	-	-	-
barium	88.8 j	33.5 j	71 j	83.8 j	84.3 j
beryllium	-	-	-	-	-
cadmium	b	-	-	b	-
calcium	130,000	82,300	124,000	146,000	146,000
chromium	-	-	-	-	-
cobalt	-	-	-	-	-
copper	b	136	b	189	b
iron	b	b	65.2 j	b	b
lead	b	16.3	-	9	b
magnesium	17,900	25,400	11,000	17,500	17,500
manganese	-	-	2.2 j	-	-
mercury	-	-	-	-	-
nickel	-	-	-	-	-
potassium	2,040 j	2,180 j	2,330 j	4,730 j	4,640 j
selenium	-	-	-	-	-
silver	-	-	-	-	-
sodium	43,200	23,500	11,500	64,400	64,900
thallium	-	-	-	-	-
vanadium	-	2.4 j	2.6 j	-	-
zinc	b	b	b	57.5	b
cyanide	-	-	-	-	-

Legend:

-	=	not detected above quantitation limit
b	=	detected in sample at concentrations: < 10 x concentration detected in associated blank samples for di-n-butylphthalate < 5 x concentration detected in associated blank samples for inorganic parameters
c	=	pesticide results confirmed by GC/MS
d	=	sample was re-extracted and re-analyzed
j	=	estimated value
p	=	sample analysis experienced some interference, may not provide useful information

6.1.4 Wipe Sampling

In order to determine whether there is evidence that pesticides have migrated from the site into the Hagerstown stormwater drainage system (Section 3.1), wipe sampling was conducted of the storm drain located on Mitchell Avenue (Figures 9 and 13). This sampling was conducted on May 25, 1993 in accordance with the CLP Special Analytical Services (SAS) under Case number 7891-C-01. The wipe samples were analyzed for pesticides and PCBs, no other analyses were performed. DDT, DDD, and DDE were detected by this sampling, as summarized in Table 6K below.

Table 6K Wipe Sampling - Pesticide/PCB Constituents

	Duplicate	
(µg/sample)	WIPE-1	WIPE-2
4,4'-DDD	9.7 djp	5.7 djp
4,4'-DDE	26 dj	13 dj
4,4'-DDT	320 dp	230 d

d = sample was re-extracted and re-analyzed
j = estimated value
p = sample analysis experienced some interference, may not provide useful information

The storm drain, which measures about 1.5 feet by 4.0 feet, is located on the west shoulder of Mitchell Avenue just north of the Penn Central railroad track bridge (Figure 9, Photo 14). Because of the slope of the site and the design of the roadways, much of the runoff from the site is directed to this drain via Mitchell Avenue.

One wipe sample (WIPE-1) was collected, along with a duplicate (WIPE-2) and a field blank (WIPE-3). Wipe sampling was conducted in accordance with the limited guidance provided in "A Compendium of Superfund Field Operations Methods".[28] In addition, the U.S. EPA Central Regional Laboratory was able to provide further guidance.[42] Each sample consisted of three 4 in. x 4 in. Johnson and Johnson sterile gauze pads. Each pad was pretreated with 15 mL of pesticide grade hexane solvent. The pads were then used to collect the samples. (Note: the blank sample, WIPE-3, was not applied to the sample area.)

The sample area was a 3 ft. x 3 ft. grid superimposed over the storm drain, and this grid was further subdivided into three 1 ft. x 3 ft. subgrids. The method used in collecting the samples was to firmly rub one pad against the grating and asphalt encompassed by each subgrid, thus three pads were used for each sample area of 3 ft. x 3 ft. Both the original sample (WIPE-1) and the duplicate sample (WIPE-2) were collected this way.

Each set of sample pads were then placed in certified precleaned 16 oz glass jars and packed for shipment. Six unopened pads, which were not pretreated with hexane, were also provided to the laboratory for the purpose of performing method blanks and other quality control measures that the laboratory deemed necessary. The laboratory selected by the EPA CLP for this case was:

Western Research Institute
365 North 9th Street
Laramie, WY 82071-3395

The analytical data validation process has not been completed for this case, but non-validated data have been provided for use in writing this draft ESI Report. The laboratory did not detect any compounds above the method detection limits in the field blank or the method blanks (recall that the scan was restricted to pesticides and PCBs). The laboratory reported that redilution of the samples were required to bring the analytical methods within required operating parameters.

7.0 Toxicological Evaluation

7.1 Summary

The Central Chemical site is a former pesticide and fertilizer blending facility located in Hagerstown, Washington County, Maryland. The Central Chemical plant operated in this capacity from the early 1930's until the late 1960's, when the pesticide blending operations ceased. Fertilizer manufacturing continued until Central Chemical totally shut down its operations in 1984. Subsequently, Central Chemical has leased it property to tenants who use the site for a variety of activities not related to the formulation of pesticides and fertilizers. Currently, access to the site is restricted by a fence that surrounds most of the property.

During its years of operation, Central Chemical processed very large quantities of pesticides including DDT, chlordane, Guthion, Sevin, Daconil and Omite. In addition, the company is suspected of disposing large amounts of pesticides and other toxic materials into a quarry area and a former sinkhole area located on company premises. The former sinkhole was thought to communicate directly with underlying groundwater. A series of discoveries by State and County agencies of improper disposal and storage practices and environmental contamination -- including the migration of DDT from the site into Antietam Creek -- led to regulatory actions requiring Central Chemical to take corrective actions.

Since 1976, periodic sampling of various environmental media on Central Chemical property and in the surrounding area has been conducted. Earlier sampling revealed contamination of soil and groundwater on-site, and of sediments off-site. These findings led to a more comprehensive round of sampling by MDE on May 24 and 25, 1993 as part of the Extended Site Investigation (ESI). In the discussion below, all estimates of daily doses and associated health risks were computed using ESI sampling data.

Evaluation of potential health risks associated with the site was conducted in two stages. First, the observed contaminant levels in the various media were compared to the appropriate worst-case, risk-based screening levels developed by the USEPA.[73] Contaminants which exceeded the screening levels were further evaluated for cancer and non-cancer health outcomes using more refined, yet conservative, exposure scenarios.

The following media contained contaminants which exceeded USEPA screening levels in the first evaluation stage: On-site surface soil (polycyclic aromatic hydrocarbons (PAHs), pesticides including DDT, and metals); off-site surface water (metals at levels toxic to aquatic life) and sediments (PAHs and metals); off-site groundwater (lead); and on-site groundwater (a variety of organic and inorganic compounds).

In the second evaluation phase, which used more refined exposure scenarios, none of the compounds in surface soil or sediments selected during the first phase were found to pose a threat to human health when considered **individually.** However, taken **collectively**, pesticides as a group posed an excess lifetime cancer risk of 1.07 E^{-4} under the trespasser scenario which assumes incidental ingestion of on-site surface soil during childhood. **This cancer risk is slightly higher than the level deemed acceptable by USEPA.** Carcinogenic PAHs and inorganic elements detected in on-site surface soils contributed an additional lifetime cancer risk of 1.25 E^{-5} and 3.05 E^{-5}, respectively. Thus, the total excess cancer risk from all carcinogens in soil was estimated to be 1.50 E^{-4} under the trespasser exposure scenario.

None of the chlorinated hydrocarbon pesticides detected in Antietam Creek sediments surpassed EPA benchmarks. These compounds nonetheless present an opportunity for human exposure through bioaccumulation in fish. DDT and chlordane, in particular, exhibit a great capacity to bioaccumulate in aquatic organisms. Recreational fishing was observed in Antietam Creek during the ESI. However, no fish samples were taken to confirm this potential exposure pathway.

Lead was detected at a level slightly above USEPA's action level to protect human health in one residential well downgradient from the site. However, the source of this lead can not be definitively linked to the site. No other contaminants in off-site residential wells were found at sufficient levels to pose a risk to human health.

Although the first evaluation stage identified a number of pesticides, volatile and semivolative organics, and metals in on-site groundwater which exceeded EPA benchmarks, this pathway was not evaluated further during the second phase for the following reasons. Currently, there are no receptors for this pathway. The on-site monitoring wells are not used for drinking water. Residents within two miles of the site are connected to a public water supply whose source is not impacted by the site. The closest residential well is located 2.2 miles from the site, and downgradient residential wells tested during the ESI did not appear to be affected by the site.

7.2 Supporting Data

Observed, potentially site-related contamination levels are compared to the USEPA Region III worst-case, risk-based screening levels[73] in Sections 7.2.1 - 7.2.3. Compounds which exceed these thresholds are further evaluated for adverse health effects in Sections 7.3. and 7.4, using more refined exposure scenarios appropriate to the site (see Section 7.2.4).

7.2.1 Soil Samples

Six on-site (Soil-2 - Soil-6) and one background (Soil-1) soil samples were taken as part of the ESI. These samples were analyzed for volatile and semi-volatile organic compounds, pesticides and metals. A comparison of on-site samples to the background sample revealed that extensive contamination from polycyclic aromatic hydrocarbons (PAHs) and pesticides -- attributable to the site -- has occurred. However, samples from the contaminated quarry (Soil-2 and Soil-3) and sink-hole (Soil-4, Soil-5 and Soil-8) areas were taken from subsurface soils, and thus are unsuitable for characterizing risk to on-site workers, who would be expected to have contact with surface soil from these areas.

The only surface soils sampled during the ESI were from an unvegetated area near the railroad tracks that was on company property but outside the fence that surrounds most of the facility (Soil-6 and Soil-7). Because these surface soils are accessible to trespassers, the contamination levels found in samples Soil-6 and Soil-7 were compared to USEPA Region III risk-based screening levels for residential soils.[73] The various PAHs compounds assayed were first converted into their benzo(a)pyrene (B(a)P) equivalent concentrations using the method of Clement, and then compared to the B(a)P benchmark.

Table 7A presents the maximum concentrations of contaminants in surface soils which exceeded the USEPA screening levels. PAHs, pesticides (including DDT), arsenic, and beryllium were found on the site at levels above their corresponding cancer risk-based benchmarks, while manganese exceeded its non-cancer benchmark. The background soil concentrations for these contaminants are shown for comparison, although they are not strictly comparable because Soil-1 is from subsurface soil. All of the on-site contaminants exceeded background levels except beryllium. Thus, the pattern of on-site surface soil contamination appears to be the result of Central Chemical operations.

Table 7A Maximum On-site and Background Levels of Contaminants in Soil

CONTAMINANTS*	HIGHEST BACKGROUND CONC. µg/kg	HIGHEST ON-SITE SURFACE SOIL CONC. µg/kg	FOR POLYCYCLIC AROMATIC HYDROCARBONS ONLY:	
			Relative Potency Estimates	Equivalent B[a]P Site Conc. µg/kg
ORGANICS				
Polycyclic Aromatic Hydrocarbons				
Benzo(a)Anthracene	ND	1,700	0.145	246.5
Benzo(a)Pyrene	ND	1,400	1.0	1,400
Benzo(b)Fluoranthene	ND	3,100	0.140	434
Dibenz(a,h)Anthracene	ND	440	1.11	488.4
Total PAH	ND	na	na	2,568.9
Pesticides			Not Applicable	
α-BHC	ND	960		
ß-BHC	ND	1,700		
Chlordane	0.29	2,600		
4,4′-DDD	ND	8,600		
4,4′-DDE	7.8	67,000		
4,4′-DDT	6.6	240,000		
Dieldrin	ND	2,900		
INORGANICS				
Arsenic	10,000	24,900		
Beryllium	3,400	700		
Manganese	697,000	151,000		

Source: ESI samples taken May 24 and May 25, 1993.

Abbreviations: ND = not detected
na = not applicable

*: All compounds in Table 7A except manganese exceed cancer-risk based screening levels for residential soils. Manganese exceeds its non-cancer risk based screening level.

7.2.2 Surface Water, Sediment and Wipe Samples

Surface water, sediment and wipe samples were taken to characterize the potential migration of contaminants from the site into Antietam Creek via its tributaries and the site's storm drainage system.

Three locations were sampled to describe background conditions in surface water and sediments (SW-1 and Sed-1, Sed-5, and SW-6 and Sed-6). Another three locations downstream from the site were sampled to determine whether contaminants had been released from the site to surface water (SW-2 and Sed-2, SW-3 and Sed-3, and SW-4 and Sed-4). The surface water and sediment samples were analyzed for organic and inorganic compounds. In addition, two wipe samples from a storm drain which receives site runoff were analyzed for pesticides and PCBs.

Antietam Creek and its tributaries are not a source of drinking water. Thus, it is inappropriate to compare surface water contaminants to drinking water benchmarks. Downstream surface water contaminant levels (SW-2, SW-3 and SW-4) were therefore compared to Ambient Water Quality Criteria (AWQC) standards for the protection of freshwater aquatic life.[74] It is important to note that there are no AWQC standards for many of the chemicals analyzed. No organics, including pesticides, were found at levels above the AWQC standards. Only inorganic arsenic (1.2 µg/L) and iron (116 µ/L) exceeded AWQC thresholds among all measured downstream contaminants for which AWQC standards exist. However, these levels cannot be definitively linked to the site since a background sample (SW-6) contained higher amounts of both iron and arsenic than the downstream samples.

Human exposure to contaminated streams could potentially occur through the ingestion of sediments and dermal contact with water during recreational activities that include wading, swimming and fishing.

The maximum levels of contaminants observed in sediment samples taken downstream from the site were compared to USEPA Region III screening levels for residential soils[73], since no benchmarks for sediments have been developed. Similarly, no benchmarks have been developed for human dermal exposure to surface water. Thus, dermal exposures will be evaluated qualitatively in Sections 7.3 and 7.4.

Table 7B shows that only three PAH's and three metals were detected at concentrations in downstream sediments which exceeded the risk-based screening levels. However, Table 7B also shows that none of these downstream levels can be definitively attributed to the Central Chemical site since the maximum background sediment levels were comparable to or substantially higher than those found in downstream sediments. Thus, the observed excess levels of PAH and metals in downstream sediments is likely to reflect a regional pollution problem, whose sources have not yet been completely identified.

Table 7B Maximum Downstream and Background Levels of Contaminants in Sediments

CONTAMINANTS*	**HIGHEST BACKGROUND CONC. µg/kg**	**HIGHEST DOWN-STREAM CONC. µg/kg**	**FOR POLYCYCLIC AROMATIC HYDROCARBONS ONLY:**	
			Relative Potency Estimates	Equivalent B[a]P Max. Downstream Conc. µg/kg
ORGANICS				
Polycyclic Aromatic Hydrocarbons				
Benzo(a)pyrene	3,600	1,200	1.0	1,200
Benzo(b)Fluoranthene	6,100	2,400	0.140	336
Dibenz(a,h)Anthracene	660	250	1.11	277.5
Total PAH	NA	NA	NA	1,813.5
INORGANICS			**Not Applicable**	
Arsenic	4,400	4,700		
Beryllium	630	850		
Manganese	34,200,000	328,000		

Source: ESI samples taken May 24 and May 25, 1993.

*: All compounds in Table 7B except manganese exceed cancer-risk based screening levels for residential soils. Manganese exceeds its non-cancer risk based screening level.

Several chlorinated hydrocarbon pesticides -- including DDT, chlordane, dieldrin, and BHC -- and their isomers were detected in sediments above background levels. The distribution of DDT, DDD and DDE in sediments and in the wipe sample clearly implicate Central Chemical as the source of this contamination (see Section 6.1.2)

While none of these chlorinated hydrocarbon pesticides exceeded the risk-based screening levels for the sediment ingestion scenario, their presence provides an opportunity for human exposure through consumption of contaminated fish. DDT and chlordane, in particular, have a great capacity to bioaccumulate, having been assigned the maximum bioaccumulation factor value of 50,000 for freshwater.[74] Although this exposure pathway cannot be confirmed because no fish samples were taken during the ESI, it is a possibility since fishing has been observed in Antietam Creek (see Photo 12).

7.2.3 Groundwater

Four residential wells were sampled to characterize the impact of the site on off-site groundwater used as a drinking source. Three of the tested residential wells (corresponding to samples RW-2 - RW-5) were located southeast of Hagerstown, which is thought to be downgradient from the site. One well, located north of Hagerstown, was sampled for background levels (RW-1). The samples were analyzed for volatile and semi-volatile organics, pesticides and inorganics.

The measured contaminant levels were compared to USEPA Region III risk-based screening levels for adult residential drinking water.[73] None of the compounds detected in the downgradient or background residential wells exceeded USEPA benchmarks. However, USEPA has not developed a benchmark (i.e., reference dose or RfD) for inorganic lead. Instead, USEPA has established an action level for lead of 15 μg/L in drinking water, above which humans should not be exposed. Lead (16.3 μg/L) was detected in one downgradient well (RW-2) at slightly above this action level.

Four samples were collected from three on-site monitoring wells (MW-2, MW-3, MW-D, and MW-5) to examine whether contaminants from the site had leached into underlying groundwater. No background monitoring well was established for comparison.

The groundwater under the site was found to be heavily contaminated. Four volatile or semivolatile organic compounds, 10 pesticides, and two metals were found at levels which exceeded the USEPA Region III screening levels for cancer for residential drinking water. Two other compounds (one volatile organic and one metal) exceeded benchmarks for non-cancer health effects. Most of the contaminants are chemicals that were used or disposed of on-site by the Central Chemical Company. Thus, these contaminants appear to be site-related, even though this cannot be conclusively demonstrated because of the lack of a background monitoring well.

