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REMEDIAL ACTION INVESTIGATION

FORMER SOLVENT CHEMICAL CORPORATION SITE
NIAGARA FALLS, NY

RECRA RESEARCH, INC.
TOTAL CHEMICAL WASTE MANAGEMENT THROUGH APPLIED RESEARCH

P.O. Box 448 / Tonawanda, New York 14150

REMEDIAL ACTION INVESTIGATION

FORMER SOLVENT CHEMICAL CORPORATION SITE
NIAGARA FALLS, NY

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TOTAL CHEMICAL WASTE MANAGEMENT THROUGH APPLIED RESEARCH

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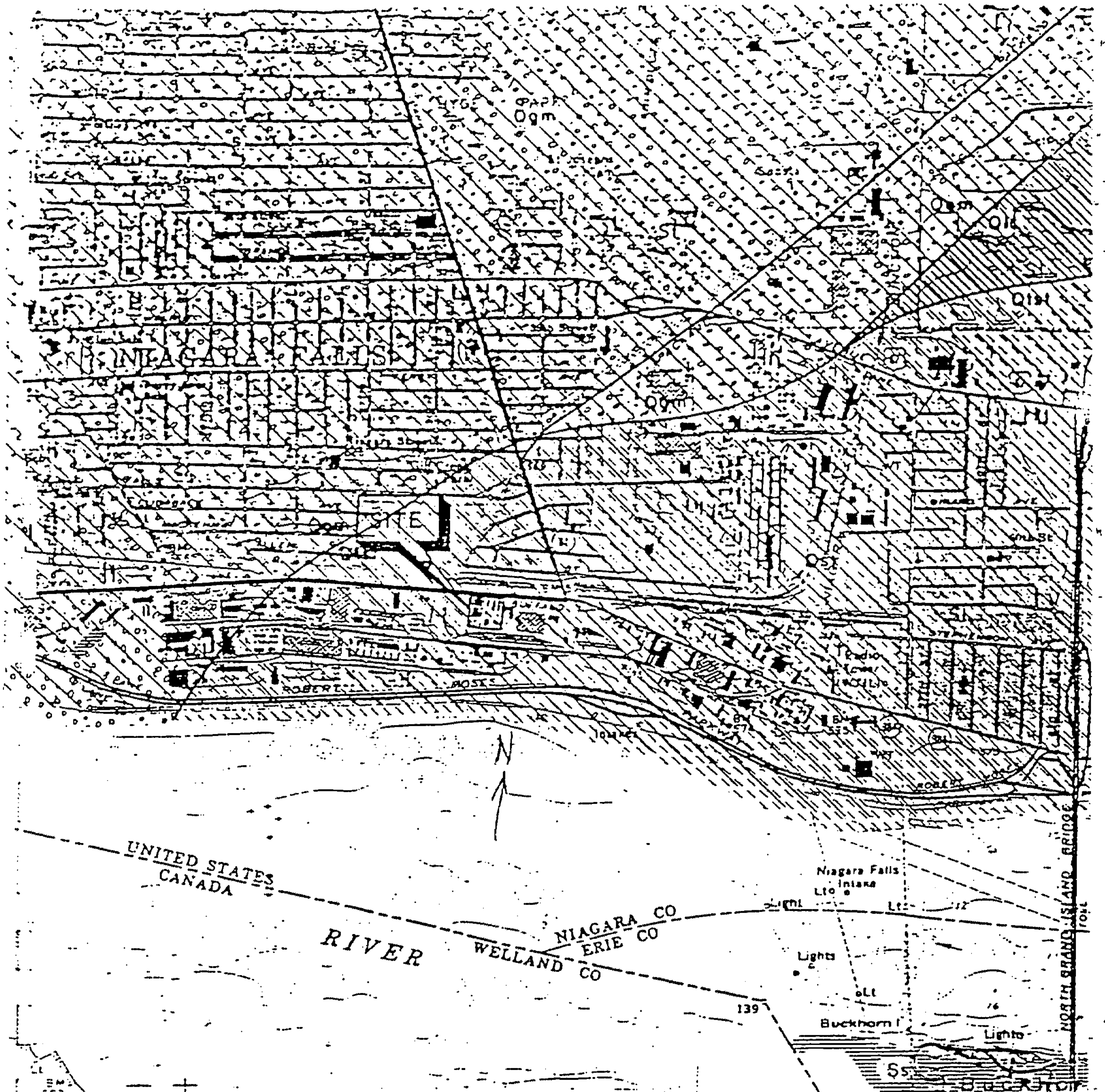
INTRODUCTION

This report presents the results of a hydrogeological investigation performed at the former Dover Chemical Corporation site. The Solvent Chemical Company, a subsidiary of Dover, operated the site from 1974 through 1978. This investigation has been conducted on behalf of Dover Chemical Corporation.

The Dover site is located on Buffalo Avenue in Niagara Falls, New York. The site occupies approximately five and one half acres on a roughly rectangular piece of property in a heavily industrialized area. The entire property has been developed and is occupied by buildings or is paved with asphalt or stoned surfaces. To the north, the site is bounded by Buffalo Avenue, to the east by a Dupont plant, to the south by a Conrail Right of Way and to the west by a vacant lot owned by Niagara-Mohawk Power Company. The site is approximately 1,000 feet north of the Niagara River and about 500 feet east of Gill Creek. It is relatively flat and at an elevation of approximately 569 feet above sea level. Figure 1 presents a map showing the location of the site.

The intent of this study is to expand on the work undertaken by Roy F. Weston, Inc. and to provide recommendations for remedial work to be performed, if deemed necessary.



SILURIAN	CAYUGA GROUP	Ss-SALINA FORMATION (GRAY MAGNESION SHALE WITH THIN BEDS OF DOLOMITE & GYPSUM)	
	NIAGARA GROUP	SI-LOCKPORT DOLOMITE (GRAY TO CHOCALATE-COLORED SACCHAROIDAL DOLOMITE WITH THIN CRINOIDAL NONMAGNESION LIMESTONE NEAR BASE)	

WISCONSIN STAGE OF PLEISTOCENE	DEPOSITS OF LAKE TONAWANDA	Olsl-LACUSTRINE SILT	
	DEPOSITS OF LAKE LUNDY	Olc-LACUSTRINE CLAY	
	GROUND MORAINE	Ogm-GLACIAL TILL	

NOTE: TAKEN FROM THE NIAGARA FA ONT.-N.Y. AND TONAWANDA WEST, N.Y. U.S.G.S. QUADRANGLES.

FIGURE 1
LOCATION MAP
OF THE
DOVER CHEMICAL SITE
NIAGARA FALLS, NEW YO

PURPOSE AND SCOPE

The purpose of this hydrogeological investigation was to explore, in greater detail than a previous study, the near surface geologic and ground water conditions at the former Dover Chemical site.

Specifically, the intent of this study has been to:

(1) define the geologic conditions within the site area;

(2) explore and define the ground-water conditions within the site area;

(3) develop the necessary maps of encountered geologic and ground-water conditions in order to permit an adequate and proper evaluation of site conditions;

(4) repair existing shallow wells to insure separation of the upper and lower water bearing zones; and

(5) present recommendations relevant to the design and operation of possible remedial measures.

In order to accomplish this, an exploration and well reconstruction program consisting of work described in the sections to follow, as well as a review of the existing data for this site has been completed. In addition, publications concerning the regional hydrogeologic conditions have been examined and are referenced.