Despite its contamination, on-site groundwater does not appear to provide a human exposure pathway for drinking water. None of the monitoring wells are potable. Virtually all of the residents within two miles of the site receive municipal water whose source is surface water not influenced by the site. Furthermore, the nearest residential well that could be located during the ESI is 2.2 miles from the site. None of the tested downgradient residential wells were found to be contaminated with compounds detected in on-site groundwater. Thus, on-site groundwater will not be considered in the remainder of the Toxicological Evaluation.

7.2.4 Exposed Populations

Trespassers can potentially be exposed to contaminants in the surface soils on the unfenced portions of Central Chemical property. There was evidence of trespassing (worn foot paths) near the ESI surface soil sampling locations, railroad tracks with unrestricted access on the eastern border of the site. The railroad tracks are near a shopping center and are known to be frequented by children living around the site. Several residential developments, including Brighton Manor, are in the immediate vicinity of the site.

The following conservative trespasser exposure scenario was used to quantify risk in the discussion below:

A 30 kg. child ingests 200 mg/day of contaminated soil, 5 days a week, 9 months a year (assuming no exposure during December through February when the ground may be frozen), for 13 years (from the ages of 6 to 18).

Inhalation of fugitive dust will be discussed in qualitative terms.

Children can also be exposed to contaminated sediments and surface water while recreating in Marsh Run 2 and Antietam Creek. Dermal exposure will be treated qualitatively. The following conservative exposure scenario was employed for the ingestion of sediments:

A 30 kg. child ingests 200 mg/day of contaminated soil, while playing in a stream 2 days a week, 7 months a year (in the warmer months, April through October) for 13 years (from the ages of 6 to 18).

7.3 Organic Contaminants

7.3.1 Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are a large family of chemicals which are formed during the incomplete combustion of organic materials such as coal, oil, garbage, or other organic substances. PAHs are mostly found in mixtures of two or more compounds. They do not burn easily and endure in the environment from months to years. PAHs can enter the body quickly and easily by all routes of exposure. PAHs bioaccumulate rapidly, but are also quickly metabolized and eliminated from most organisms.[75]

PAH compounds listed in Table 7C below were detected in on-site surface soil and sediments downstream from the Central

Chemical site at levels above USEPA benchmarks. Exposure routes of concern for these media include dermal contact and incidental ingestion. Limited inhalation of fugitive dust from surface soil is also possible. Only the incidental ingestion pathway is evaluated quantitatively below.

All of the PAH compounds in Table 7C have been classed by USEPA as B2 or known human carcinogens by the oral route.[76] B2 carcinogens have sufficient animal evidence of carcinogenicity with weaker or inadequate human data.

Table 7C presents the estimated maximum daily doses of PAHs (in B(a)P equivalent dose units) from ingestion of soil and sediments. In calculating the doses, the exposure scenarios for soils and sediments outlined in Section 7.2.4 were employed. The maximum site-related levels in soil and sediments (in B(a)P equivalent units) from Tables 7A and 7B were also used to compute doses. The oral potency factor for B(a)P and the associated estimated excess lifetime cancer risks for the various PAH's are also shown:

Table 7C Estimated Doses and Cancer Risks Associated with Polycyclic Aromatic Hydrocarbons in On-Site Surface Soil and Sediments

CONTAMINANT	Equivalent B[a]P Max. Daily Dose (mg/kg/day)	Oral Potency Factor (mg/kg/day)-1	Excess Cancer Risk
PAHS IN SOIL			
Benzo(a)Anthracene	1.63 E-7	7.3	1.19 E-6
Benzo(a)Pyrene	9.23 E-7	7.3	6.78 E-6
Benzo(b)Fluoranthene	2.89 E-7	7.3	2.10 E-6
Dibenz(a,h)Anthracene	3.24 E-6	7.3	2.36 E-6
TOTAL FROM SOIL	1.70 E-6	7.3	1.24 E-5
PAHS IN SEDIMENTS			
Benzo(a)Pyrene	2.48 E-7	7.3	1.81 E-6
Benzo(b)Fluoranthene	4.95 E-7	7.3	3.61 E-6
Dibenz(a,h)Anthracene	5.16 E-8	7.3	3.77 E-7
TOTAL FROM SEDIMENTS	7.94 E-7	7.3	5.80 E-5

Table 7C shows that all of the individual PAH compounds found in soil and sediments were associated with less than a 1 E^{-4} excess

lifetime risk of cancer. This is considered acceptable according to USEPA guidance. The total excess cancer risk from all PAH's in soil combined (1.24 E^{-5}) and in sediments combined (5.8 E^{-5}) remained within USEPA's acceptable risk range.

USEPA has not developed reference doses (RfDs) for non-cancer health effects for the PAH's in Table 7C. However, there is a growing amount of evidence in animals and humans showing severe immunotoxicity and reproductive toxicity in animals exposed to some carcinogenic PAHs. Additional research is needed to clarify these mechanisms of action.[74]

7.3.2 Pesticides

Seven chlorinated hydrocarbon pesticides were found in on-site surface soil at levels exceeding USEPA benchmarks. No other medium contained pesticides in amounts greater than the USEPA screening levels.

People can be exposed to these compounds in surface soil through dermal contact, incidental ingestion, and limited inhalation of fugitive dust. However, only the soil ingestion pathway is evaluated quantitatively below.

Table 7D presents the estimated daily dose for the seven pesticides, assuming the maximum observed soil concentrations shown in Table 7A and the exposure scenario for soil ingestion in Section 7.2.4.

All of the compounds in Table 7D, except ß-BHC, have been designated by USEPA as B2 or probable human carcinogens. ß-BHC is a class C or possible human carcinogen.[76] Table 7D presents the oral cancer potency factor[73] and estimated excess lifetime cancer risk for each compound:

Table 7D Estimated Doses and Cancer Risk Associated with Pesticides in On-Site Surface Soil

PESTICIDE COMPOUND	Max. Daily Dose (mg/kg/day)	Oral Potency Factor (mg/kg/day)-1	Excess Cancer Risk
α-BHC	6.00 E-7	6.3	4.0 E-6
ß-BHC	1.13 E-6	1.8	2.03 E-6
Chlordane	1.70 E-7	4.03 E-1 wrong	~~6.90 E-9~~ 2.1E-6
4,4'-DDD	5.70 E-6	2.4 E-1	1.37 E-6
4,4'DDE	4.44 E-5	3.4 E-1	1.51 E-5
4,4-DDT	1.59 E-4	3.4 E-1	5.41 E-5
Dieldrin	1.92 E-6	16	3.08 E-5
TOTAL CANCER RISK FROM SOIL	NA	NA	~~1.07 E-4~~ 1.1E-4

Abbreviations: NA = Not Applicable

As can be seen from Table 7D, none of the pesticides <u>individually</u> pose a significant excess lifetime risk of cancer (i.e., each has an excess cancer risk estimate below 1 E^{-4}). However, taken <u>collectively</u>, pesticides in soil are associated with an estimated excess lifetime cancer risk of 1.07 E^{-4}, which slightly exceeds USEPA's acceptable risk range.

USEPA has not developed oral RfDs for adverse health effects other than cancer for α-BHC, ß-BHC, DDT, DDE or DDD. The estimated daily doses from soil for chlordane and dieldrin do not exceed their oral RfDs (6.0 E^{-5} mg/kg/day and 5.00 E^{-5}, respectively). Thus, observed on-site surface soil levels of chlordane and dieldrin would not be expected to cause non-cancer adverse health effects.

A possible exposure pathway to the above pesticides exists through the consumption of contaminated fish. As discussed above, chlorinated hydrocarbon pesticides were detected in Marsh Run 2 and Antietam Creek sediments. This chemical class is highly persistent in the environment and has a great capacity to bioaccumulate in fish. Fishing in Antietam Creek was observed during the ESI. However, no fish samples were taken. Thus, it is not currently possible to evaluate this potential pathway quantitatively.

7.4 <u>Inorganic Contaminants</u>

7.4.1 <u>Arsenic</u>

Inorganic arsenic was detected in site-related surface soils and sediments in quantities that exceeded its USEPA benchmark for residential soils.

Arsenic is a naturally occurring element in the earth's crust. Pure arsenic is a gray-colored metal, but this form is not common in the environment. Rather, arsenic is usually found combined with one or more other elements which determine its form as inorganic or organic. The inorganic forms are usually more toxic than the organic forms.

Inorganic arsenic has been recognized as a human poison since ancient times, and large doses can produce death. Lower level exposure may produce injury in a number of different body tissues.[77] In addition to its adverse non-cancer effects, inorganic arsenic is a Group A or known human carcinogen through the oral and inhalation routes.[76]

Arsenic is not readily absorbed through the skin, and incidental dermal contact is not likely to cause irritation. However, arsenic is absorbed by the digestive tract and through the lungs. Thus, the major exposure pathway of concern for arsenic in soils and sediments is through incidental ingestion. Inhalation of fugitive dust is also a possible, albeit limited, route of exposure.

Using the trespasser exposure scenario described in Section 7.2.4, a maximum daily dose of arsenic from incidental ingestion of surficial soil was estimated to be $1.65 E^{-5}$ mg/kg/day.[73] Using an oral potency factor for arsenic of 1.75/(mg/kg/day),[73] this dose is associated with an excess lifetime cancer risk of $2.89 E^{-5}$. **This value is within USEPA's acceptable risk range for cancer.**

Arsenic's oral RfD for adverse health effects other than cancer is $3.00 E^{-4}$ mg/kg/day.[73] The estimated maximum dose from soil ingestion is less than this RfD. The associated hazard quotient (the ratio of the maximum observed dose to the RfD) is 0.05. A hazard quotient less than one indicates that the observed level of a substance is unlikely to cause adverse non-cancer health outcomes in exposed populations. **Thus, a hazard quotient of 0.05 supports the conclusion that observed arsenic levels in on-site surface soil are not expected to cause adverse non-cancer effects.**

The maximum daily intake of arsenic from ingesting contaminated sediments was estimated to be $9.7 E^{-7}$ mg/kg/day, using the exposure scenario described in Section 7.2.4. This dose is lower than that estimated for surface soils. Since the estimated dose from surface soil was not associated with any adverse health outcomes, it follows that **the arsenic present in sediments does not pose an excess risk of cancer or non-cancer health effects to exposed persons.**

7.4.2 Beryllium

Beryllium was detected in surface soil and sediments at levels surpassing its USEPA benchmark for residential soils.

Beryllium is a hard, gray metal that does not occur naturally. Beryllium ore is converted into alloys that are used in making electrical and electronic parts and molds for plastic. Exposure to small amounts of beryllium over long time periods may cause weakness and shortness of breath.[78] In addition, beryllium is classified by USEPA as a group B2 probable human carcinogen. The oral cancer potency factor for beryllium is 4.3/(mg/kg/day).[76]

The maximum daily dose of beryllium to trespassers from consuming on-site surface soil was estimated to be $4.64 E^{-7}$ mg/kg/day, under the exposure assumptions described in Section 7.4.2. This dose is associated with an excess lifetime cancer risk of $1.58 E^{-6}$. **This value is within USEPA's acceptable risk range for cancer.**

USEPA has established an oral RfD for beryllium of 5 E^{-3} mg/kg/day. Using this RfD, the hazard quotient for beryllium found in on-site soils is 0.00009. **Thus, incidental ingestion of beryllium contaminated soils located in the vicinity of the site is not expected to cause any non-cancer health effects in exposed receptors.**

The maximum daily dose of beryllium from consuming contaminated sediments was estimated to be 1.75 E^{-7} mg/kg/day. This dose is lower that calculated for soil ingestion scenario. It follows then that the **beryllium levels detected in sediments are not expected to pose a significant excess cancer risk or cause non-cancer adverse health outcomes in persons who incidentally ingest the sediments.**

7.4.3 Manganese

Manganese was detected in on-site surface soils and sediments at levels above the EPA screening levels for residential soils.

Manganese is a naturally occurring substance found in many types of rock. People are regularly exposed to low levels of manganese in water, air, soil and food. A certain amount of manganese in the diet is believed to be necessary for good health.

At this time, USEPA does not have enough evidence to determine whether or not manganese is carcinogenic. USEPA has established an oral RfD of 5.0 E^{-3} for effects other than cancer.[73] Chronic exposure of workers to high levels of manganese has produced adverse effects on the central nervous system, including mental and emotional disturbances and incoordination.[79]

Using exposure scenarios described above, the daily maximum estimated doses of beryllium from ingestion of surface soil and sediments are 1.00 E^{-4} and 6.77 E^{-5}, respectively. These doses correspond to hazard quotients of 0.020 and 0.014, respectively. **These values indicate that beryllium is not likely to cause adverse non-cancer health outcomes in persons who incidentally ingest surface soils or sediments contaminated by the site.**

7.4.4 Lead

Lead was detected in one residential well at a concentration (16.3 µg/L) that is slightly greater than the USEPA action level for the protection of human health (15 µg/L).[78] Exposure to lead through drinking water is the major pathway of concern.

Lead is a naturally occurring inorganic element that is frequently found in small amounts in nature. Chronic exposure to low levels of lead can interfere with the blood forming and reproductive systems, kidney function and metabolism, and produce subtle effects on personality, memory, learning, reaction time, psychomotor function, and motor coordination. Infants and young children are very sensitive to the toxic effects of lead on the nervous system. Impaired neurological development has been observed in children exposed to relatively low concentrations of lead. At higher concentrations, lead is toxic to the central nervous system and can produce neurological motor dysfunction.[81]

No threshold level of lead exposure has been identified that does not induce some degree of neurotoxicity. The USEPA has withdrawn the RfD for lead from the IRIS database. Current opinion supports the reasoning that toxicity is reduced with reduced exposure. Until the relationship between toxicity and dose is more clearly understood, all exposure to lead should be avoided to the extent feasible.

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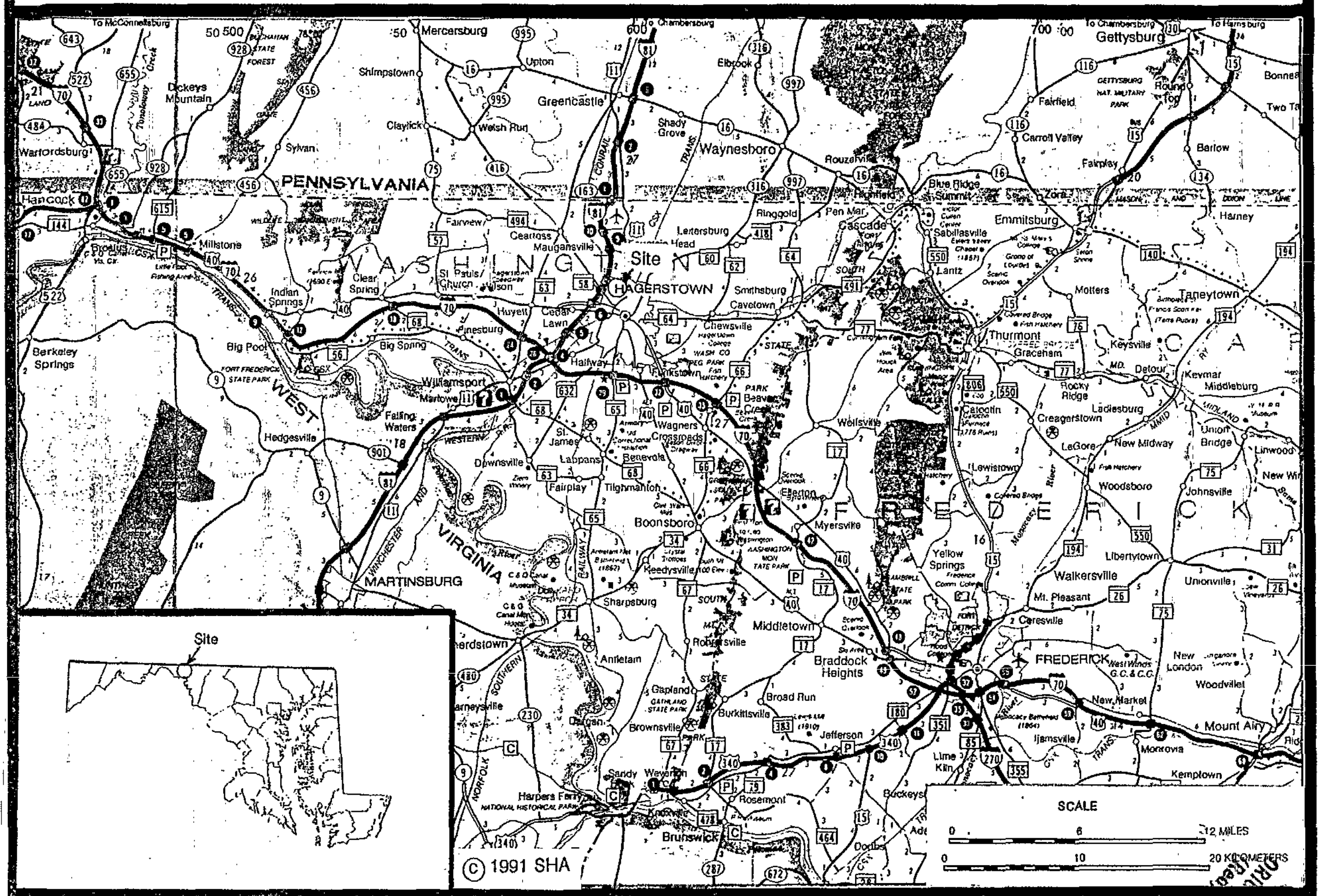
9.0 Figures and Photographs