FIELD INVESTIGATION

As part of the analysis for this confirmatory hydrogeologic investigation, a subsurface investigation was performed. The work consisted of reconstructing the six shallow piezometers that had been previously installed, excavating 14 exploratory test pits and installing two test wells in drilled boreholes. Piezometers were installed in each of the test pits and test wells in order to allow for the monitoring of ground-water levels in the unconfined water table. The four existing bedrock wells were used to monitor ground-water levels in the dolomite bedrock underlying the site. Locations of test pits and test borings performed for this investigation as well as borings performed during the previous investigation are shown on Sheet 1 of the drawings appendiced to this report.

Reconstruction of Piezometers

Wells B-1 through B-6 had previously been installed by the firm of Roy F. Weston in December of 1979. The piezometers that were installed at these locations were constructed in such a way that it was believed that they could act as conduits for movement of contaminated water from the upper water-bearing zone through the well annulus into the bedrock aquifer. The piezometers were constructed with their screened section situated within the suspected clay layer, and the gravel used to fill the well annulus extends from within two feet of the ground surface to the top of the encountered bedrock surface. It was decided that these piezometers should be removed, the borings grouted up to the top of the suspected clay, and the piezometers reinstalled on top of this layer. The original logs for these piezometers, constructed by Weston, are presented in the Appendix. The reconstruction work was performed by Empire Soils Investigations, Inc., Orchard Park, New York under the continuous direction and supervision of field geologists from Wehran Engineering.

At the location of Well B-1, the four inch diameter PVC casing and well screen were pulled, and the hole was reamed using a hollow stem auger to remove the gravel pack. The hole was backfilled with a Portland Cement and bentonite grout up to the top of the clay layer as indicated on the Weston logs. A 1-1/4 inch steel piezometer with a 1-1/4 x 24 inch Johnson "Redhead" well point was installed to the top of the clay. The peizometer was supported at the ground surface until the grout hardened. Sand pack was placed from the bottom of the well point to one foot above the screen and then the remaining portion of the hole was grouted to the surface.

At the location of Wells B-2 through B-6 it proved to be impossible to remove the in-place 4 inch PVC well screen from the hole. When the casing was pulled, it separated from the PVC screen, which remained in the bottom of the hole. At these wells, the screen was ground up by reaming the hole with the hollow stem auger. Also, the upper soils in these wells became unstable and would not maintain vertical sides. The entire hole was then backfilled with a Portland cement and bentonite grout. A new boring was then drilled adjacent to the existing well, with the hollow stem auger to the top of clay elevation (indicated on the Weston logs) and a new 1-1/4 inch steel piezometer was installed. These new wells were sand packed from the bottom of the well point to one foot above the screen. Cement and bentonite grout was then placed from the top of the sand pack to the ground surface.

Logs showing the reconstruction of all wells B1 through B6 are presented in the Appendix of this report.

Exploratory Test Pits and Test Wells

A total of 14 test pits were excavated and two test wells were installed to observe shallow subsurface conditions throughout the area of investigation. The test pits were excavated with a Case backhoe supplied through Recra Research, Inc. The test wells were installed with a hollow stem auger drill rig supplied by Empire Soils Investigations, Inc. All test pit excavations and test well installations were performed under the direct supervision of a field geologist from Wehran Engineering. The geologist selected the test pit and test well locations in the field, maintained a continuous log of the encountered conditions as the work proceeded, and collected the required type and number of soil samples.

Soils encountered were visually classified in the field. Representative bulk samples were obtained from the test pits and test wells as required. These specimens were sealed in moisture-tight jars for possible further examination and testing. All collected samples were returned to the office of Wehran Engineering where they were further examined. Personnel from Recra Research, Inc. were also present during the test well installations and test pit excavations and collected soil samples for chemical analysis.

In addition to the bulk jar samples collected in Test Pits 4 and 12, one undisturbed tube sample was extracted. In Test Pit 4 the tube sample was taken in the lacustrine clay and in Test Pit 12 within the Recent alluvial soil.

All test pits were excavated until the top of the lacustrine unit or other confining layer was encountered, until the backhoe was refused, or until the hole collapsed. The test pits provided for direct observation and logging of soil changes, elevations and rates of groundwater inflow, and stability during excavation.

In each test pit a 1-1/4 inch steel piezometer equipped with a 1-1/4 inch x 24 inch Johnson "Redhead" well point was installed. In test pits where the lacustrine clay, the glacial till, or the recent alluvium soil was partially penetrated, the soil was backfilled and compacted with the backhoe before installation of the piezometer. The remaining soil in the test pit was backfilled and compacted around the piezometer. Logs of the test pit excavations and piezometer construction are presented in the Appendix.

At two locations on the site it was impossible to excavate test pits where desired, due to access constraints. Instead, test wells were drilled by Empire Soils Investigations, Inc. Representative bulk samples were obtained from auger cuttings and sealed in moisture-tight glass jars for possible further examination and testing. Logs of the test wells are presented in the Appendix.

In each test well a 1-1/4 inch steel piezometer equipped with a 1-1/4 inch x 24 inch Johnson "Redhead" well point was installed. These piezometers were sandpacked from the bottom of the well point to one foot above the screen. Cement and bentonite grout was then emplaced up to the ground surface.

Previously Installed Bedrock Wells

Four bedrock wells were installed by Roy F. Weston, Inc. in December of 1979. These extend 23 feet into the bedrock and were used for the hydrogeologic assessment of the bedrock aquifer. The logs presented in the Weston report for the borings performed at these well locations and the drawings showing the "Monitoring Well Construction", are presented in the Appendix of this report.

GEOLOGY

In this section, the characteristics and extent of the materials encountered at the Dover Chemical site are described. In order to put the site into perspective within the larger geologic framework of the region, and to describe the geologic history that led to the formation of each strata, a brief discussion of the regional geology is presented. The discussion of the regional geology has been prepared from a search of the geologic literature on the area. The geology of the subject site is then described in detail based on the conditions encountered during the hydrogeologic investigation.

Regional Geology

The discussion of regional geology will be in the order in which the units were formed, with the oldest strata described first and succeedingly younger units following.

Figure 1 illustrates the regional bedrock and surficial geology as mapped by Kindle and Taylor (1914). The intent of this map is to provide an understanding of the general orientation and occurrence of the geologic formations in the area of the site. It indicates that the bedrock underlying the entire site and surrounding area is the Lockport Dolomite, which is Silurian in age. As its name implies, this formation is almost entirely dolomite, (a slightly soluble, calcium magnesium carbonate), except for a relatively thin section of limestone near the base of this 150-foot thick formation. The Lockport Dolomite, well known as the erosion-resistant rock that caps Niagara Falls and the Niagara Escarpment, appears to be flat-lying in area exposures, but actually dips at about 30 feet to the mile to the southwest, toward the Michigan Basin. It is characterized as hard, dark gray to chocolate-colored, saccharoidal (granular) dolomite containing small (commonly 1/2 inch to 5 inches in diameter) cavities, many of which are filled with gypsum. Thickness of individual beds ranges from thin: one inch to one foot, to thick: one foot to three feet (Johnston, 1964).

Glacial deposits overlie the bedrock in the area. The easily eroded residual soils and decomposed rock have been stripped away by the advancing glacial ice that deposited the glacial till.

It is recognized that during the Pleistocene Epoch at least four distinct ice invasions, separated by interglacial periods, occurred in North America. In the Niagara area there is considerable evidence of at least two invasions, although the remnants of the earlier glacial deposits, of inferred Kansan age, are few (Kindle and Taylor, 1914). It is clear that all deposits associated with glaciation on the Dover property were deposited during the Wisconsin Ice Age, the last of the ice ages during the Pleistocene Epoch.

The glacial till is a nonstratified mixture containing mostly sandy silt with boulders, pebbles, and some clay (Johnston, 1964). The till was deposited directly by the ice sheet and is composed of rock and soil materials which were quarried by the advancing ice, then ground up and "plastered down" beneath the ice. The till cover in the Niagara Falls area is generally less than 10 feet thick, and the poorly sorted nature of the till causes it to have a relatively low permeability (Johnston, 1964).

Following the slow retreat of the ice front to a position further north of Niagara Falls, "ponded" glacial meltwaters formed Lake Lundy (Kindle and Taylor, 1914). Figure 1 illustrates the area in which Lake Lundy clay is at the surface. Lake Lundy provided a large body of quiet water for the slow accumulation of laminated silts and clays, which are characteristically dense and compact, on top of the till. This silt and clay has been observed to have extremely low permeabilities (Johnston, 1964).

Further retreat of the ice front eventually opened up a lower spillway for Lake Lundy and the lake was drained, forming Lake Tonawanda south of the Niagara escarpment and Lake Iroquois to the north, on the Ontario Plain. The materials deposited in Lake Tonawanda have been described by Kindle and Taylor (1914) as predominantly silt, with varying amounts of fine sands and occasional clay layers. The area covered by Lake Tonawanda silt deposits is indicated on Figure 1.

Site Geology

Detailed descriptions of the material encountered on site, are presented on the boring and test pit logs in the Appendix of this report. The soil descriptions presented were developed based on visual examination, index testing, and grain size analysis. The descriptions are in accordance with the soil classification system developed by D.M. Burmister. An outline of the modified Burmister system used in this study is presented on the Key to Soils Identification, and the results of the laboratory tests are presented on the Grain-Size Distribution curves in the Appendix. Each of the strata are graphically depicted on the Geologic Cross-Sections presented with this report.

The general character, areal extent, and significance of each major geologic stratum will be discussed in the following sections. The strata will be described individually, in order of increasing depth.

<u>Fill</u>

Recent fill deposits containing a heterogeneous mixture of brown silt frequently mixed with black cinders, brick fragments, wood and miscellaneous rubble were encountered over most of the property. As can be seen on the geologic cross sections the fill has a maximum thickness of eight feet.

It appears that much of the study area represents what once was a marsh adjacent to the river and that it was probably filled for grading purposes. The result is that the site is some eight feet higher than it may have been in past times.

<u>Recent Alluvium</u>

This unit underlies the fill and is found at the ground surface where the fill is not present. The recent Alluvium is continuous and was found in all of the test pit logs. This unit has an average thickness of about four feet.

In general, the Recent Alluvium consists of dark grey to light brown and orange silt with varying amounts of clay and sand, and at Test Pit 12 consisted of silty sand. Generally, a six to twelve inch layer of highly organic soils and root matter was found to cap the Recent Alluvium. The consistency of the Recent alluvial soils was observed to range from soft to relatively dense depending on degree of water saturation. The saturated soils encountered below the water table tended to be the softer and were predominantly gray to dark gray in color.

The origin of the Recent Alluvium is somewhat difficult to determine as they do not fit the descriptions of the type of glacial deposits reported by Kindle and Taylor (1914), to be present in the site area. It is interpreted that these soils represent materials deposited by the Niagara River along a post-glacial erosional surface, possibly during times when the river level was higher or during flood stages. The soils may represent redeposited Tonawanda silts.

Regardless of origin, these soils are significant to the present study in that they provide some containment of, or at least inhibit, the flow of water from the upper water-bearing zone down to the underlying bedrock aquifer. The ability of these soils to provide containment of the upper water-bearing zone was indicated in the test pit excavations by the significant quantities of water trapped above them and from the grain size tests which indicate a high percentage of materials passing the No. 200 sieve. However, as indicated by the materials encountered in Test Pit 12, portions of this deposit may contain significant sand layers or pockets. This characteristic of the material is important because, for a portion of the site, these materials directly overlie the bedrock, and are the only naturally occurring layer which affords some hydrologic separation between the two water-bearing zones. As it became apparent that the Recent Alluvium was acting as the only confining layer over portions of the site, full penetration of this material was avoided.

Lacustrine Clay

Below the Recent Alluvium, lacustrine clays were encountered in Test Pits 1 and 4 at the northern end of the site. The lacustrine clay encountered in Test Pit No. 4 is believed to have a thickness of two feet, based on attempted tube sampling. In Test Pit No. 1, one and one half feet of the lacustrine clay was penetrated without reaching its lower limit. Full penetration of this material was avoided because of its utility as a confining layer over the portions of the site where it was encountered.

In general, the lacustrine clays encountered consisted of laminated red-brown, stiff silty clay. In Test Pit 1, occasional gray filled joints were observed. Based on observations of the test pits excavated during this investigation, it is apparent that the extent of the lacustrine clay layer is limited to the extreme northeastern portion of the site. It is our interpretation that the lacustrine clay which may have been deposited on the remainder of the site during the last glacial period was removed by erosion prior to deposition of the now present Recent Alluvium. The limited extent of the lacustrine clay under the site area will cause this relatively impermeable material to have little significance as a confining medium in the site ground-water system.

Glacial Till

Underlying the lacustrine clay (where present), and otherwise underlying the Recent Alluvium, glacial till was encountered throughout the northern half of the site. In Test Pit 9 the glacial till was encountered at a depth of 8.0 feet and refusal, believed to represent bedrock, was reached at a depth of 8.5 feet. In all other test pits where the surface of the glacial till was penetrated, excavations of 1.5 to 4.5 feet into the till were accomplished without reaching refusal or the base of the till. Based on the conditions encountered in the test pits, the occurrence of glacial till appears limited to the northern half of the subject site. However, it is possible that along the eastern portion of the site, where the depth of the test pit excavations were relatively shallow, the glacial till may be present at greater depths.

In general, the glacial till consisted of dense red-brown clayey silt, with some sand and varying amounts of gravel and cobbles. The thickness of the glacial till on site is uncertain, as it was not fully penetrated by any of the test pits performed during this investigation (except for Test Pit 9).

The poorly sorted nature of the glacial till soils generally cause them to have relatively low permeabilities (Johnston, 1964). However, the limited extent of these materials within the site area lessens their significance as confining stratum.

Bedrock

Bedrock was encountered in all of the previously performed borings and in some of the test pits excavated during this investigation. However, it was penetrated only by the deep borings performed by Weston. The logs for these borings mention only that the bedrock encountered was dolomite.

It is believed that this bedrock represents the Lockport Formation of upper Silurian age. The Lockport typically is a massively bedded dolomite with concentrated zones of thin bedding and fracturing. Minor solutioning of this unit is also typical.

The Lockport Dolomite is the most important aquifer in the Niagara Falls region. The uppermost portion of the unit that was penetrated is reported by Johnston (1964) to serve as a water-bearing zone. It is significant to this study as being a point of concern in the protection of the regional ground-water system from impact.

Discussion of Permeability

Based on laboratory grain-size analyses, a search of the pertinent literature, and previous experience with the soils of the Niagara Falls area, the unconsolidated materials encountered on the site can be expected to vary considerably in their ability to transmit water. For instance, experience indicates that permeability of the glacial till is likely to range from approximately 10^{-6} cm/sec to 10^{-7} cm/sec, which would allow this unit to act as a confining horizon. However, subsurface exploration indicated that this unit exists only along the northern half of the site, reducing its significance as a major confining layer. Similarly, an anticipated permeability for the lacustrine clay of 10^{-7} to 10^{-8} would enable this unit to serve as a confining horizon. However, due to its limited areal extent, it is insignificant as a confining layer.