Regional Highway Map

Figure 1



Street Map

Figure 2

Reprinted by permission of ADC Publications, 1987.
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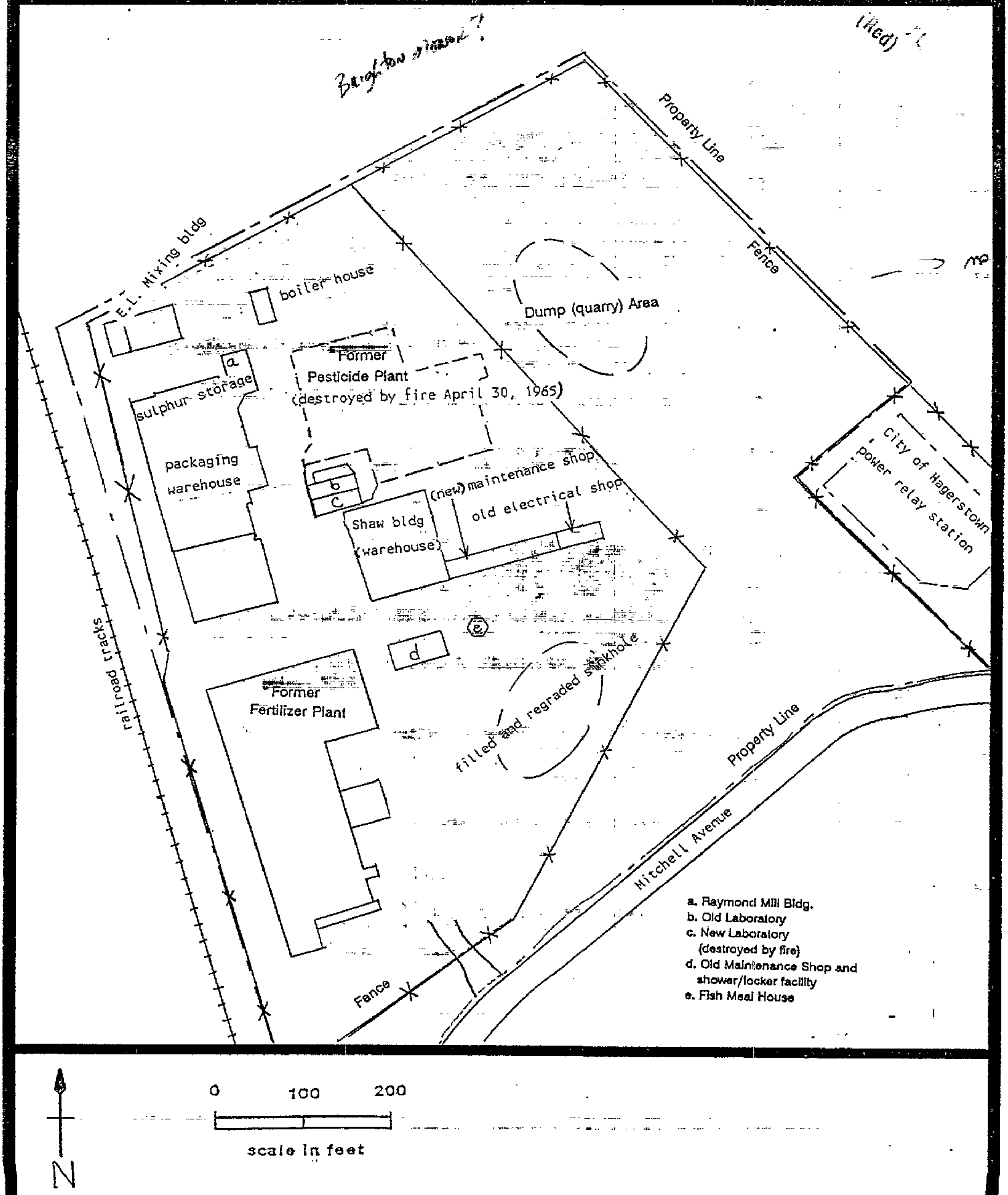
SITE SKETCH

Figure 3

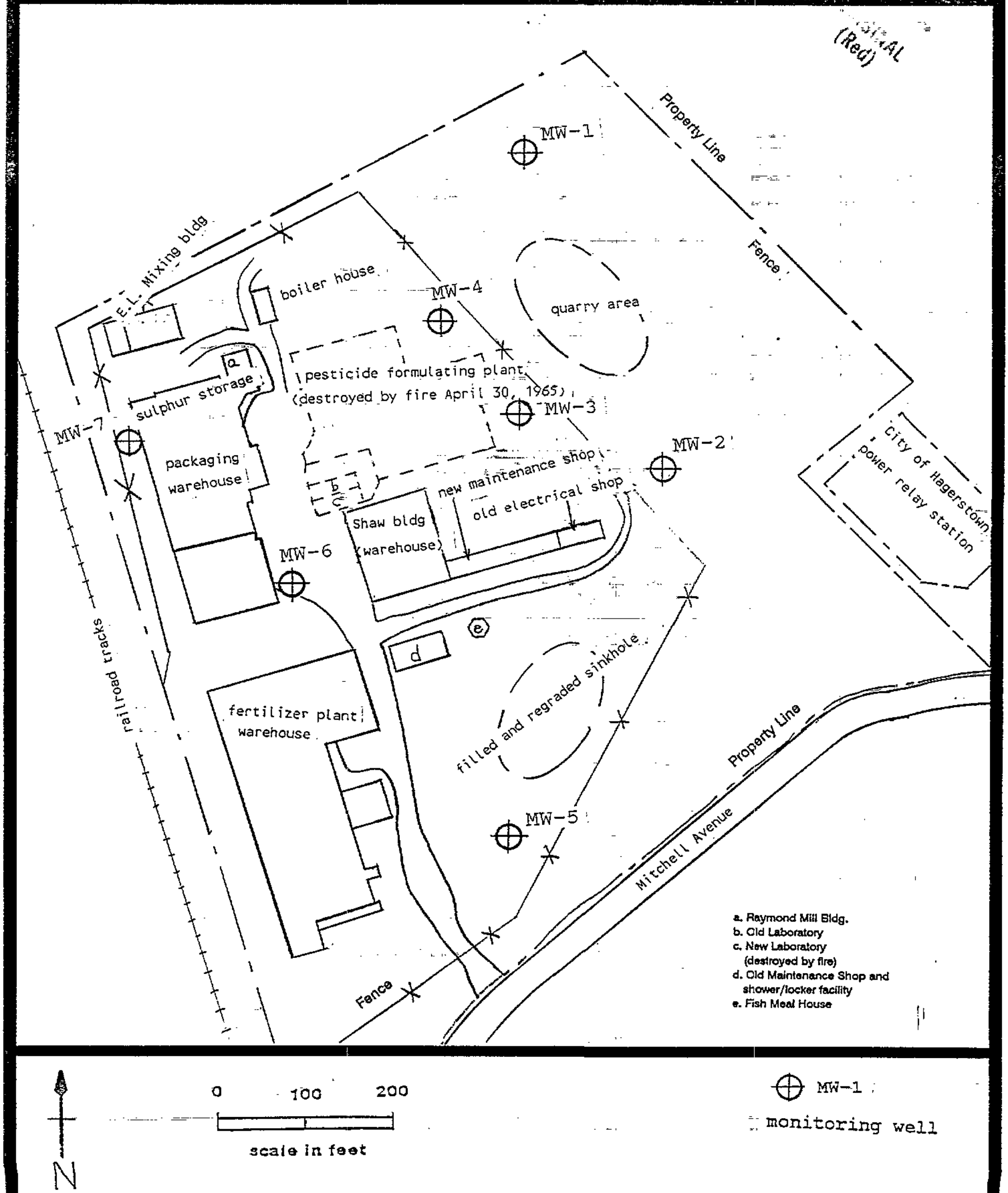


From: Roy F. Weston Inc., Phase I Environmental Investigation - Central Chemical Corporation, Plate 1.

L

MONITORING WELLS LOCATIONS

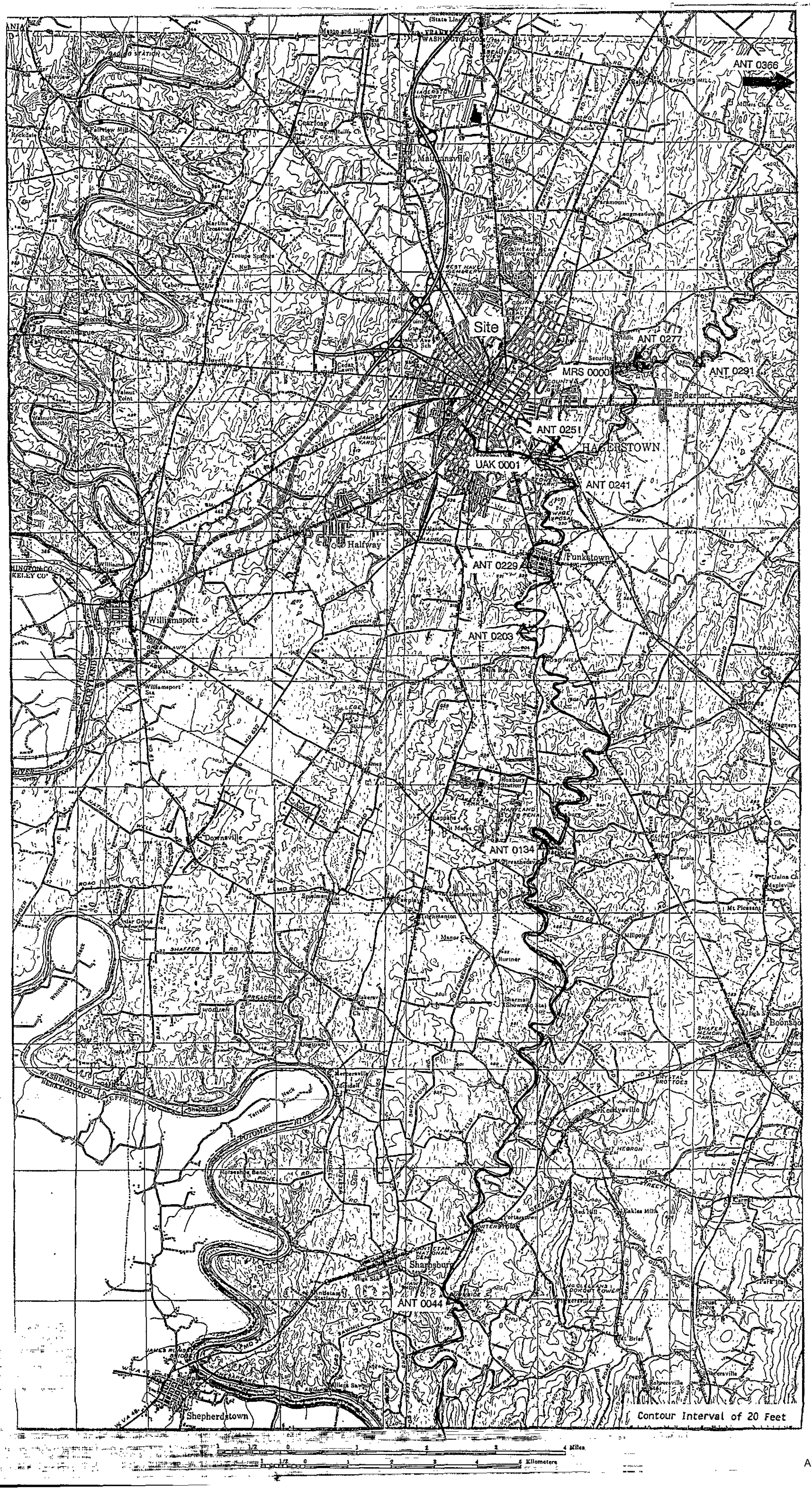
Figure 4

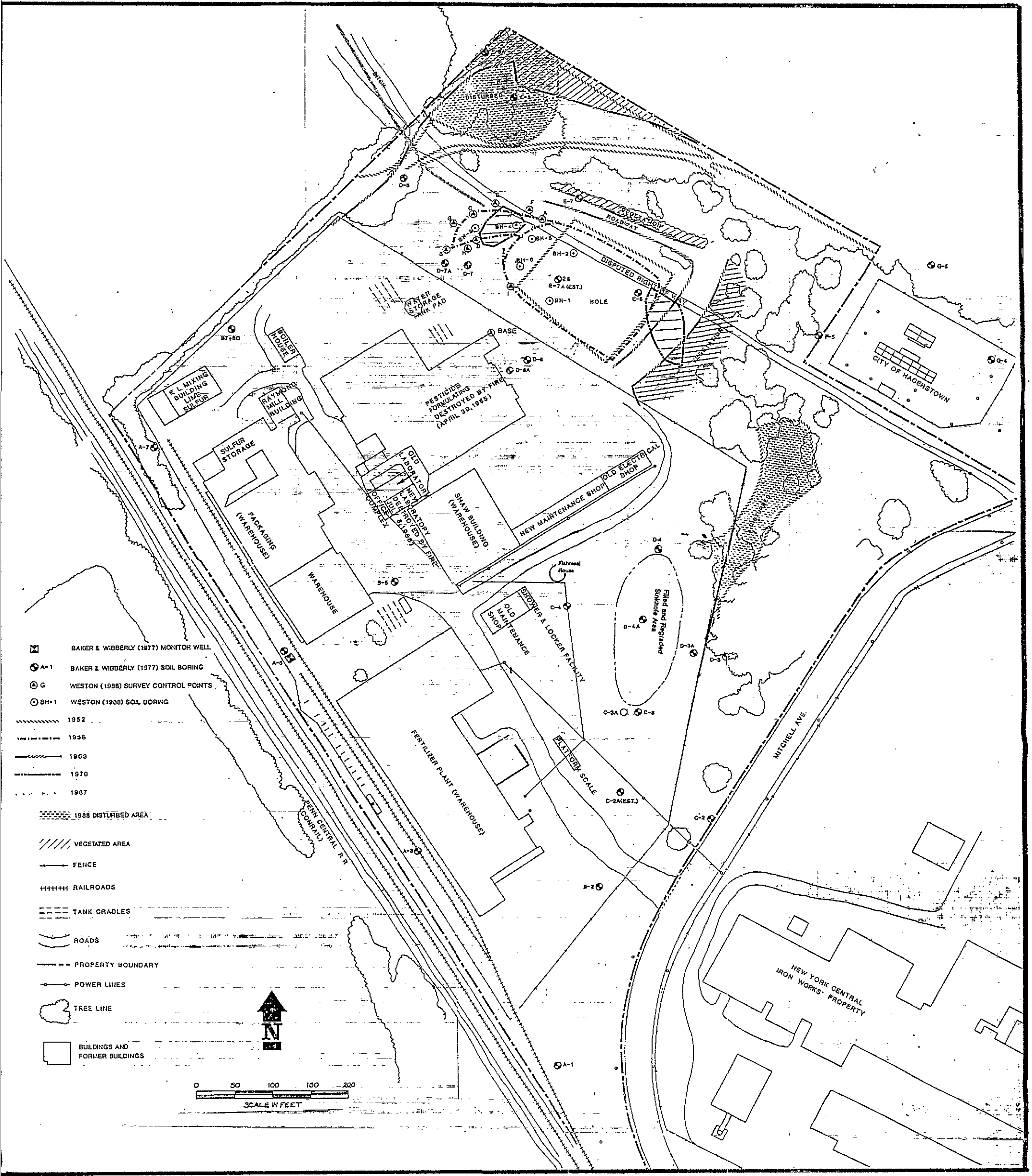


From: Roy F. Weston Inc., Phase I Environmental Investigation - Central Chemical Corporation, Plate 1.