As a consequence of its widespread distribution on the site the Recent Alluvium serves as the major semi-confining layer, separating the shallow unconfined water-bearing zone from the Lockport Dolomite. The permeability of this stratum, based on laboratory grain-size analyses, is likely to range from 10^{-5} cm/sec to 10^{-7} cm/sec with the potential for higher values in isolated, sandy zones (e.g., TP-12, S-1). An undisturbed sample of this unit was taken for laboratory permeability determinations. However, due to the contamination present in the soil the cost was prohibitive in light of existing budget constraints. Testing, therefore, was limited to grain-size analysis and index testing to determine the material character as related to permeability.

The shallow unconfined aquifer is present to some extent within and above the Recent Alluvium within the fill materials. The heterogeneous nature of these fill materials results in considerable variation, both horizontally and vertically, in the permeability of this unit. However, for the purposes of this discussion an average permeability was estimated to be on the order of 10^{-3} cm/sec.

Permeabilities of the bedrock aquifer were determined from data collected during our stepped pumping tests at Wells 3A and 4A. Based on the data collected, the permeability of the bedrock aquifer could range from 5.9×10^{-4} cm/sec (12.5gpd/ft^2) to 2.8×10^{-2} cm/sec (593.2gpd/ft^2) at Well 3A and could be in excess of 4.6×10^{-1}cm/sec (7,500gpd/ft^2) at Well 4A. Further discussion of the bedrock aquifer permeability is presented with results of the Step-Drawdown Test.

Ground Water Occurrence

Ground water within the area of the subject site was observed to occur within two water-bearing zones:

(1) A shallow unconfined water table above the Recent Alluvium deposits; and

(2) An unconfined aquifer within the upper 23 feet of the encountered bedrock.

The only ground water encountered on the site, that is believed to be recoverable on a regional scale, is that contained within the bedrock aquifer. The occurrence of ground water in the shallow water bearing zone is the result of water becoming trapped in the loose fills that are present above the Recent Alluvium. The water held within the interstices of the lacustrine clay, glacial till, and Recent Alluvium confining or semi-confining beds is less subject to movement.

As previously discussed, piezometers were installed in all test pits, test wells and repaired wells during this investigation. Ground-water levels in these piezometers, as well as in the previously installed rock wells, have been monitored throughout the course of our study. The elevations of ground water levels obtained from the piezometers are presented on Table 1. Ground water level elevations obtained from well readings performed on September 18, 1980, are shown on the Boring, Test Pit and Well Location Plan and the Geologic Cross-Sections.

Shallow Water-Bearing Zone

In the area under investigation, ground water occurs as an unconfined water table above the Recent Alluvium. This does not

TABLE 1
GROUND WATER ELEVATIONS
DOVER CHEMICAL

DATE OF READINGS:			*	*	7/30/80	8/6/80	8/14/80	9/18/80
Piezometer Number	Ground Surface Elev. (ft.)	Top of Casing Elev. (ft.)	Ground-Water Elevations (ft.)					
TP-1	568.59	571.96	-	-	dry	563.66	dry	dry
TP-2	568.81	572.28	-	-	565.11	565.88	565.36	564.95
TP-3	568.56	571.58	-	-	566.12	567.23	566.16	566.08
TP-4	568.69	570.01	-	-	562.09	563.31	562.43	561.85
TP-5	568.64	571.58	-	-	564.70	565.33	564.66	563.08
TP-6	568.62	570.89	-	-	564.85	565.24	565.10	564.97
TP-7	568.56	569.90	-	-	564.86	565.05	564.65	565.07
TP-8	568.14	569.42	-	-	565.50	565.82	565.59	566.09
TP-9	568.60	573.27	-	-	dry	564.57	563.77	dry
TP-10	568.97	572.82	-	-	564.19	565.87	565.24	564.47
TP-11	568.50	572.76	-	-	565.55	566.11	565.64	565.43
TP-12	568.12	570.19	-	-	566.02	566.34	566.23	565.81
TP-13	568.47	573.48	-	-	566.19	566.53	566.27	566.15
TP-14	568.42	572.53	-	-	566.07	566.43	565.45	565.20**
TW-1	568.36	570.56	-	-	565.35	562.21	565.39	565.27
TW-2	568.50	570.49	-	-	563.66	564.09	563.91	562.32
B-1	568.92	571.13	560.91	562.11	562.63	562.33	562.88	562.46
B-1A	568.83	569.67	553.90	553.90	dry	dry	dry	dry**
B-2	568.52	570.71	564.63	565.09	566.17	566.61	566.29	566.21
B-2A	568.82	569.39	552.82	552.85	547.81	550.39	547.89	551.56
B-3	568.55	571.42	567.17	567.54	566.13	567.32	566.63	566.00
B-3A	568.00	570.27	559.10	559.31	559.98	560.07	560.06	558.87
B-4	567.68	569.65	566.52	566.81	565.36	565.80	565.53	565.15
B-4A	567.68	570.54	559.56	559.42	558.00	557.74	558.00	588.23**
B-5	567.15	569.74	566.00	566.74	564.70	565.79	564.70	565.24
B-6	567.45	568.46	565.23	565.69	565.46	565.91	565.54	565.56

* Water level elevations by Weston, no dates given.

** Water level elevations recorded 9/19/80 represent a regional water table system, which is reported to be of limited occurrence and extent in the Niagara Falls area (Johnston, 1964). However, it should be realized that this shallow ground water system occurs in the loose fill and highly organic soils which overlie the Recent Alluvium stratum, and that such soils within and beyond the site limits are believed to be in hydrologic communication. Recharge of ground water within these materials in the general area of the site occurs naturally as the result of percolating meteoric water which becomes trapped and accumulates in the fill above the less permeable Recent Alluvium.

In addition to the naturally occuring recharge, it has been reported that the site water supply system is experiencing a water loss on the order of 30,000 to 40,000 gallons per day on a regular basis. This water loss would represent a major portion of the recharge to the shallow water-bearing zone within the site proper. This volume of water would also act as an additional driving force, aiding in the dispersal of water from the shallow zone both horizontally and vertically. Therefore, water introduced to the ground water system by subsurface leakage becomes a significant factor in controlling movement of ground water beyond the site limits.

Factors such as obstruction to flow by subsurface structures (i.e. building foundations) can measurably affect the observed ground water table configuration. Furthermore, the fill materials exposed in the test pits exhibited significant permeability contrasts due to their heterogeneous nature. This would result in anisotropic conditions within the saturated zone which was very apparent in several test where high ground water flows were observed from isolated zones i: fill materials. Hence, the ground water table configuration acro: site is believed to be more complex than that which could be devel the existing data.

Some general observations which can be made from the data pre are that recharge to the system from off-site sources seems to ori: from the southeast. In addition, the relatively shallow ground-wa: levels observed in the west-central portion of the site could be a manifestation of recharge by subsurface leakage in the water supply system. Elimination of this recharge could change, and possibly simplify, the presently observed ground water levels.

Examination of the ground water level elevations reveal an app: northward flow direction on the northern and eastern portions of th site. However, the encountered geologic formations on the northern of the site and along the northern limit do not favor ground water f beyond the northern site limits. This apparent flow direction is mo likely due to the backing up of ground water around the recharge mou located in the west central portion of the site. If anything, the northern limit of the site seems more likely to represent the shore : of the observed ground water basin, as the fill materials which accommodate the shallow water bearing zone thin out or are absent. Horizontal ground water flow off site probably occurs in a westerly direction as indicated by the ground water levels in the southwestern portion of the site. At the same time, because of the lack of a significant confining layer under the southwestern quarter to the southern half of the site, vertical discharge of ground waters from the shallow zone down to the lower bedrock aquifer probably accounts for a major portion of ground water discharge from the shallow zone.

Comparison of the vertical hydraulic gradient to the very slight horizontal hydraulic gradient illustrated reveals that a much greater driving force is exerted on ground water moving in a downward/vertical direction. For example, at the location of Wells 3 and 3A, the hydraulic gradient between the shallow ground water table and the lower bedrock aquifer is about 1.86. In comparison, the hydraulic gradient across the surface of the shallow water bearing zone based on a comparison of ground water level elevations at Well B-3 and Well B-5 is only about 0.34. Also the cross-sectional area available for vertical migration is much greater than that available for horizontal migration. So even with a two order of magnitude difference in the permeability between the saturated fill soils and the underlying semi-confining Recent Alluvium soils, the volume of ground water discharge in the vertical direction probably will exceed the discharge in the horizontal direction.

In addition to obstructing horizontal ground water flow, foundations installed for buildings and other structures may promote downward/vertical movement of waters from the shallow water bearing zone. This would be true if the foundation penetrated the relatively soft soils which make up Recent Alluvium in order to obtain the required bearing capacity. Such penetration or possible excavation of the Recent Alluvium for foundation installation would further reduce the ability of the alluvium to act as a confining layer.

The existing site sewer system seems to have little effect on the movement of ground water in the shallow zone. This is because during our investigation the invert and water level elevations obtained in the manholes were, in many cases, well above the observed ground water level. Elevations observed of the manhole inverts and the water levels are presented on Table 2 and on the Geologic Cross-Sections. Rather than providing for discharge from the ground water system they may, in most cases, provide recharge to the system.

Unconfined Bedrock Aquifer

The areal extent and nature of the bedrock aquifer is of major interest to the evaluation of the ground water resources beneath the subject site. It represents the uppermost water bearing formation of regional significance and is considered to be the major point of concern in terms of contaminant dispersal.

The bedrock aquifer discussed in this report was encountered through boreholes which penetrated the upper 22 feet of the Lockport Dolomite. The ground water contained in the upper portions of the bedrock throughout the region is generally confined by the overlying glacial till and lacustrine clay deposits and to a somewhat lesser degree by the underlying relatively unfractured bedrock, as suggested by Johnston (1964). However, as in the case of this site, unconfined conditions may occur.

It is reported by Johnston (1964) that a series of confined aquifers are contained within the Lockport Dolomite. Each of the

TABLE 2

UTILITY LINE ELEVATIONS

DOVER CHEMICAL
9/19/80

Utility Line #	Invert Elevation (ft.)	Water Elevation (ft.)
YD-1	568.68	Dry
YD-2	567.29	567.49
MH-1	563.55	563.69
MH-2	562.95	566.74
MH-3	565.14	Dry
MH-4	559.22	560.38
MH-5	562.92	566.28
MH-6	559.66*	Dry
MH-7	566.46	566.71
Sump	–	569.22
Monitoring Station	559.34	559.49

* Elevation shown represents the upper surface of soil which has apparently accumulated in the MH and is not believed to be the true invert elevation.

Confined aquifers is separated by sections of rock, with little vertical fracturing. Vertical movement between these aquifers is believed to be limited because the vertical fractures which exist are relatively tight and do not permit any significant ground water flow through them. Ground water flow in the Lockport is predominantly along near-horizontal bedding plane joints which have become widened by solutioning. The uppermost aquifer, of concern to this investigation, is generally contained in a fractured zone which extends 10 to 15 feet below the bedrock surface. In this aquifer, ground water flow occurs readily along both horizontal and vertical joints.

The discussions of bedrock aquifers specific to this site are based on data collected from wells previously installed by Roy F. Weston during December 1979. During our investigation of the site, two of these wells were found to be either not conducive to data collection or no data could be obtained.

Specifically, Well No. 1A would not permit entry below 22 feet and water was not encountered to that depth. Well No. 2A contains water cascading from an apparent fractured zone at a depth of approximately 16 feet below the top of the casing to the lower reaches of the well. This condition makes it difficult to obtain accurate readings of the static ground-water level (if one exists). It also would indicate that ground water level readings from this well are of an intermediate static ground water level between an upper and a lower water bearing zone in the bedrock. This intermediate ground water level would not be compatible with ground water levels obtained from the other site bedrock wells which seem to represent different hydrologic conditions. The remaining bedrock wells, 3A and 4A, permitted observation of apparently undisturbed static ground water levels.

Given the fact that reliable data on the bedrock aquifer during this investigation was limited to only two wells, it was not possible to construct a ground water contour map. It is therefore necessary to utilize the piezometric map prepared by Weston to approximate the flow direction in the bedrock aquifer. A copy of the study, "PIEZOMETRIC SURFACE, 12/18/79, BEDROCK AQUIFER" as presented by Roy F. Weston, March 1980, is presented in the Appendix. The data present in Weston's report indicated that the encountered bedrock aquifer flows from the southwest to the northeast across the site area.

Data collected during this investigation from Wells 3A and 4A are in general agreement with the direction of ground water flow presented by Weston. The observed flow direction indicates that discharge of ground waters in the bedrock aquifer is occurring northeast of the site, away from the Niagara River. This flow direction and discharge may be due to industrial pumping in the area. Given the observed flow direction and comparison of the observed ground water Elevations +558.87 and +558.23, in Wells 3A and 4A respectively, with water levels in the Niagara River, (which based on U.S.G.S. map should be around Elevation +561 feet), it appears that recharge to the bedrock aquifer in this area is supplied by the river. Also, although the shallow and bedrock water bearing zones are separated by the semi-confining layer of Recent Alluvium, the observed difference in hydrologic head between these two zones will permit recharge to the bedrock aquifer from the shallow zone.

The significant difference in water levels of the four bedrock piezometers and the drastically different response to pumping at Wells 3A and 4A during the Step-Drawdown Test (to be discussed in detail in the following sections), serve to illustrate the complexity of ground water movement through the upper bedrock underlying the site. These observations indicate that ground water flow in the upper bedrock is strongly anisotropic. Conditions which apparently existed during the investigation by Weston certainly did not exist during our study of this area. Therefore, use of the ground water contour map of the bedrock aquifer presented by Weston, for interpreting ground water movement across the site, must be limited to providing only a hint as to what the actual flow system may be. Furthermore, prediction of the hydraulic properties for the bedrock aquifer or range of variations of such, from one point to another within the site area, is not possible with the data available.

Step-Drawdown Test of the Upper Lockport Dolomite

On September 18 and 19, 1980 step-drawdown pump tests were conducted on Wells 3A and 4A, in an attempt to determine several of the bedrock aquifer parameters. These parameters include: 1) the specific capacity of the pumping wells; 2) the amount of drawdown likely to be encountered at various pumping rates; and 3) aquifer tramissibility and permeability. Knowledge of these parameters is essential to understanding the hydrogeology of the site, and can be utilized in accepting or rejecting various remedial measures that might be considered.

Procedure

The step-drawdown test entails pumping of the aquifer at progressively increased discharge rates, while measurements of the drawdown within the well are taken. For a given discharge, the rate of drawdown will decrease with time, eventually reaching a quasi-equilibrium level. At this point, the discharge is increased and drawdown is measured until, once again, a quasi-equilibrium drawdown is achieved.