Previous Sampling of Sediments - June 1976

Figure 5





Previous Sampling
Borehole and Monitoring Well Locations - B&W
Borehole Sampling Locations - Weston

Figure 6

Adapted from Weston Report (1989)

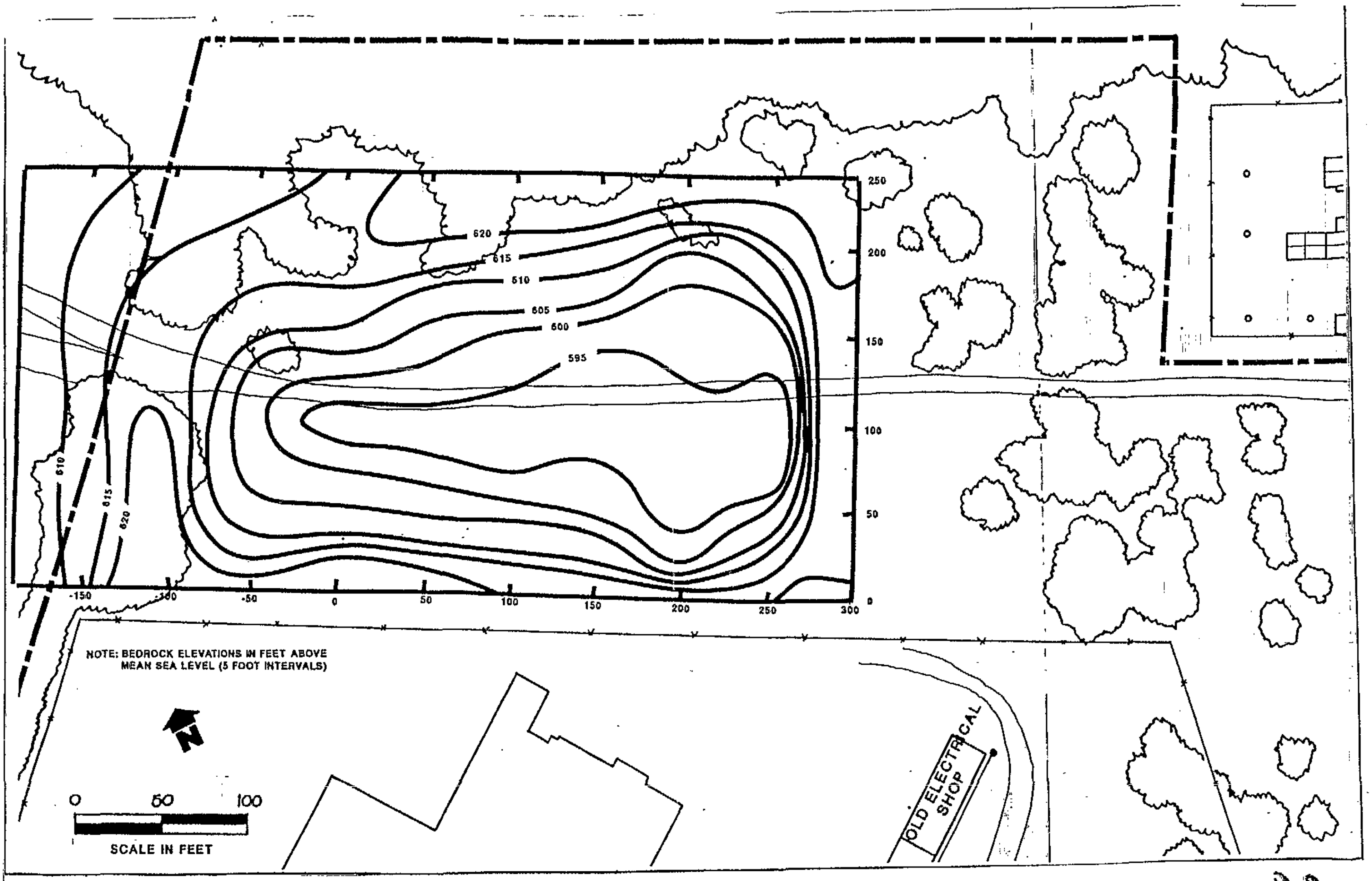


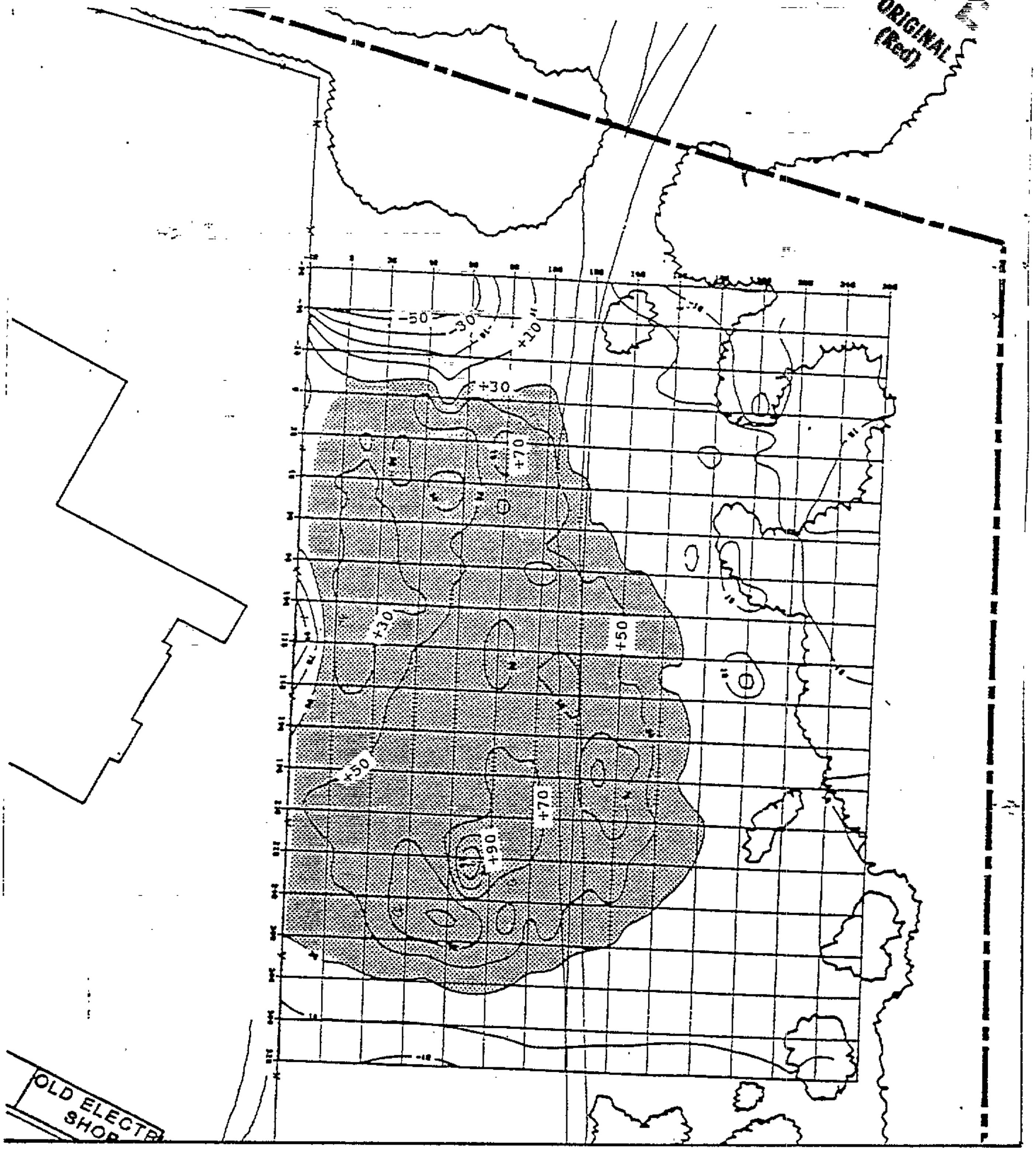
Figure 7

ORIGINAL (Red)

GPR Study - Weston (1989)
Depth to Bedrock

EM-31 Survey - Weston (1989)

Figure 8



contour interval is 20 MMHOS/M

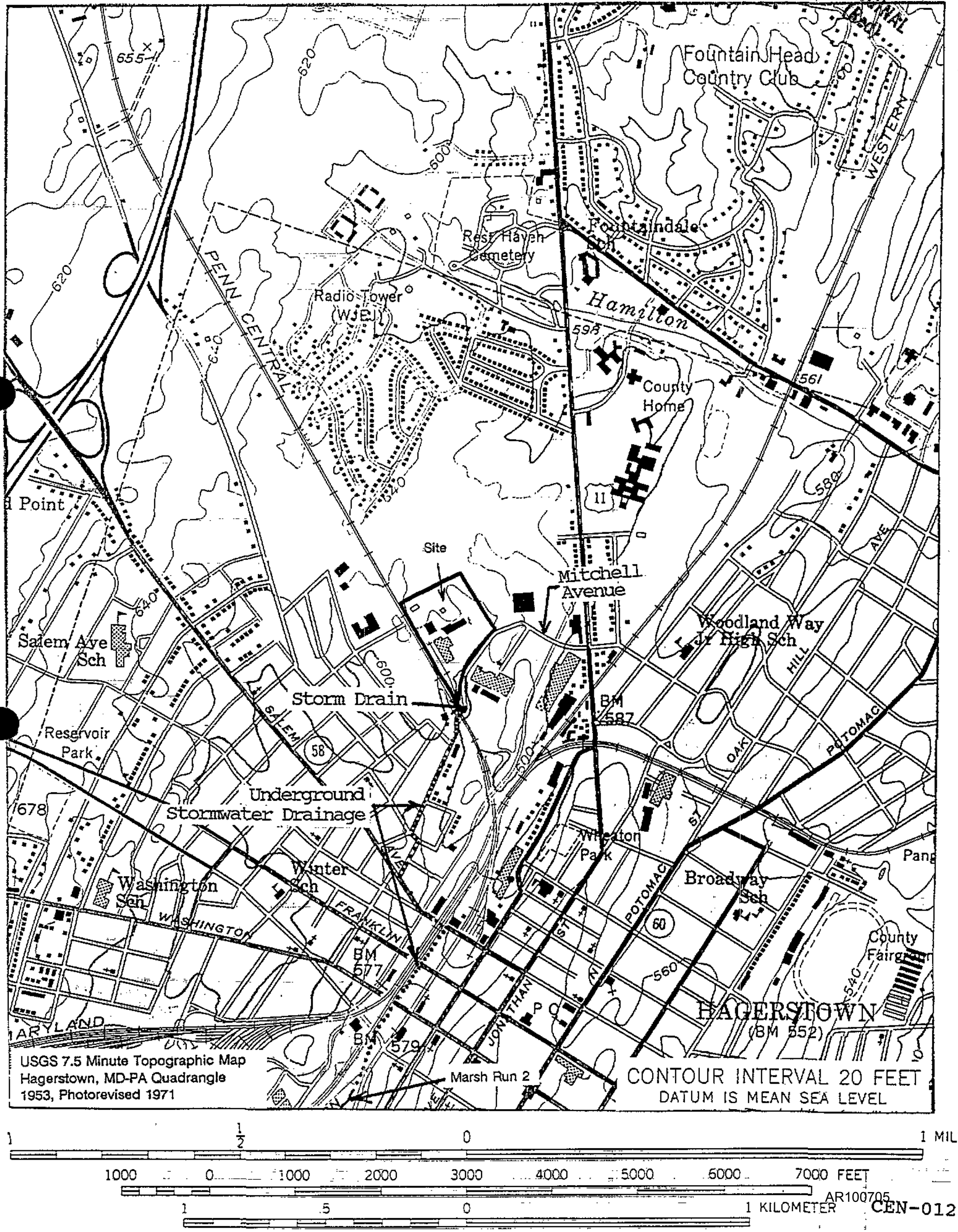
EM-31 run in quadrature component

from Roy F. Weston, Inc., August, 1989

Topographic Map of Site Vicinity

Figure 9

ORIGINAL (Red)

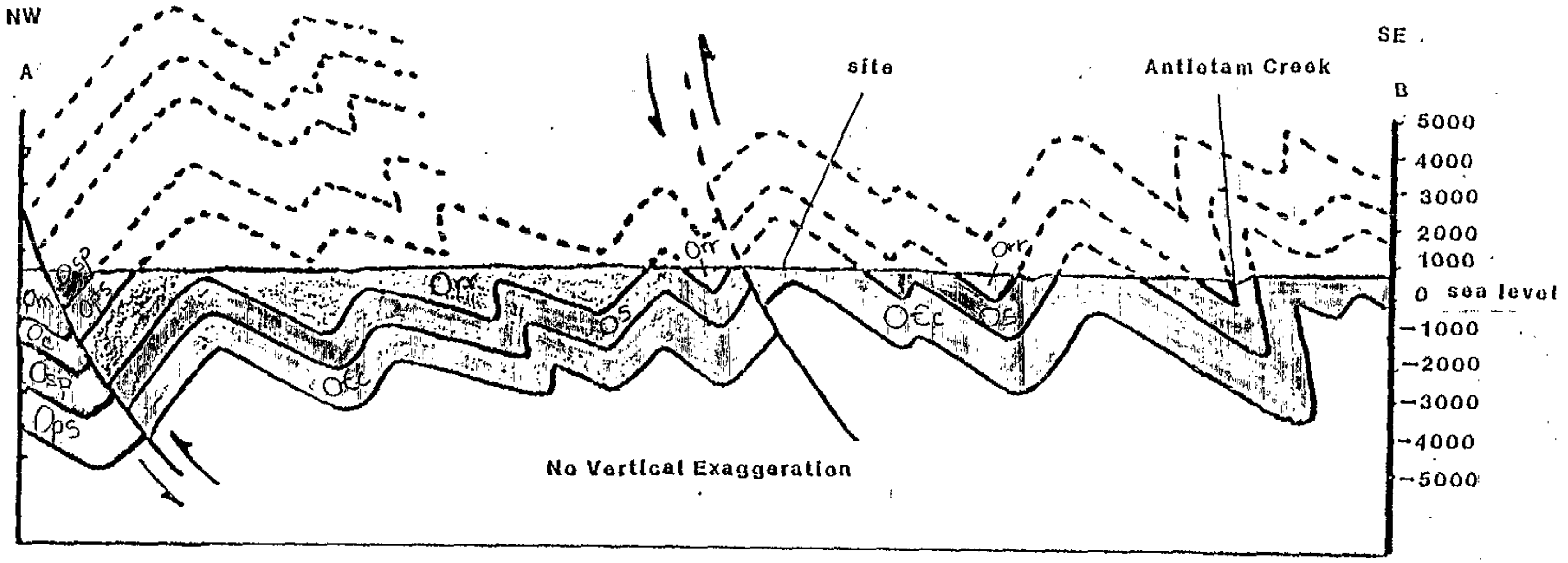


USGS 7.5 Minute Topographic Map
Hagerstown, MD-PA Quadrangle
1953, Photorevised 1971

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

STYLIZED GEOLOGIC CROSS-SECTION

Figure 10



KEY

Om	Martinsburg Shale
Oc	Chambersburg Limestone
Osp	St. Paul Group
Ops	Pinesburg Station Dolomite
Orr	Rockdale Run Formation
Os	Stonehenge Limestone
OЄc	Conococheague Limestone

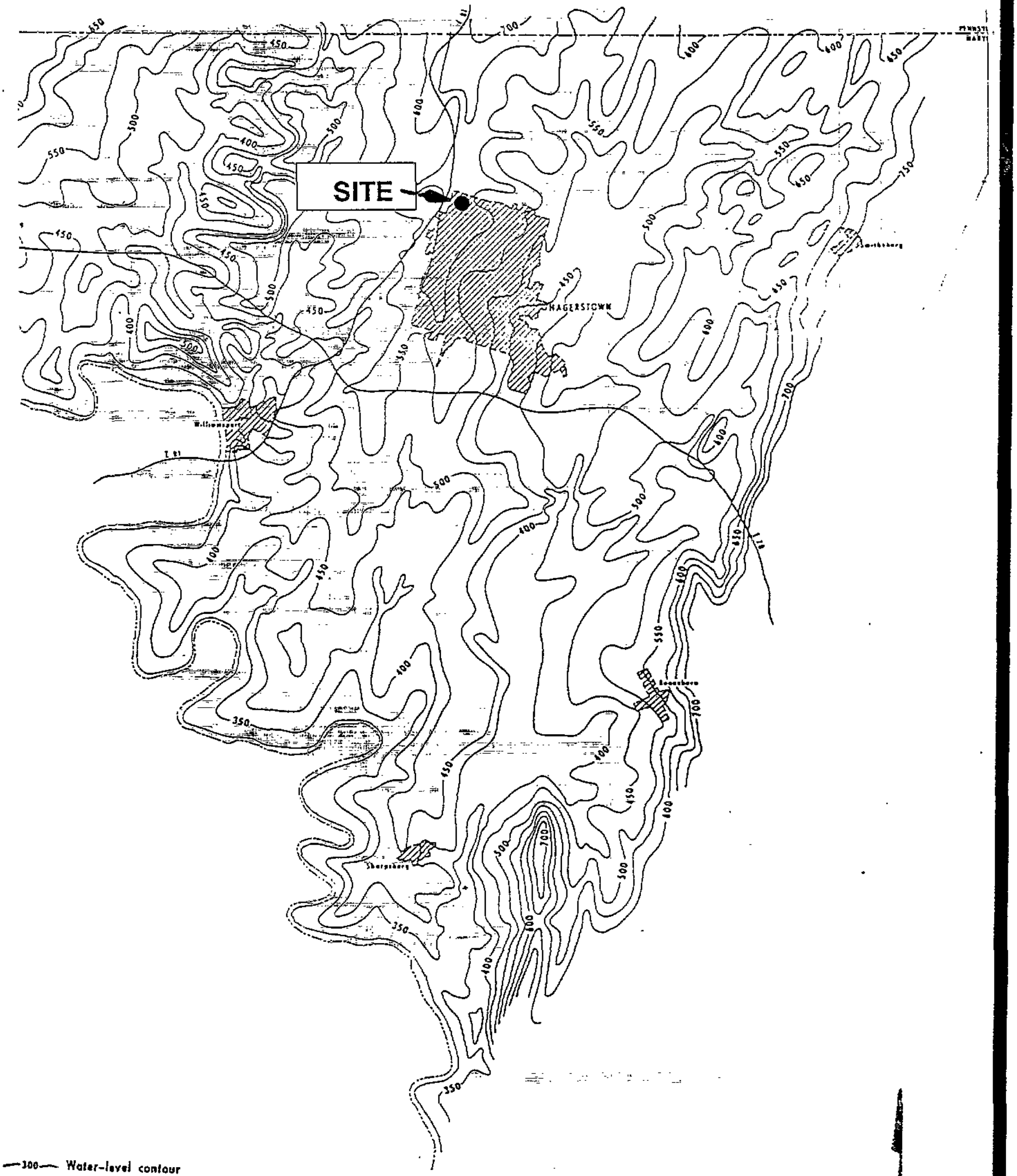
0 5000 10,000

scale in feet

MDE, J. Mathes, 1989.

WATER LEVEL CONTOUR MAP

Figure 11

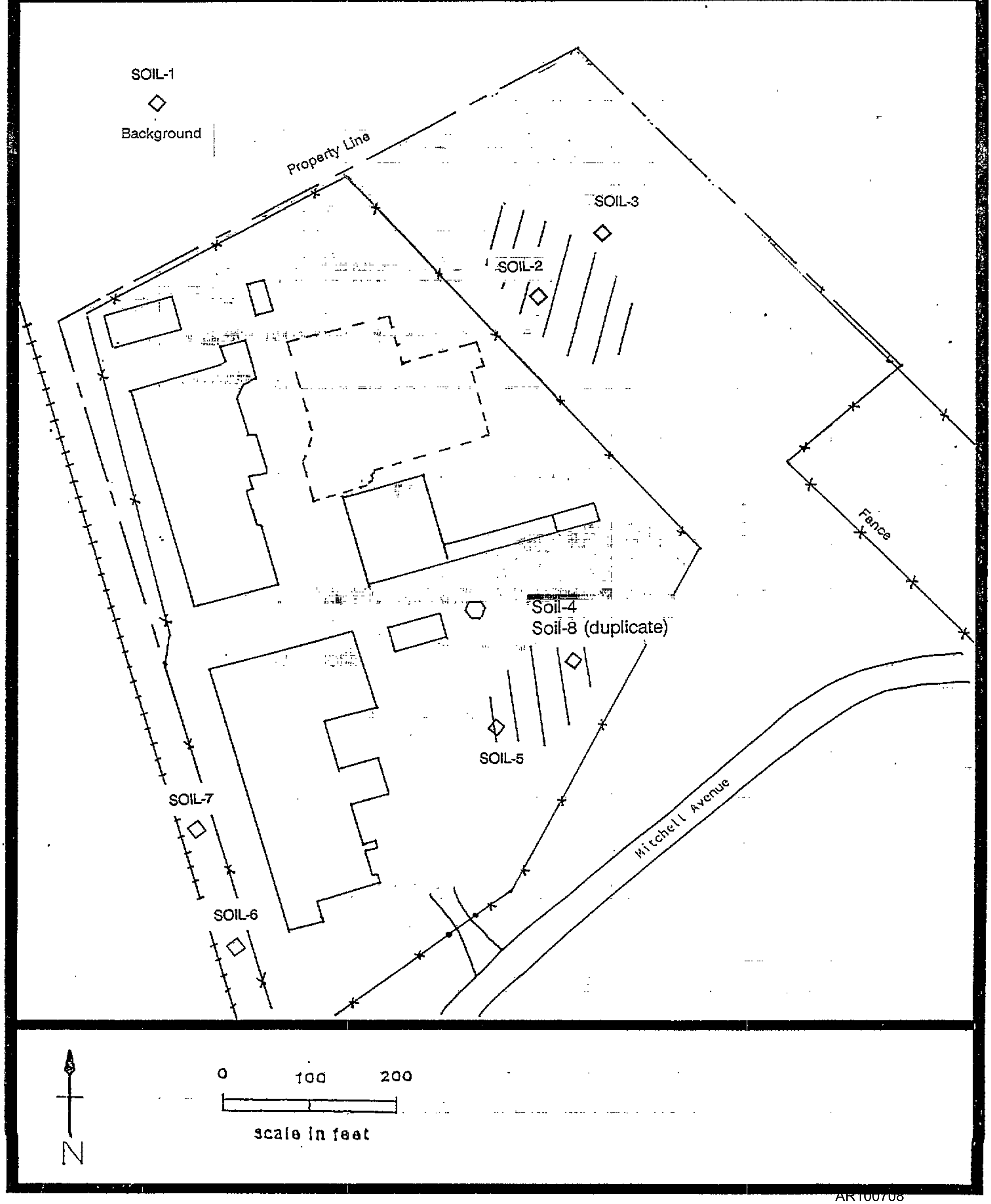


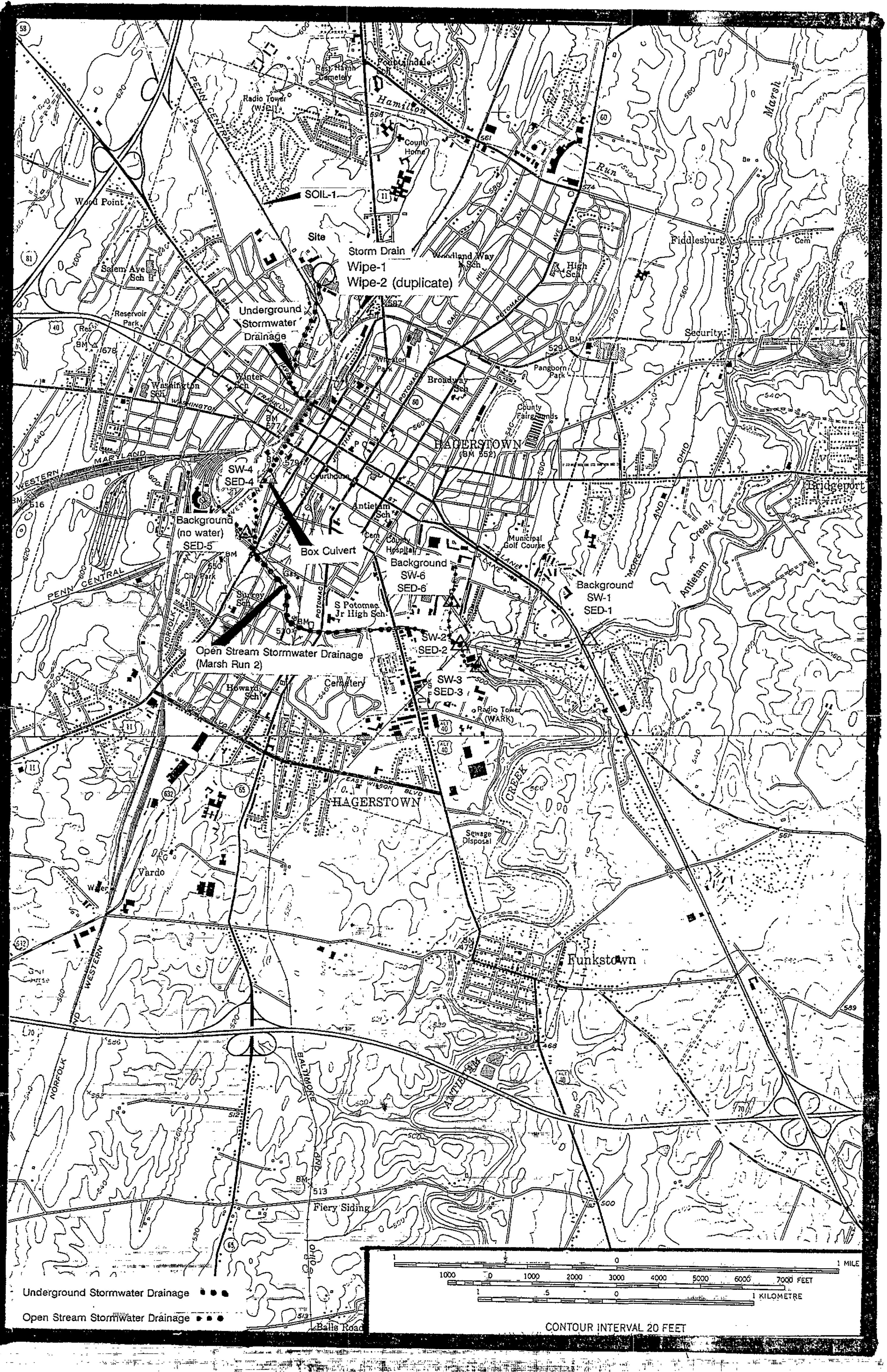
From: MD Geological Survey. Report of Investigations #19 - Hydrogeology of the Carbonate Rocks, Frederick and Hagerstown Valleys, MD. 1973.

Soil Sample Locations

Figure 12

ORIGINAL (Red)



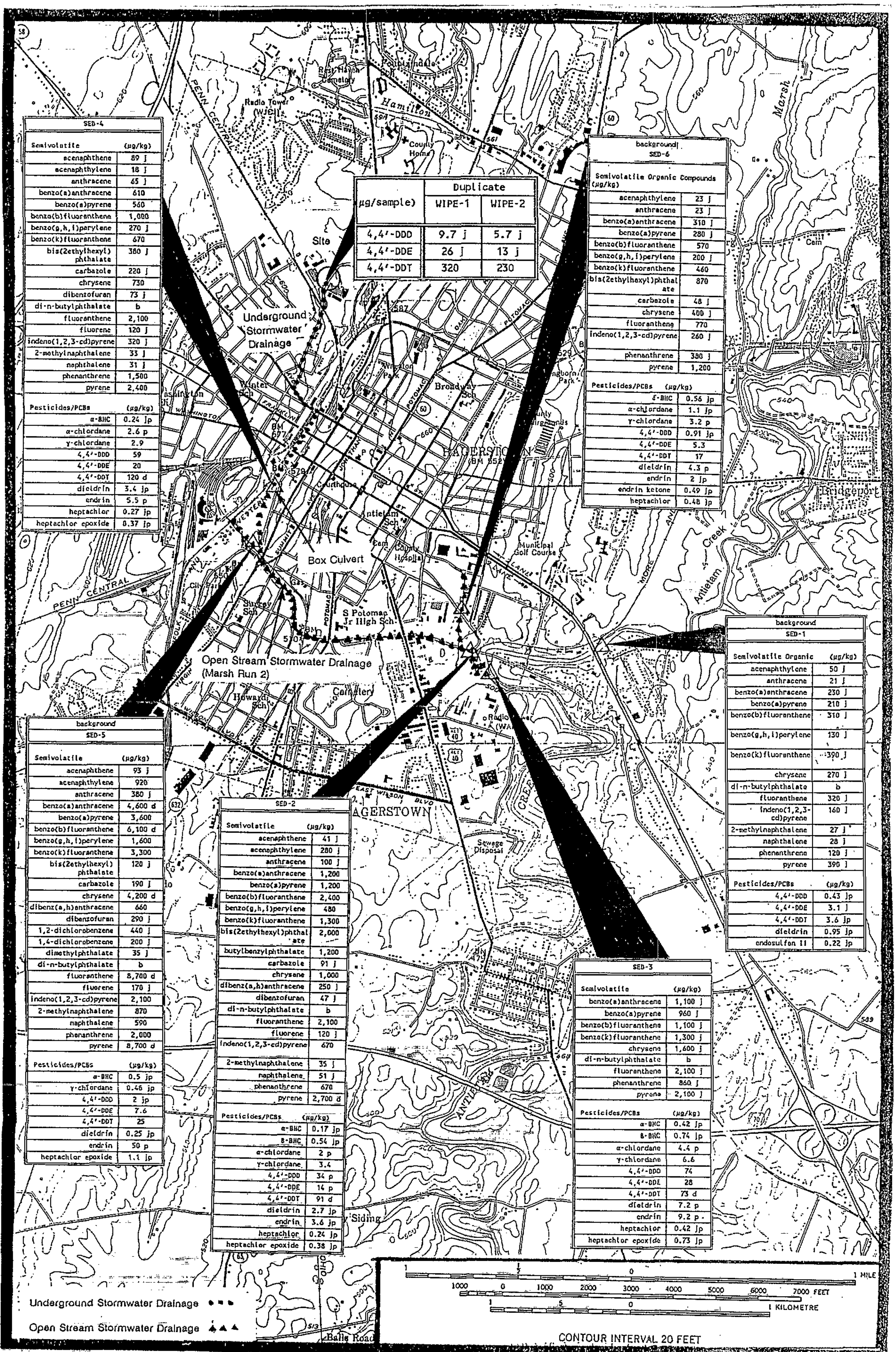


Surface Water/Sediment Sampling Locations

Figure 13

Organic Sediment Sampling Results

Figure 13A



µg/sample)	Duplicate WIPE-1	Duplicate WIPE-2
4,4'-DDD	9.7 j	5.7 j
4,4'-DDE	26 j	13 j
4,4'-DDT	320	230

SED-4

Semivolatile	(µg/kg)
acenaphthene	89 J
acenaphthylene	18 J
anthracene	65 J
benzo(a)anthracene	610
benzo(a)pyrene	560
benzo(b)fluoranthene	1,000
benzo(g,h,i)perylene	270 J
benzo(k)fluoranthene	670
bis(2ethylhexyl) phthalate	380 J
carbazole	220 J
chrysene	730
dibenzofuran	73 J
di-n-butylphthalate	b
fluoranthene	2,100
fluorene	120 J
indeno(1,2,3-cd)pyrene	320 J
2-methylnaphthalene	33 J
naphthalene	31 J
phenanthrene	1,500
pyrene	2,400

Pesticides/PCBs	(µg/kg)
α-BHC	0.24 jp
α-chlordane	2.6 p
γ-chlordane	2.9
4,4'-DDD	59
4,4'-DDE	20
4,4'-DDT	120 d
dieldrin	3.4 jp
endrin	5.5 p
heptachlor	0.27 jp
heptachlor epoxide	0.37 jp

background SED-6

Semivolatile Organic Compounds (µg/kg)	
acenaphthylene	23 J
anthracene	23 J
benzo(a)anthracene	310 J
benzo(a)pyrene	280 j
benzo(b)fluoranthene	570
benzo(g,h,i)perylene	200 J
benzo(k)fluoranthene	460
bis(2ethylhexyl)phthalate	870
carbazole	48 J
chrysene	400 J
fluoranthene	770
indeno(1,2,3-cd)pyrene	260 J
phenanthrene	380 J
pyrene	1,200

Pesticides/PCBs (µg/kg)	
δ-BHC	0.56 jp
α-chlordane	1.1 jp
γ-chlordane	3.2 p
4,4'-DDD	0.91 jp
4,4'-DDE	5.3
4,4'-DDT	17
dieldrin	4.3 p
endrin	2 jp
endrin ketone	0.49 jp
heptachlor	0.48 jp

background SED-1

Semivolatile Organic	(µg/kg)
acenaphthylene	50 J
anthracene	21 J
benzo(a)anthracene	230 J
benzo(a)pyrene	210 J
benzo(b)fluoranthene	310 J
benzo(g,h,i)perylene	130 J
benzo(k)fluoranthene	390 J
chrysene	270 J
di-n-butylphthalate	b
fluoranthene	320 J
indeno(1,2,3-cd)pyrene	160 J
2-methylnaphthalene	27 J
naphthalene	28 J
phenanthrene	120 J
pyrene	390 J

Pesticides/PCBs	(µg/kg)
4,4'-DDD	0.43 jp
4,4'-DDE	3.1 J
4,4'-DDT	3.6 jp
dieldrin	0.95 jp
endosulfan II	0.22 jp

background SED-5

Semivolatile	(µg/kg)
acenaphthene	93 j
acenaphthylene	920
anthracene	380 J
benzo(a)anthracene	4,600 d
benzo(a)pyrene	3,600
benzo(b)fluoranthene	6,100 d
benzo(g,h,i)perylene	1,600
benzo(k)fluoranthene	3,300
bis(2ethylhexyl) phthalate	120 j
carbazole	190 J
chrysene	4,200 d
dibenz(a,h)anthracene	660
dibenzofuran	290 J
1,2-dichlorobenzene	440 J
1,4-dichlorobenzene	200 J
dimethylphthalate	35 j
di-n-butylphthalate	b
fluoranthene	8,700 d
fluorene	170 J
indeno(1,2,3-cd)pyrene	2,100
2-methylnaphthalene	870
naphthalene	590
phenanthrene	2,000
pyrene	8,700 d

Pesticides/PCBs	(µg/kg)
α-BHC	0.5 jp
γ-chlordane	0.46 jp
4,4'-DDD	2 jp
4,4'-DDE	7.6
4,4'-DDT	25
dieldrin	0.25 jp
endrin	50 p
heptachlor epoxide	1.1 jp

SED-2

Semivolatile	(µg/kg)
acenaphthene	41 J
acenaphthylene	280 j
anthracene	100 j
benzo(a)anthracene	1,200
benzo(a)pyrene	1,200
benzo(b)fluoranthene	2,400
benzo(g,h,i)perylene	480
benzo(k)fluoranthene	1,300
bis(2ethylhexyl)phthalate	2,000
butylbenzylphthalate	1,200
carbazole	91 J
chrysene	1,000
dibenz(a,h)anthracene	250 J
dibenzofuran	47 J
di-n-butylphthalate	b
fluoranthene	2,100
fluorene	120 J
indeno(1,2,3-cd)pyrene	670
2-methylnaphthalene	35 J
naphthalene	51 j
phenanthrene	670
pyrene	2,700 d

Pesticides/PCBs	(µg/kg)
α-BHC	0.17 jp
β-BHC	0.54 jp
α-chlordane	2 p
γ-chlordane	3.4
4,4'-DDD	34 p
4,4'-DDE	14 p
4,4'-DDT	91 d
dieldrin	2.7 jp
endrin	3.6 jp
heptachlor	0.24 jp
heptachlor epoxide	0.38 jp

SED-3

Semivolatile	(µg/kg)
benzo(a)anthracene	1,100 j
benzo(a)pyrene	960 J
benzo(b)fluoranthene	1,100 J
benzo(k)fluoranthene	1,300 j
chrysene	1,600 j
di-n-butylphthalate	b
fluoranthene	2,100 j
phenanthrene	860 J
pyrene	2,100 J