Limiting factors encountered during the course of this test included the narrow diameter of the existing boreholes (≤3") which precluded the use of a submersible pump, and limited the test to the relatively low discharge rates (≤35gpm) available when using a centrifugal pump. The latter was of particular significance in the testing of Well 4A, in which pumping at a rate of 35 gpm for several hours resulted in insignificant drawdown within the well.

Well 3A

Well 3A is located along the southern perimeter of the site. The initial water level in this well was 8.17 feet below the top of the casing (9/18/80). During the morning of 9/18/80, after initial pumping to determine discharge rates, the water level was measured at 8.82 feet. At 1:46 P.M., 9/18/80 Step #1 was begun at a discharge rate of 5 gpm, and was continued for a total of twenty minutes, at which time the drawdown had stabilized at about 0.42 feet.

For Step #2 the discharge was increased to 20gpm, and an initial surge of light brown, foaming liquid was observed. This surge was accompanied by an additional 0.54 feet of drawdown within the first two minutes of pumping. Step #2 was continued for a total of 105 minutes, at which time the total drawdown had stabilized at 4.02 feet.

Step #3 was conducted at a discharge rate of 25-27 gpm. The initial increase of the discharge rate resulted in an additional 0.23 feet of drawdown within the first three minutes of Step #3. Pumping was continued for 103 minutes with a total drawdown of 5.02 feet. The cone of influence created during pumping of this well did not extend radially outward a distance great enough for it to be observed in Well 4A. At 5:18 P.M. pumping ended and the well was allowed to recover. After 56 minutes the well had recovered 3.90 feet of the drawdown; at 861 minutes the recovery was 4.65 feet.

Well 4A

Well 4A is located along the western perimeter of the site, near the southwestern corner of the Dover Chemical property. The water level at the beginning of the test was 10.54 feet below the top of casing (9:27 A.M. 9/19/80). The well was pumped at an initial rate of 10gpm, for 21 minutes, at which time drawdown had stabilized at 0.17 feet.

For Step #2, the discharge rate was increased to 20 gpm. After 56 minutes of pumping, the drawdown had increased by 0.06 feet to 0.23 feet and remained stable at that level. For Step #3, the discharge was increased to 30 gpm, the limit of the centrifugal pump in use. After 51 minutes of pumping, the drawdown had increased by only 0.02 feet at which time the test was concluded.

Results

The results of any pump test must be evaluated with caution, for their analysis is based on a number of assumptions. A few of the more important assumptions, which are often not satisfied in the field, include: 1) the aquifer must be homogeneous, isotropic, and of infinite lateral extent; 2) the well must fully penetrate the aquifer, and 3) flow within the aquifer must be laminar.

Bearing in mind such limitations, the results of the analysis can be summarized as follows:

Well 3A

Specific Capacity	2.5 - 15 gpm/ft of drawdown for Q = 5 gpm to 27 gpm
Transmissivity	250 gpd/ft to 12,000 gpd/ft (assuming a storage coefficient of 0.30 to 0.001, Johnson 1964)
Hydraulic Conductivity	5.9×10^{-4} cm/s (12.5gpd/ft^2) to 2.8×10^{-2} cm/s (593.2gpd/ft^2) assuming aquifer thickness of 20 feet.

Well 4A

Specific Capacity	>74 gpm/ft of drawdown
Transmissivity	>150,000 gpd/ft
Hydraulic Conductivity (Permeability)	$>3.5 \times 10^{-1}$ cm/s (75,000 gpd/ft^2)

The results for Well 3A are consistent with values summarized by Johnston (1964). Well 4A, however, yields values significantly greater than reported for the Lockport Dolomite. This may be due to: 1) location of well on or adjacent to a zone of increased fracture density and/or solutioning; 2) location of well near source of reported 30,000-

40,000 gpd water loss on the Dover Chemical site (the actual location of the water main leak was not known at the time of this report) or 3) location of well in direct, hydraulic connection with the Niagara River. It is interpreted that, given the assumptions these analyses are based on and the wide range in results obtained, such results are only suitable for making a general comparison between conditions which exist at the two well locations.

The results of these tests further illustrate the great diversity of hydrologic conditions which exist in the bedrock aquifer within the site limits. From a practical viewpoint, the complex flow system in the Lockport Dolomite at this site will hinder development and construction at any remedial measure directed toward amelioration of contamination in the aquifer.

WATER QUALITY

In order to evaluate water quality and the extent of contamination at the Dover site, a soil and groundwater sampling program was undertaken. This program entailed the analysis of waters collected from on-site sewers; groundw in the shallow and deep water bearing zone discussed in the geologic section c this report; and subsurface soil samples.

Sampling Program

Personnel

The surface and groundwater sampling program involved the collection of w and soil samples from manholes, test pits, and test wells and water samples fr monitoring wells on the Dover site by Recra Research, Inc. personnel. Water a sediment samples from the sewer manholes were collected on July 21, 1980. Soi samples were obtained from the test pits and test wells when they were constru on July 22 and 23, 1980. Water samples from the test pits, test wells and mon wells were collected on July 30 and 31 and August 1, 1980. All samples for ch analysis were taken to Recra Research, Inc. laboratories in Tonawanda, New Yor

Sample points

The locations of the sampling points are presented on Sheet 1 of the plan drawings. The six PVC monitoring wells installed by Roy F. Weston were recons by Wehran Engineering using 1 1/4 inch diameter galvanized steel. On Sheet 1, are designated by the letter "B" followed by an identifier number. In the analytical data tables and this portion of the report, these wells have been designated by the letter "W" followed by an identifier number. The four bedro wells constructed by Roy F. Weston are identified as B-1A through B-4A on Shee and W-1A through W-4A in the analytical data tables and in this section of the report. Samples taken from the test pits are identified by the letters "TP" followed by a number, while those from the test wells are designated by the letters "TW" followed by a number. The test pits and test screened in the shallow water-bearing zone and differ only construction. The sampling information is presented in the is included as an appendix to this document.

In this investigation, fourteen test pits and two test and equipped with piezometers to permit water level measurem previously installed shallow monitoring wells were reconstru monitoring points, which included the four bedrock wells, wa but three wells were collected and analyzed as part of the gr program. No samples could be obtained from TP1, TP9, or W-1A

As previously mentioned, water and sediment samples from analyzed. These samples were obtained from five manholes. T designated as MH-1 through MH-5 on Figure 2.

Soil samples were collected from each test pit and one of (TW-2) during the excavation and drilling operations. The soi taken to Recra Research's laboratories in Tonawanda for analys samples were obtained as shown in Table 3.

Sampling Procedures

Prior to sampling groundwaters, all monitoring points were pumping. Where possible, this involved evacuation and recharge If the sample points could not be evacuated, a minimum of three was removed prior to sampling to guarantee a representative sam were pumped with an ISCO Model 1580 Sampler equipped with teflo To avoid cross-contamination, separate sampling lines were used sample.