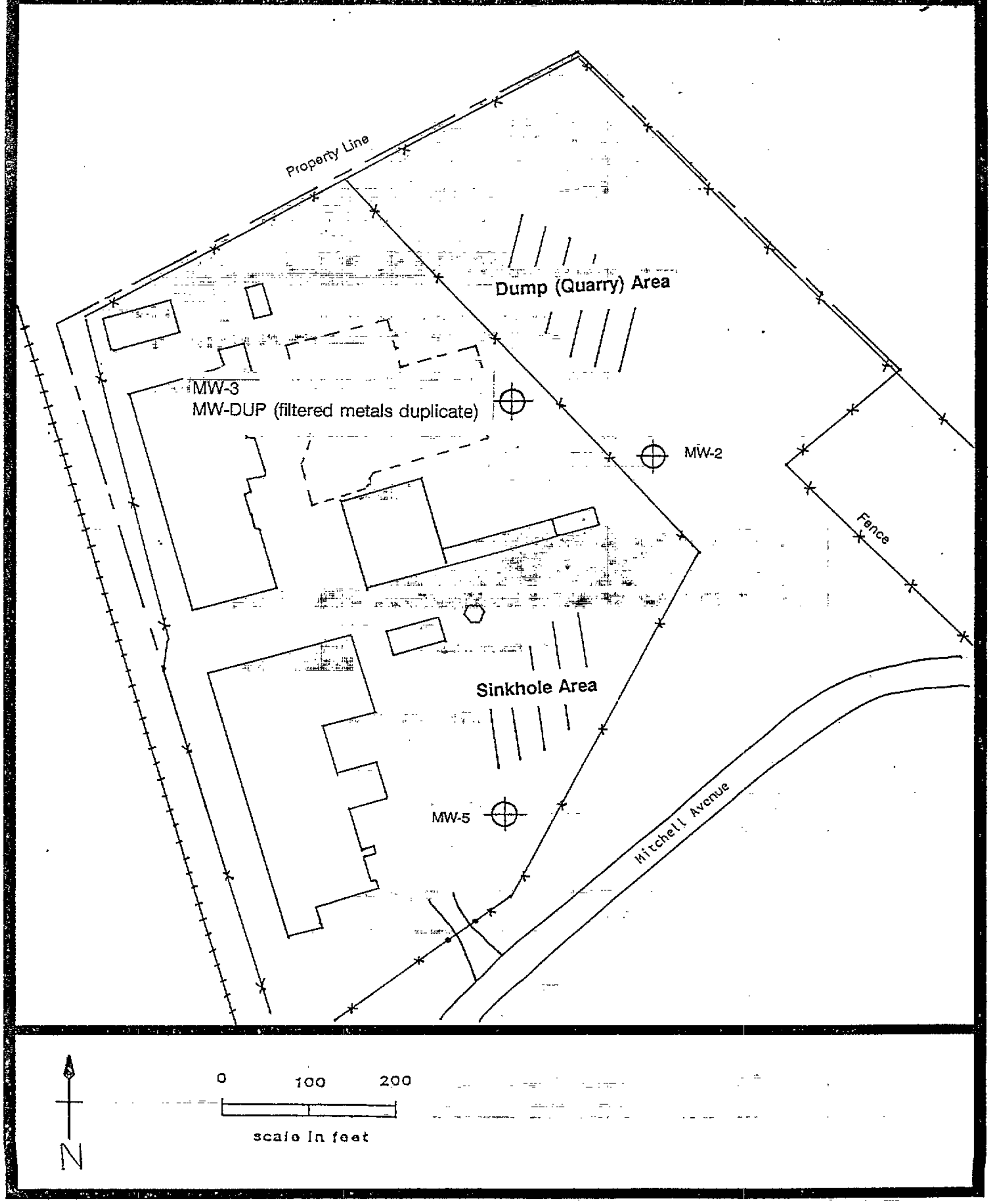
Pesticides/PCBs	(µg/kg)
α-BHC	0.42 jp
β-BHC	0.74 jp
α-chlordane	4.4 p
γ-chlordane	6.6
4,4'-DDD	74
4,4'-DDE	28
4,4'-DDT	73 d
dieldrin	7.2 p
endrin	9.2 p
heptachlor	0.42 jp
heptachlor epoxide	0.73 jp

d = sample was re-extracted and re-analyzed
j = estimated value
p = sample analysis experienced some interference

Monitoring Well Sample Locations

Figure 14

ORIGINAL (Re



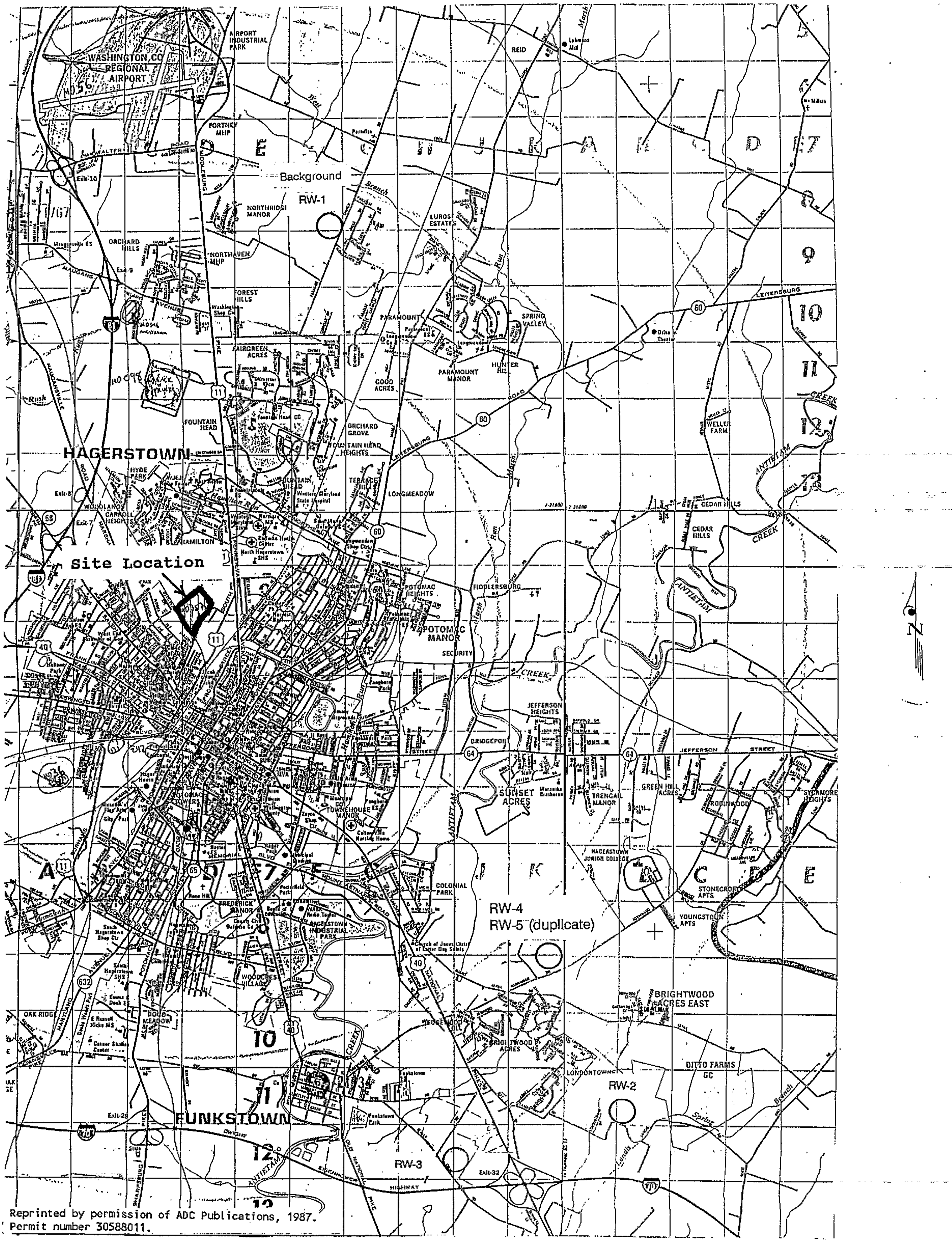


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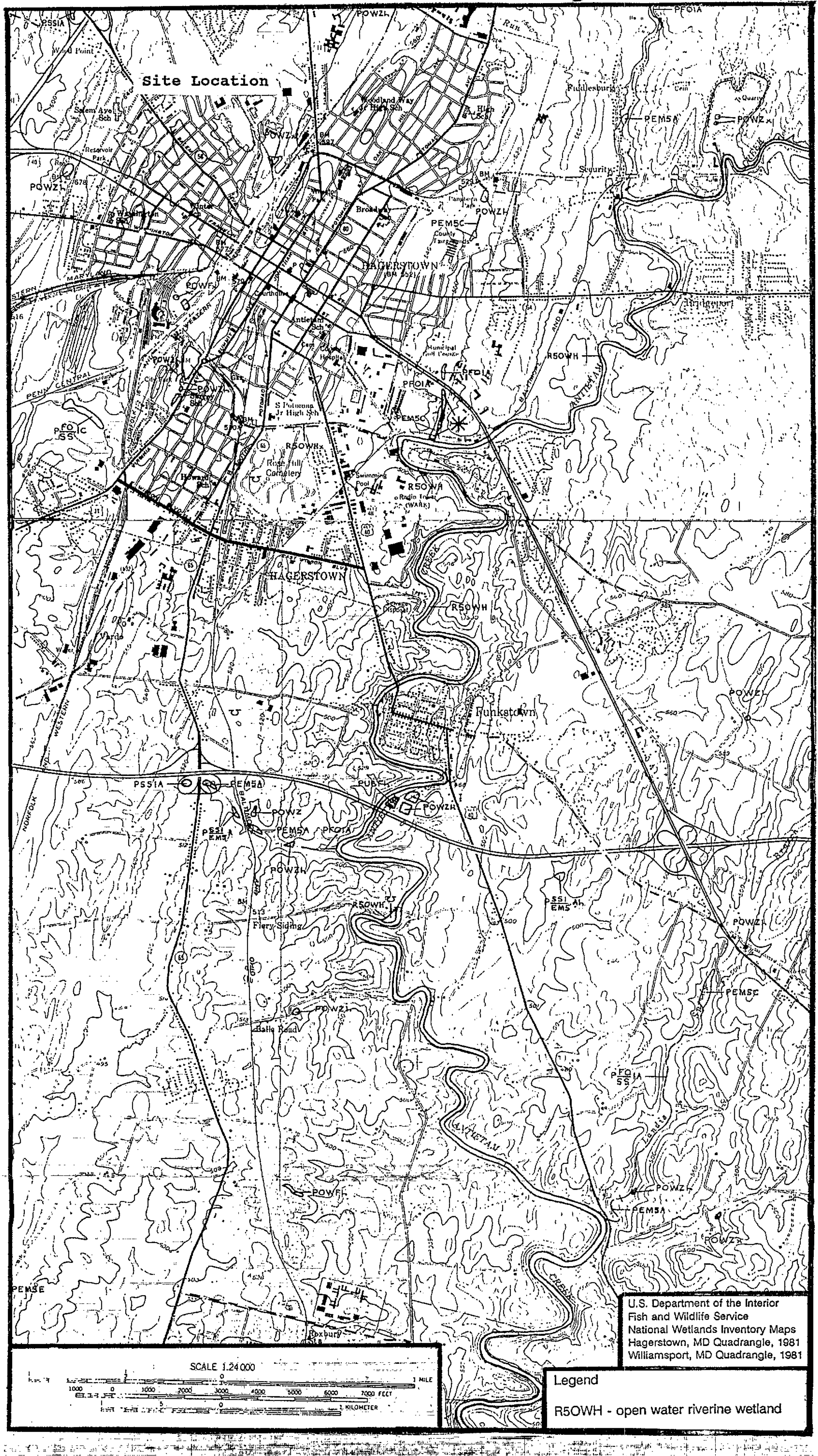
Figure 15

Residential Well Sampling Locations

0 1 2

Miles



U.S. Department of the Interior
Fish and Wildlife Service
National Wetlands Inventory Maps
Hagerstown, MD Quadrangle, 1981
Williamsport, MD Quadrangle, 1981

Legend

R5OWH - open water riverine wetland

Figure 16

Wetlands Map of the Site Vicinity

EPA REGION III

SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID # 124300

PAGE # CEN-012606B

IMAGERY COVER SHEET
UNSCANNABLE ITEM

Contact the CERCLA Records Center to view this document.

SITE NAME CENTRAL CHEMICAL - HAGERSTOWN

OPERABLE UNIT 00

SECTION/BOX/FOLDER 1c / 5 / PFE 3

REPORT OR DOCUMENT TITLE Draft Expanded Site Inspection of the Central Chemical site MD 302

DATE OF DOCUMENT 01 - September 1993

DESCRIPTION OF IMAGERY Central Chemical Corporation - Hagerstown - MD 302

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 oversized map.

Photo 1 Sinkhole Area (facing west to north)

CEN-012607b

Photo 2 Quarry (Dump) Area (facing northeast to southeast)

CEN-012608b

PFE
ORIGINAL
(Red)

Photo 3 Soil 4/Soil 8 (duplicate) (sinkhole area)

CEN-012609B

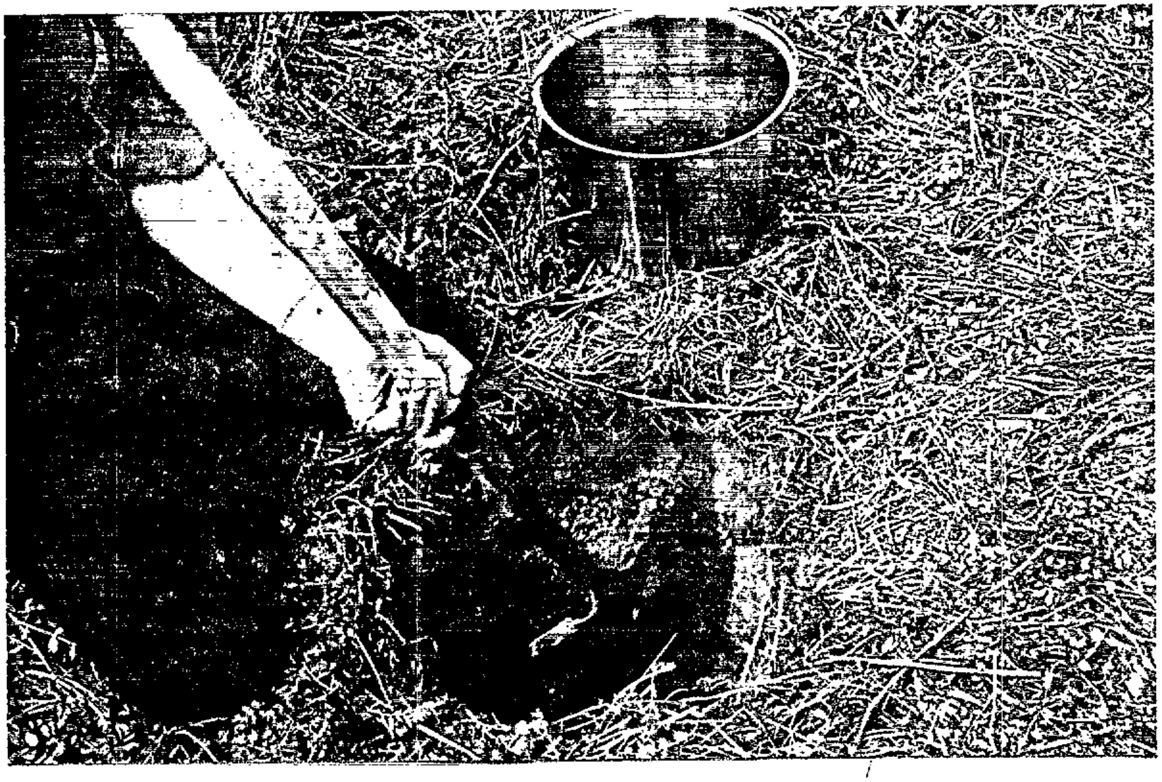


Photo 4 Soil 5 (sinkhole area)

Photo 5 Soil 2 (dump area)

CEN-012611

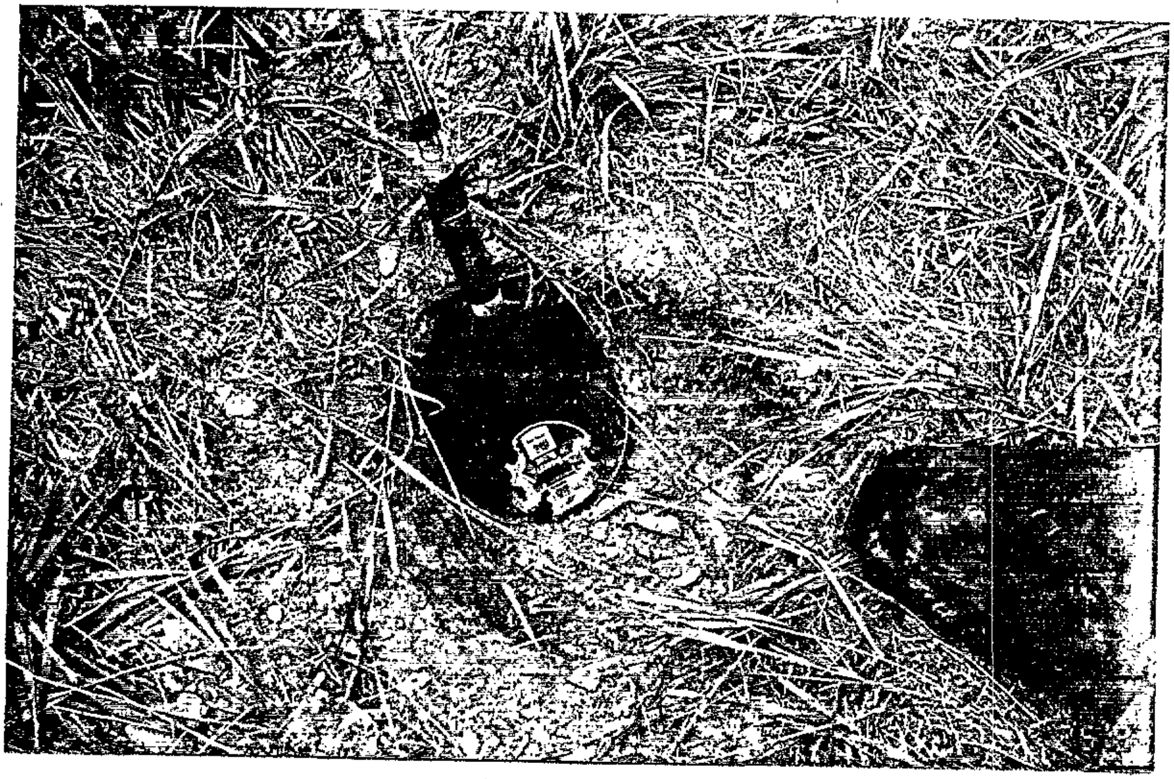


Photo 6 Soil 3 (dump area)

CEN-012612

PFE ORIGINAL (Red)

Photo 7 SW-4/SED-4 (Box culvert outfall into Marsh Run 2)

CEN-012613B

Photo 8 Marsh Run 2 flowing into City Park from Box Culvert Outfall

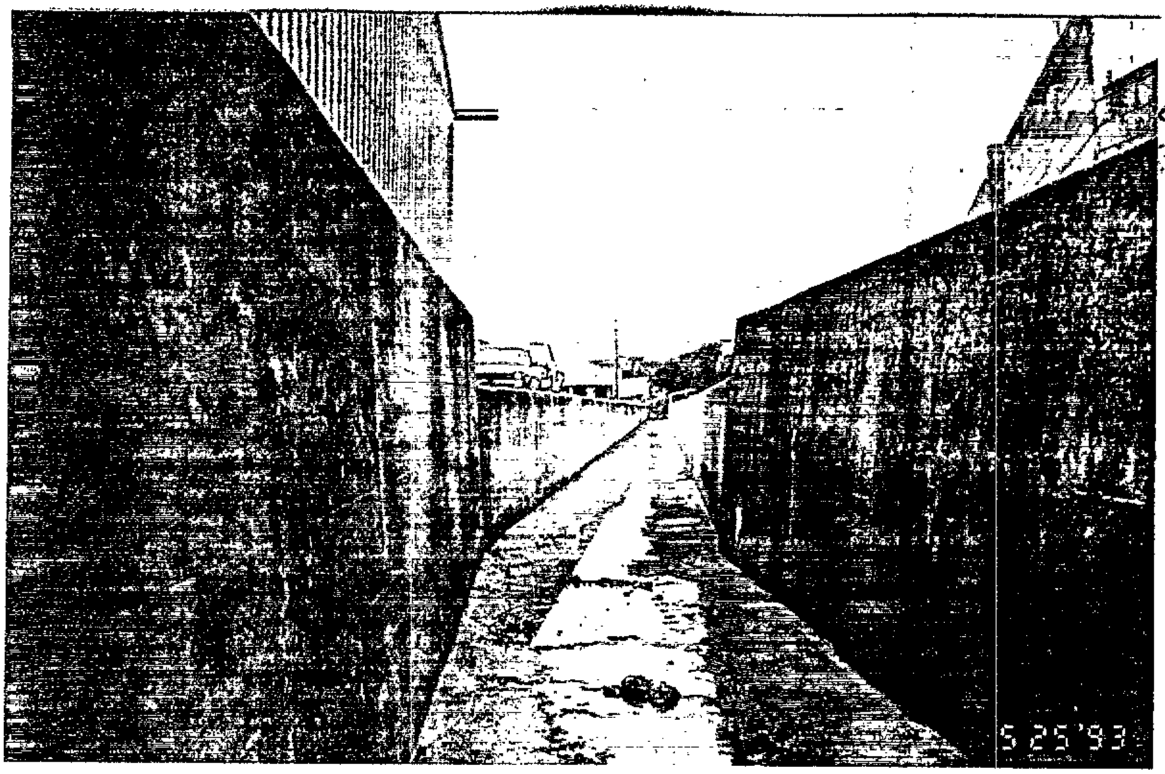


Photo 9 SW-6/SED-6 (Stormwater tributary of Marsh Run 2 - facing north)

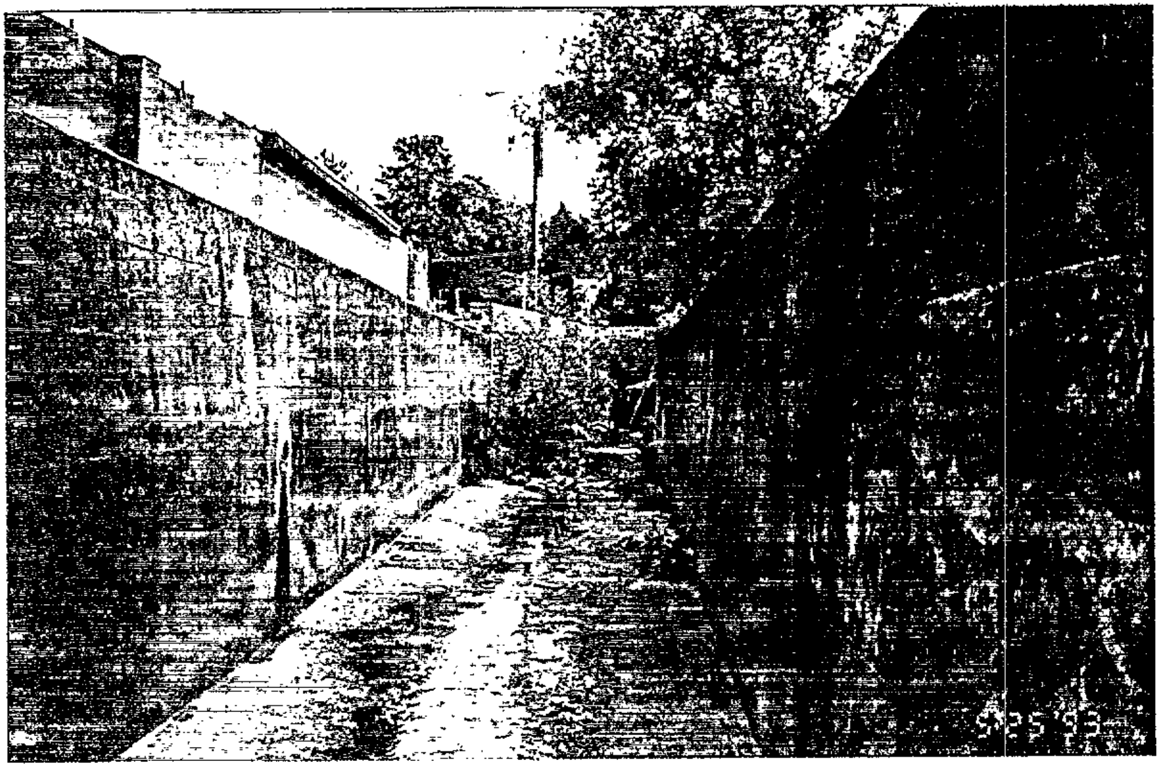


Photo 10 SW-6/SED-6 (Stormwater tributary of Marsh Run 2 - facing south)

Photo 11 SW-3/SED-3 (Antietam Creek at convergence with Marsh Run 2)

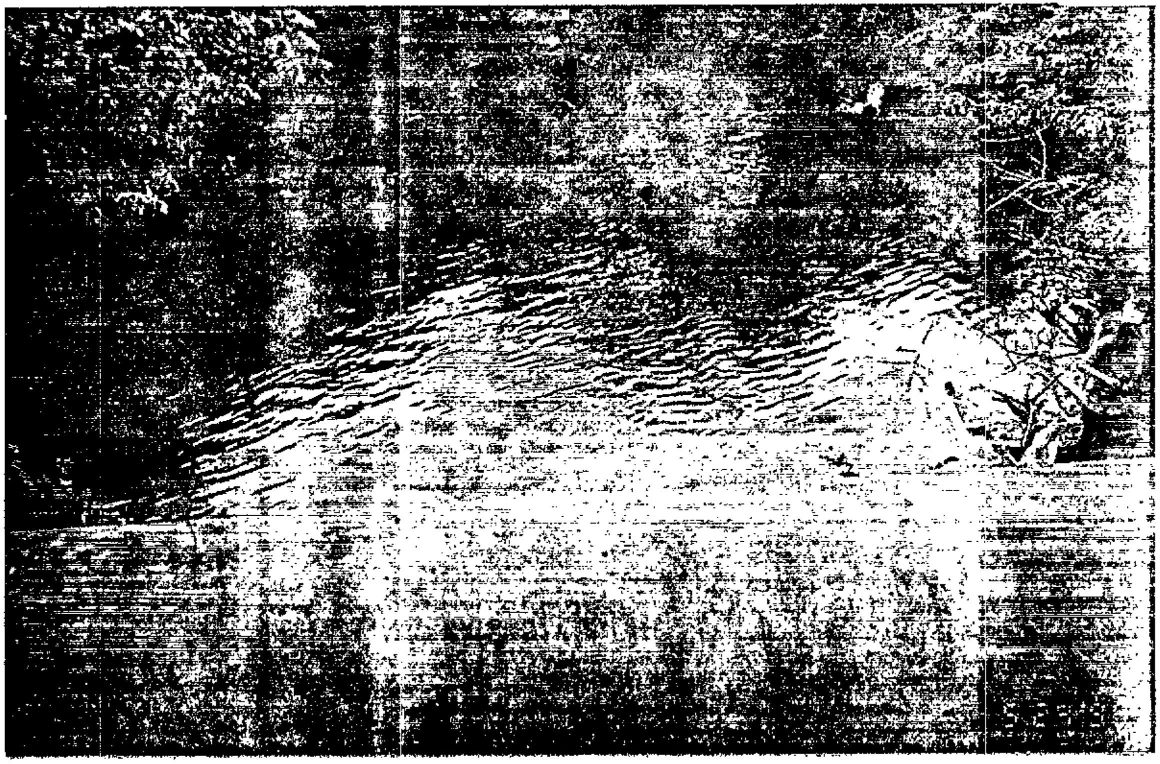


Photo 12 Antietam Creek - boy observed fishing

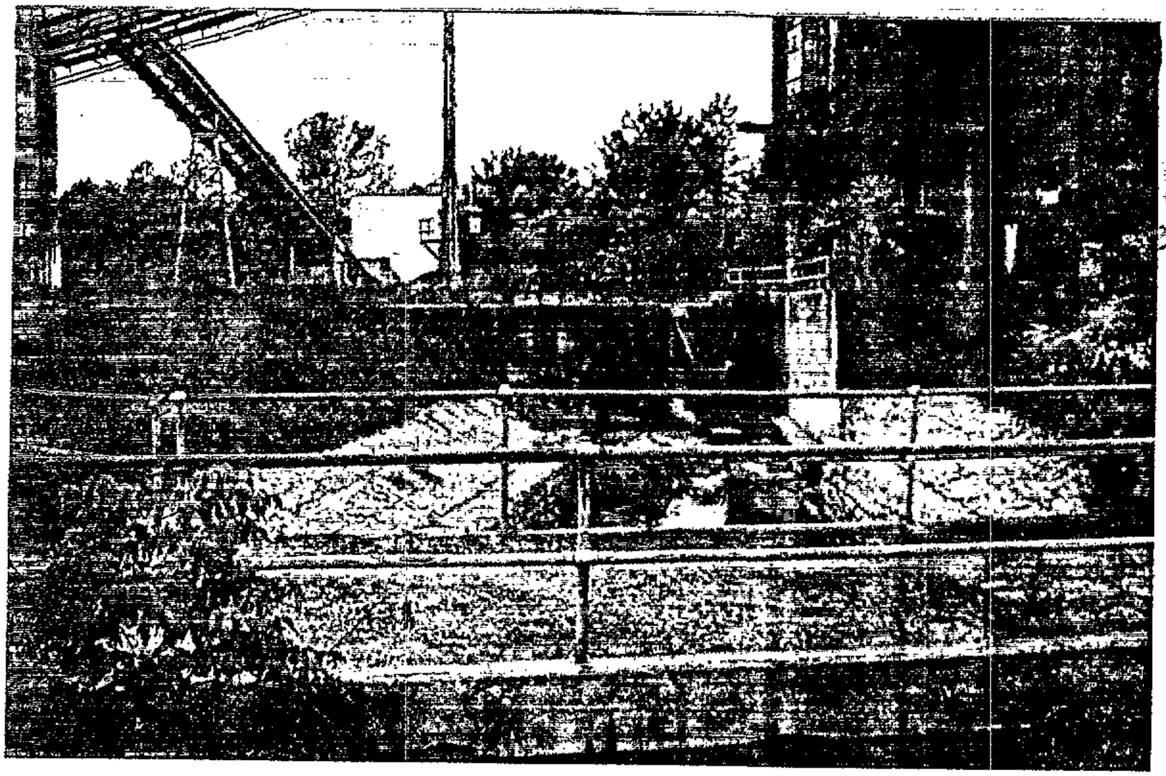


Photo 13 Looking upstream from convergence of Marsh Run 2 with Antietam Creek (vacant MELP is visible)

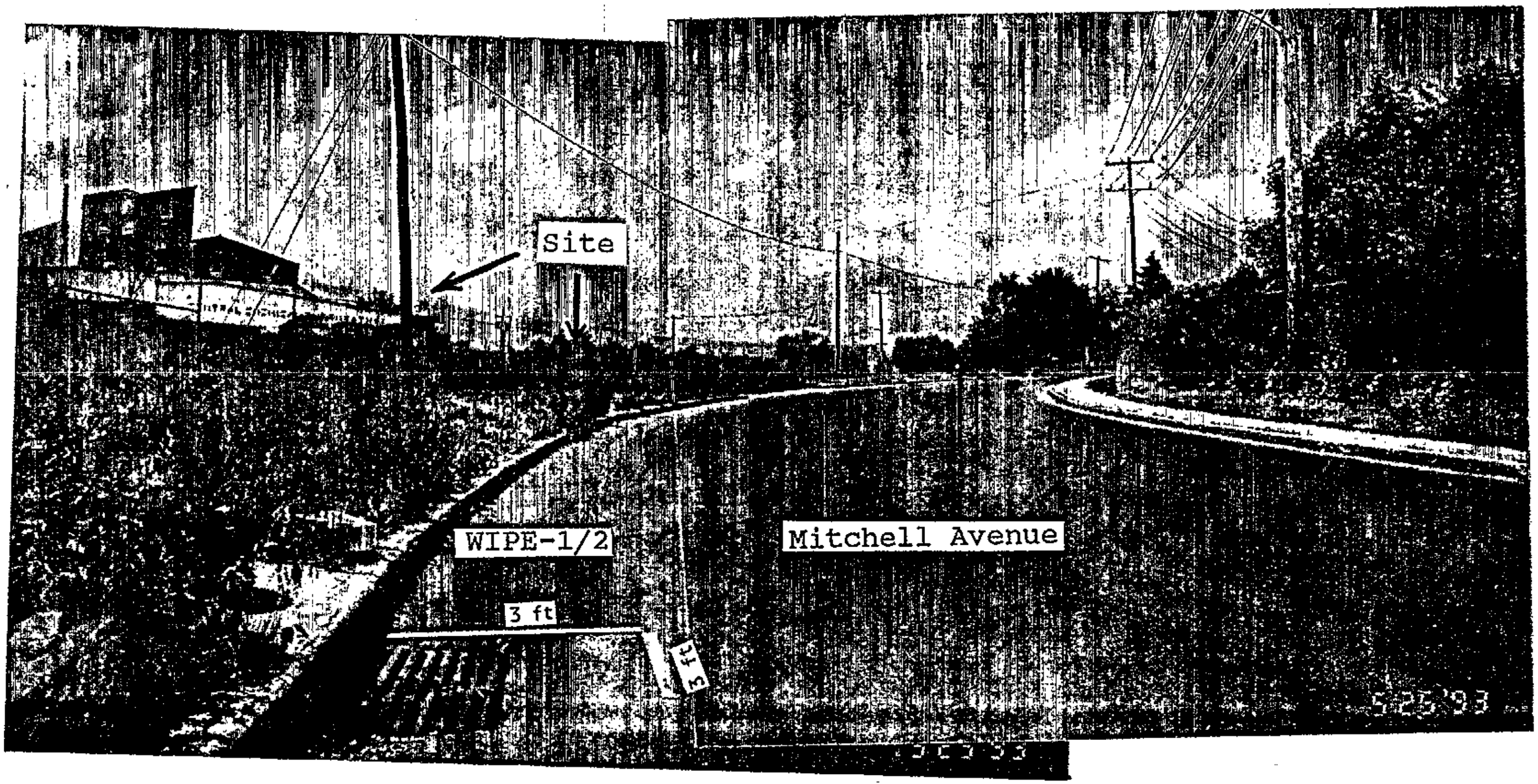


Photo 14 WIPE-1/2 (duplicate)
Stormwater drain adjacent to site

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Appendix A

Weston Monitoring Well Logs

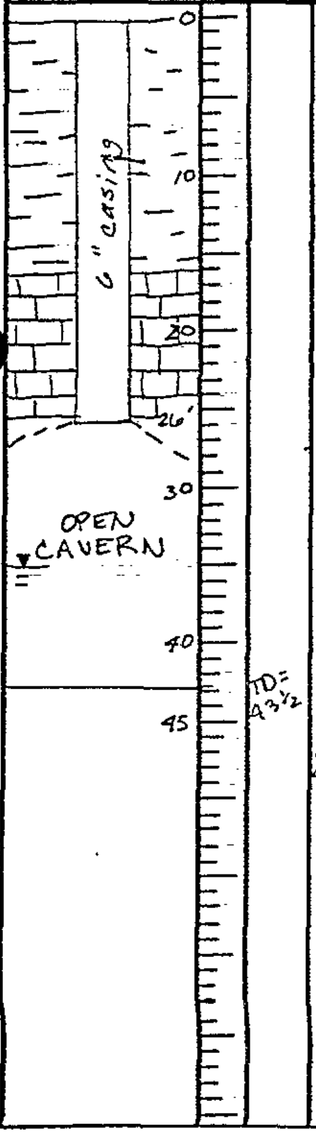
WELL LOG

Page 1 of 1

Location

OFF ORIGINAL (Red)