FIGURE 2 – MANHOLE LOCATIONS

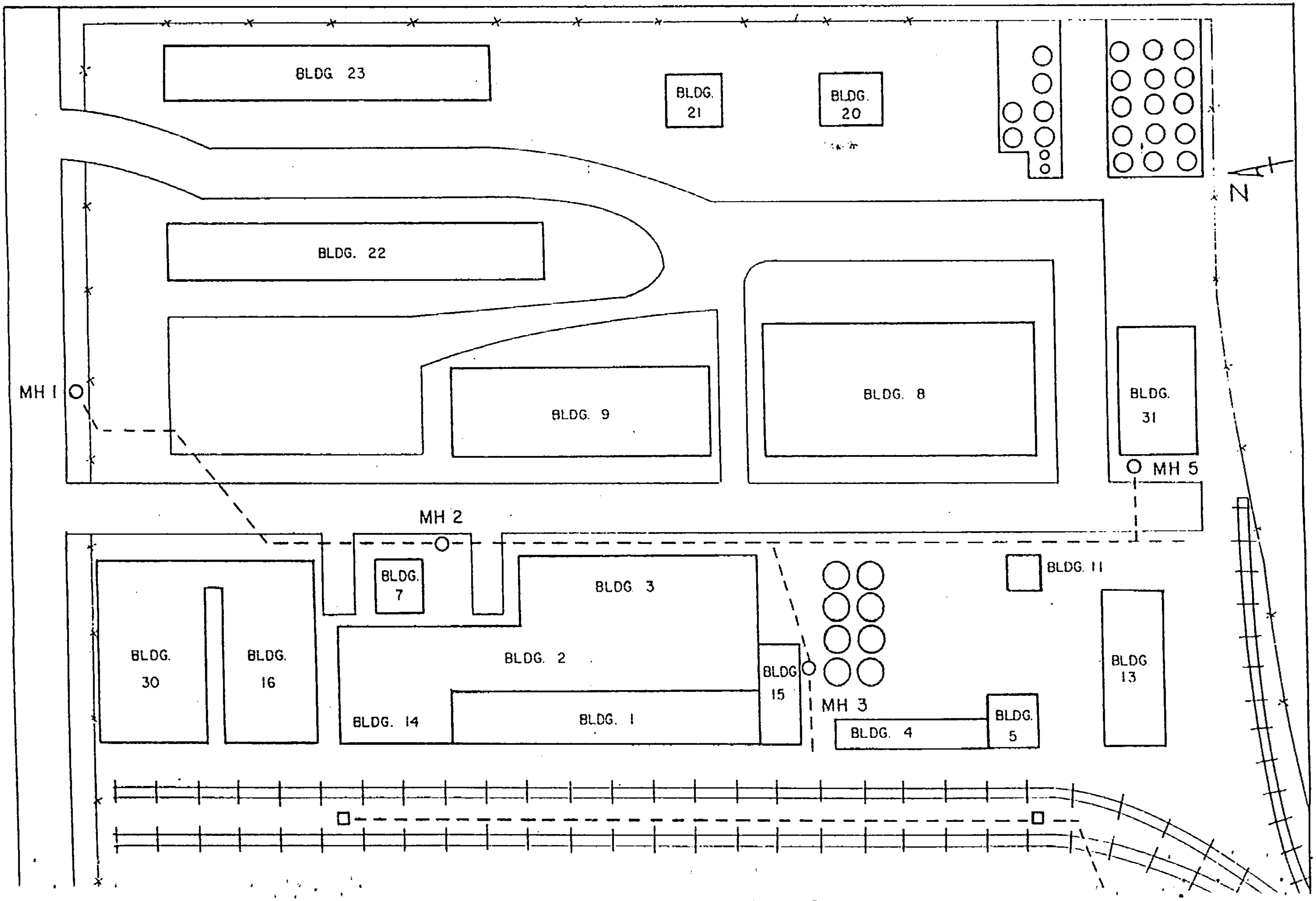


TABLE 3

TEST PITS - DOVER CHEMICAL - SEDIMENT COLLECTIONS

TEST PITS	DEPTHS	COMMENTS
TP 1	1' 7'	Benzene or chlorobenzene odor was detectible to one degree or another in every test pit on t property. The degree of contamination seemed to grade from North (least) to South (most). The southern most test pits such as TP 13, TP 1 TP 8, TP 12, etc. required the use of a respirator by the field technicians when sampling. TW-1 and TW-2 were augered because of their close proximity to buildings that were in use. It was decided that the backhoe would cause too much damage to sidewalks and foads.
TP 2	1' 7.5'	
TP 3	1' 4' 8.9'	
TP 4	1' 8'	
TP 5	1 4.5' 8'	
TP 6	4' 7.5'	
TP 7	4' 8'	
TP 8	1' 4'	
TP 9	6' 8.5'	
TP 10	3' 6'	
TP 11	2' 5'	
TP 12	3' 5'	
TP 13	1' 4.5'	
TP 14	2' 4' 6'	
TW 2	2' 4'	augered test pit
TW 1	No samples collected	

WATER QUALITY

Sampling Procedures (continued)

Sewer water samples were grab samples collected with an ISCO peristaltic pump. Where sufficient depth permitted, samples were collected approximately six to eight inches below the water surface. Sediments in the storm sewer were sampl using a Ponar grab sampler.

Water samples were collected in both plastic and glass bottles that had been scrupulously cleaned and rinsed. In addition to cleaning, bottles were rinsed three times with the sample prior to collection. All bottles contained foil or teflon-lined caps. Water samples for volatile organic analyses were collected in teflon faced septa sealed vials. Soil samples were placed in clean glass sample jars with foil or teflon-lined caps.

Analytical Program

Parameters

Groundwater samples from the deep wells (W2A, W3A, W4A) and the reconstructec shallow wells (W1-W6) were analyzed for the following parameters:

pH
Conductance
Total Organic Carbon
Ammonia
Chlorides
Zinc
Ortho dichlorobenzene
Meta dichlorobenzene
Para dichlorobenzene
1,2,3,-trichlorobenzene
1,2,4,-trichlorobenzene
1,3,5,-trichlorobenzene
Monochlorobenzene
Benzene

The test pits (TP2-TP8, TP10-TP14), test wells (TW-1 and TW-2), and the sewer (MH1-MH5) water samples were analyzed for pH; conductance; total organic carbon; and ortho-, meta- and para dichlorobenzene. The leachates from the test pit soils were analyzed for the same parameters as the test pit water samples, with the exception of total organic carbon. The test pit soils and sewer sediment samples were analyzed for ortho-, meta-, and para dichlorobenzene, only.

Analytical Methods

Procedures utilized were in accordance with one or more of the following reference texts:

1. Standard Methods for the Examination of Water and Wastewater, 14th Edition, APHA, AWWA, WPCF.
2. Methods for Chemical Analysis of Water and Wastes, United States Environmen Protection Agency.
3. Water Standards of the American Society for Testing and Materials (ASTM).
4. Manual of Analytical Methods for the Analysis of Pesticide Residues in Human and Environmental Samples, U.S.E.P.A., 1974.

The New York State leaching potential test procedure was utilized for the soil sample analysis.

Analytical Results

Analytical results for ground and surface waters are summarized in Tables 4 through 7. Soil and sediment data are given in Tables 8 through 10.

TABLE 4

ANALYTICAL RESULTS

DOVER CHEMICAL CORPORATION
BUFFALO AVE. REMEDIAL ACTION

Report Date: 9/9/80
Samples Received: 7/30/80 - 8/1/80

TEST PIT PIEZOMETERS

SAMPLE IDENTIFICATION	PARAMETER (UNITS OF MEASURE)		
	pH (STANDARD UNITS)	CONDUCTANCE (μmhos/cm)	TOTAL ORGANIC CARBON (mg/l)
TP2	7.53	2,640	23
TP3	7.31	3,300	28
TP4	7.70	1,030	6.0
TP5	7.12	1,290	32
TP6	7.15	4,190	160
TP7	7.15	4,440	170
TP8	6.75	4,440	40
TP10	7.52	2,030	74
TP11	7.12	3,780	35
TP12	7.81	13,900	350
TP13	7.18	3,460	51
TP14	6.04	12,900	130

(Continued)

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TABLE 4 (Cont'd.)