Well No. MW-1 Drill Company Hardin-Huber Log By Sarah B. Miller
Client Central Chemical Driller Dave Taylor Field Book No. 7
Job No. 3972-01-02 Date Began 4-17-89 End 4-18-89 Log Date 6-5-89
Drilling Method Air rotary / hammer Rig
Sampling Method [✓ No Samples]
Casing Size and Type 6" Steel Screen Size none Joint Type Pipe Length 26'
Type of Pack Type of Seal
Emplacement Method Emplacement Method
Interval Interval
Development Method none Gallons Removed
Comments well is finished in an open cavern 17.5' deep
TOC elevation = 629.42' stick up = 1.89'

Lithology and Well Construction	Depth	Sample No.	Interval	Recovery	Blow Counts	OVA Rdng	Description	Remarks
			0-10'			0	reddish clayey silt, little sand and gravel (limestone sapprolite)	
			10-16'			0	no cuttings; loosing air	
			16-18'			0	bedrock at 16', clayey tight sapprolite top of bedrock is mushy gray clay	
			18-20'				limestone dust and dark gray dense limestone with some calcite veins (5 min/ft)	
			20-26'			0	dusty dark gray limestone and medium gray limestone; no veins; after blow out, large chips have brown veins along sides	
			26-43½'				cavern – no rock (bottom of cavern has ~8' of muddy water in it)	

WESTON

Location

WELL LOG

Page 1 of 1

Well No. MW-3 Drill Company Hardin-Huber Log By Sarah B. Miller

Client Central Chemical Driller Dave Taylor Field Book No. 1

Job No. 3972-01-02 Date Began 4-20-89 End 4-21-89 Log Date 6-5-89

Drilling Method Air Rotary, hammer Rig

Sampling Method (No Samples)

Casing Size and Type 6" steel Screen Size Joint Type Pipe Length

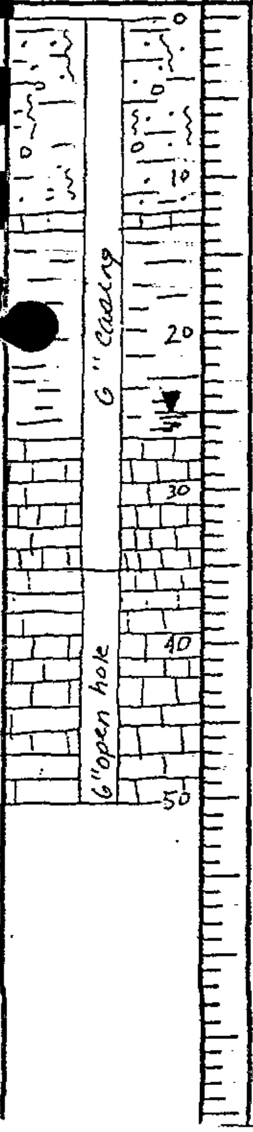
Type of Pack Type of Seal

Emplacement Method Emplacement Method

Interval Interval

Development Method air surge / submersible pump Gallons Removed 200+

Comments TOC elevation = 627.04' stick up = 2.02'



Lithology and Well Construction	Depth	Sample No.	Interval	Recovery	Blow Counts	OVA	Description	Remarks
			0-10'			0	silty gravelly topsoil	slight smell of pesticide
			10-12'			0	metal or boulder (change to hammer)	
			12-15'			0	bouldery clay and fill, alternately hard and soft material	
			15-20'			0	moist red clay, no cuttings returned.	
			20-26½'			0	moist dark gray clay	water at 25' after drilling
			26½-30			0	medium gray and dark gray limestone, white moist powdered clay pebbles.	
			30-35			0	dust and dark gray clay balls dust stops from 31-35	
			35-40			0	light gray limestone, moist powdery dust	
			40-47			0	moist dust, limestone	
			47			0	water-bearing fracture	
			47-50			0	gray limestone	

WESTON

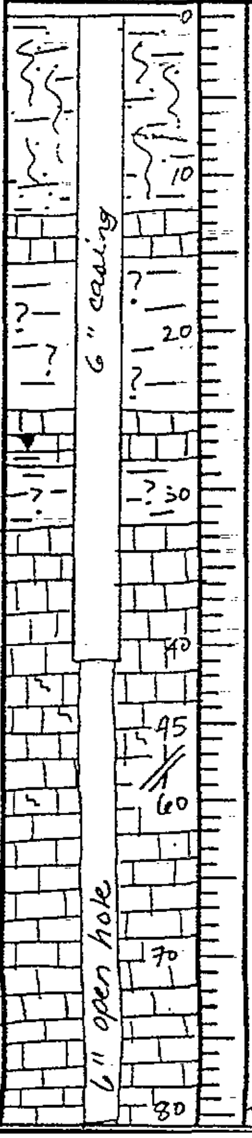
WELL LOG

Page 1 of 1

Location

FE
ORIGINAL (Red)

Well No. MW-2 Drill Company Hardin-Huber Log By Sarah E Muller
Client Central Chemical Driller Dave Taylor Field Book No. 1
Job No. 3972-01-02 Date Began 4-18-89 End 4-19-89 Log Date 6-5-89
Drilling Method Air rotary / hammer Rig
Sampling Method [✓ No Samples]
Casing Size and Type 6" steel Screen Size none Joint Type Pipe Length 92'
Type of Pack Type of Seal
Emplacement Method Emplacement Method
Interval Interval
Development Method air surge Gallons Removed 100+
Comments grayish water, smell of rotten eggs
TOC elevation = 618.33' stickup = 2.0[illegible]'



Lithology and Well Construction	Depth	Sample No.	Interval	Recovery	Blow Counts	OVA	Description	Remarks
			0-10'			0	topsoil - red brown/dark brown clayey silt, some gravel	
			10-12'			0	red brown clay, topsoil	
			12-15'			0	gray limestone with calcite veins	
			15-25'			0	void space/weathered zone cuttings are moist brown clay	
			25-28'			0	gray limestone	
			28-32'			0	void space/mud-filled cavity	
			32-41'			0	gray limestone	
			41-63'			0	light gray limestone with small calcite veins	
			63-80'			0	soft gray limestone with brown staining	water at 47' gray water smells like rotten eggs ~1 gpm
			80-82'			0	hard dark gray limestone	

WESTON

Location

ORIGINAL (Red)

WELL LOG

Page 1 of 1

Well No. MW-4 Drill Company Hardin-Huber Log By Sarah B. Miller

Client Central Chemical Driller Dave Taylor Field Book No. 1

Job No. 3972-01-02 Date Began 4-20-89 End 4-21-89 Log Date 6-5-89

Drilling Method Air rotary / hammer Rig

Sampling Method (No Samples)

Casing Size and Type 6" steel Screen Size Joint Type Pipe Length

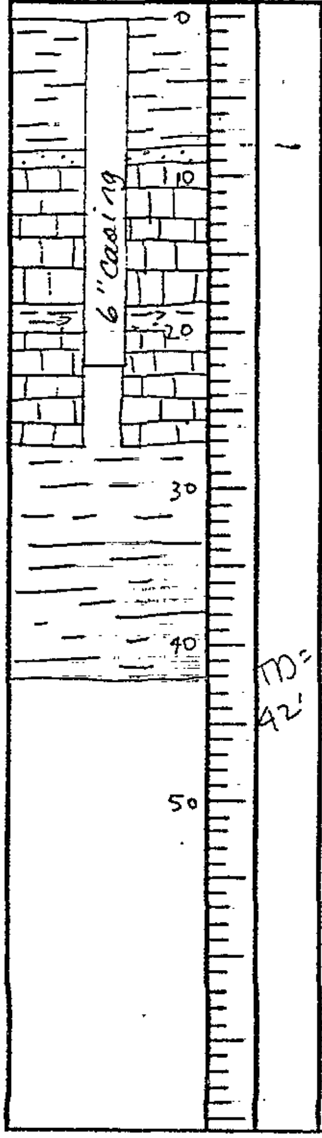
Type of Pack Type of Seal

Emplacement Method Emplacement Method

Interval Interval

Development Method none Gallons Removed

Comments TOC elevation = 628.97' stick up = 2.31'



Lithology and Well Construction	Depth	Sample No.	Interval	Recovery	Blow Counts	OVA	Description	Remarks
			0-8'			0	red and black clay	
			8-9'			0	coarse gray sand	
			9-18'			0	medium gray Limestone, dust little calcite veining	
			18-20'			0	mud-filled void	
			20-22'			0	dark gray limestone with white calcite veins	
			22-27'			0	light gray and medium gray Limestone with white veins of calcite	
			27-42'			0	mud-filled void	no water encountered

WESTON

Location

ORIGINAL
(Red)

WELL LOG

Page 1 of 1

Well No. MW-5 Drill Company Hardin-Huber Log By Sarah B. Miller

Client Central Chemical Driller Dave Taylor Field Book No. 1

Job No. 3972-01-02 Date Began 4-24-89 End 4-26-89 Log Date 6-5-89

Drilling Method Air rotary / hammer Rig

Sampling Method [✓ No Samples]

Casing Size and Type 6" steel Screen Size Joint Type Pipe Length

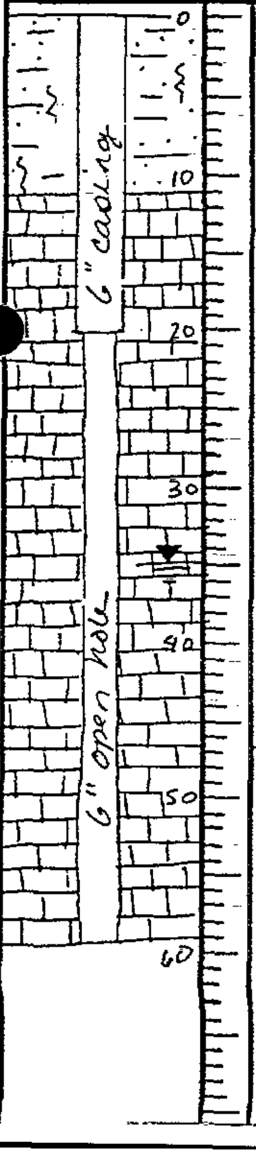
Type of Pack Type of Seal

Emplacement Method Emplacement Method

Interval Interval

Development Method air surge / submersible pump Gallons Removed 45+

Comments water after drilling was at 35', below static which is ~17½'
TOC elevation = 609.68' stick up = 2.38'



TD: 59'

Lithology and Well Construction	Depth	Sample No.	Interval	Recovery	Blow Counts	Description	Remarks
			0-10'			moist redbrown silty clay/topsoil	
			10-11'		(?)	moist redbrown silty clay with some sand / topsoil	
			11-20'			dusty light gray limestone, soft with some iron staining and concretions	
			20-30'			heavy dust, gray-white limestone with calcite veins (28-29½' is soft w/brown dust)	
			30-54'			heavy dust, med-dark gray limestone with some calcite veins	
			54-59'			no dust, dk gray limestone with white calcite veins	water at 54', tan at first, changes to lig gray.

B

WESTON

WELL LOG

Location

ORIGINAL (Red)

Page 1 of

Well No. MW-6 Drill Company Hardin-Huber Log By Sarah B Miller

Client Central Chemical Driller Dave Taylor Field Book No. 1

Job No. 3972-01-02 Date Began 4-26-89 End 4-27-89 Log Date 6-5-89

Drilling Method Air rotary / hammer Rig

Sampling Method [✓ No Samples]

Casing Size and Type 6" steel Screen Size Joint Type Pipe Length

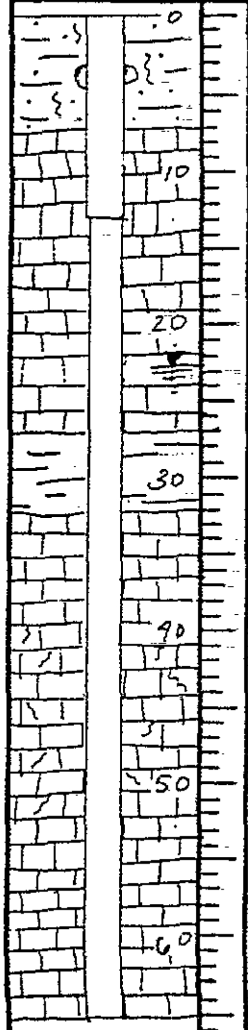
Type of Pack Type of Seal

Emplacement Method Emplacement Method

Interval Interval

Development Method air surge/submersible pump Gallons Removed 130+

Comments moisture found between 27 and 32' and fracture at 52' are sources of water in [illegible] TOC elevation = 618.98' stickup = 2.04'

Lithology and Well Construction	Depth	Sample No.	Interval	Recovery	Blow Counts	OVA	Description	Remarks
			0-7'				topsoil and gravel (fill) Small cavern at 3'	
			7-13'				dark gray limestone with white calcite veins, light brown dust	
			13-27'			0	soft light gray powdery limestone	
			27-32'				mud-filled void, brown silt and clay; moisture.	
			32-35'				soft (2 min/ft) limestone	
			35-40'				soft limestone, medium gray	
			40-52'				medium gray limestone with calcite veins	
			52-55'				medium gray limestone with veins	fracture at 52' produces ~.5gp
			55-65				medium gray limestone	
	TD= 65'							

WESTON

WELL LOG

Location

ORIGINAL (Red)

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Well No. MW-7 Drill Company Hardin-Huber Log By Sarah B. Miller

Client Central Chemical Driller Jeff Field Book No. 1

Job No 3972-01-02 Date Began 4-26-89 End 4-27-89 Log Date 6-6-89

Drilling Method Air rotary / hammer Rig

Sampling Method [✓ No Samples]

Casing Size and Type 6" steel Screen Size Joint Type Pipe Length

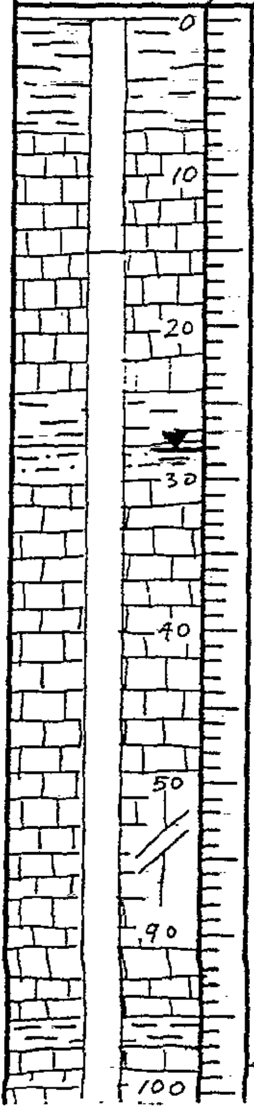
Type of Pack Type of Seal

Emplacement Method Emplacement Method

Interval Interval

Development Method air surge / submersible pump Gallons Removed 100+

Comments TOC elevation = 616.33' stickup = 1.63'

Lithology and Well Construction	Depth	Sample No.	Interval	Recovery	Blow Counts	OVA	Description	Remarks
			0-7'			0	red and light brown silty clay	
			7-12'			0	light → dark gray weathered limestone (soft from 7-10')	
			12-15'			0	hard gray limestone	
			15-24'			0	heavy gray-brown dust - no chips	
			24-27½'			0	mud-filled void - moist red clay with sand	
			27½-30'			0	light red brown silt, moist	
			30-40'			0	light-med. gray limestone, light brown dust	
			40-42'			0	moisture, no dust, no mist	
			42-60'			0	dusty light-med. gray limestone	
			60-70'			0	variable hardness, gray limestone, very dusty	
			70-85'			0	heavy dust, medium gray limestone	
			85-100'			0	moderate dust, medium gray limestone	
		TD= 100'					soft red mud from 95-97'	