ANALYTICAL RESULTS

DOVER CHEMICAL CORPORATION
BUFFALO AVE. REMEDIAL ACTION

Report Date: 9/9/80
Samples Received: 7/30/80 - 8/1/80

TEST PIT PIEZOMETERS

SAMPLE IDENTIFICATION	PARAMETER (UNITS OF MEASURE)		
	ORTHO-DICHLOROBENZENE 1,2 (µg/l)	META-DICHLOROBENZENE 1,3 (µg/l)	PARA-DICHLOROBENZENE 1,4 (µg/l)
TP2	32	17	21
TP3	1,700	18	460
TP4	210	<5	150
TP5	1,900	180	230
TP6	19	9	<5
TP7	11,000	670	3,100
TP8	40,000	2,300	5,100
TP10	1,500	<5	760
TP11	480,000	<100	250,000
TP12	16,000	6,000	23,000
TP13	48,000	2,600	8,200
TP14	21,000	<100	5,800

COMMENTS: Comments pertain to data on all pages of this report. Samples were collected by Recra personnel during the period from 7/21/80 - 8/5/80.

FOR RECRA RESEARCH, INC. [signature]

DATE 9/10/80

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TABLE 5

ANALYTICAL RESULTS

DOVER CHEMICAL CORPORATION
BUFFALO AVE. REMEDIAL ACTION

Report Date: 9/9/80
Samples Received: 7/30/80 - 8/1/80

TEST WELLS

PARAMETER	UNITS OF MEASURE	SAMPLE IDENTIFICATION TW-1	TW-2
pH	Standard Units	8.17	6.70
Conductance	μmhos/cm	3,060	2,300
Total Organic Carbon	mg/l	26	28
ortho-dichlorobenzene	μg/l	31	5.9
meta-dichlorobenzene	μg/l	7.4	40
para-dichlorobenzene	μg/l	17	65

COMMENTS: Organic Carbon analyses may not include volatile organics since the sample is purged with an inert gas prior to analysis.

FOR RECRA RESEARCH, INC. R. V. Fin[illegible]

DATE 9/10/80

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I.D. #723

TABLE 6

ANALYTICAL RESULTS

DOVER CHEMICAL CORPORATION
BUFFALO AVE. REMEDIAL ACTION

Report Date: 9/9/80
Samples Received: 7/30/80 - 8/5/80

SHALLOW AND DEEP WELLS

PARAMETER	UNITS OF MEASURE	SAMPLE IDENTIFICATION				
		W-1	W-2	W-2A	W-3	W-3A
pH	Standard Units	12.41	7.35	7.06	7.51	7.54
Conductance	µmhos/cm	8,400	1,500	5,000	2,490	2,230
Total Organic Carbon	mg/l	51	36	29	53	28
Ammonia	mg N/l	3.6	8.9	2.2	2.0	5.4
Chloride	mg/l	64	210	1,200	230	380
Total Zinc	mg/l	6.3	42	0.040	6.7	0.047
ortho-dichlorobenzene	µg/l	87	79	1,500	2,700	2,900
meta-dichlorobenzene	µg/l	18	11	290	2,000	860
para-dichlorobenzene	µg/l	65	40	410	5,800	2,700
1,2,3-trichlorobenzene	µg/l	5	<2	150	52	180
1,2,4-trichlorobenzene	µg/l	19	14	900	150	570
1,3,5-trichlorobenzene	µg/l	<5	<10	<80	<10	<90
monochlorobenzene	µg/l	4,000	3,900	12,000	110,000	22,000
benzene	µg/l	4,800	4,500	3,300	58,000	5,700

(Continued)

RECRA RESEARCH, INC.
I.D.#723

TABLE 6 (Cont'd.)

ANALYTICAL RESULTS

DOVER CHEMICAL CORPORATION
BUFFALO AVE. REMEDIAL ACTION

Report Date: 9/9/80
Samples Received: 7/30/80 - 8/5/80

SHALLOW AND DEEP WELLS

PARAMETER	UNITS OF MEASURE	SAMPLE IDENTIFICATION			
		W-4	W-4A	W-5	W-6
pH	Standard Units	6.80	6.88	7.86	6.64
Conductance	μmhos/cm	5,500	2,740	7,400	8,000
Total Organic Carbon	mg/l	38	35	850	38
Ammonia	mg N/l	15	4.0	13	240
Chloride	mg/l	1,800	480	1,900	2,600
Total Zinc	mg/l	22	4.5	20	230
ortho-dichlorobenzene	μg/l	260,000	16,000	31,000	1,400
meta-dichlorobenzene	μg/l	27,000	2,700	9,600	420
para-dichlorobenzene	μg/l	87,000	7,400	74,000	650
1,2,3-trichlorobenzene	μg/l	10,000	410	1,500	69
1,2,4-trichlorobenzene	μg/l	67,000	1,700	8,000	690
1,3,5-trichlorobenzene	μg/l	<10	<80	<800	<40
monochlorobenzene	μg/l	4,100	54,000	110,000	1,200
benzene	μg/l	1,600	41,000	170,000	3,600

COMMENTS: Results of analyses for specific organic compounds are based upon retention time matches between standard and sample chromatograms. Confirmational analysis has not been performed.

FOR RECRA RESEARCH, INC. R. V. Finn

DATE 9/10/80

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TABLE 7

ANALYTICAL RESULTS

DOVER CHEMICAL CORPORATION
BUFFALO AVE. REMEDIAL ACTION

Report Date: 9/9/80
Samples Received: 7/21/80

MANHOLE - WATER SAMPLES

PARAMETER	UNITS OF MEASURE	SAMPLE IDENTIFICATION				
		MH-1	MH-2	MH-3	MH-4	MH-5
pH	Standard Units	7.02	5.46	6.95	7.10	7.31
Conductance	μmhos/cm	488	4,200	3,710	2,100	336
Total Organic Carbon	mg/l	19	45	47	16	11
ortho-dichlorobenzene	μg/l	89	8,700	28,000	6,300	380
meta-dichlorobenzene	μg/l	96	1,400	<200	<10	110
para-dichlorobenzene	μg/l	48	4,600	29,000	8,700	320

COMMENTS: Values reported as "less than" (<) indicate the working detection limit for the particular sample or parameter.

FOR RECRA RESEARCH, INC. R. V. Finn

DATE 9/10/80

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I.D. #723

TABLE 8

ANALYTICAL RESULTS

DOVER CHEMICAL CORPORATION
BUFFALO AVE. REMEDIAL ACTION

Report Date: 9/9/80
Samples Received: 7/21/80

MANHOLE - SLUDGES

PARAMETER	UNITS OF MEASURE	SAMPLE IDENTIFICATION MH-1	MH-2	MH-3	MH-4	MH-5
Dry Weight	% dry	37.2	60.3	72.4	16.5	68.0
ortho-dichlorobenzene	µg/g dry	74,000	72,000	23,000	390,000	21,000
meta-dichlorobenzene	µg/g dry	30,000	11,000	1,600	24,000	4,300
para-dichlorobenzene	µg/g dry	47,000	43,000	29,000	130,000	16,000

COMMENTS: All analyses were performed according to U. S. Environmental Protection Agency methodologies where applicable.

FOR RECRA RESEARCH, INC. R. V. Finn

DATE 9/10/80

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I.D. #723

TABLE 9

ANALYTICAL RESULTS

DOVER CHEMICAL CORPORATION
BUFFALO AVE. REMEDIAL ACTION

Report Date: 9/9/80
Samples Received: 7/30/80

TEST PIT SOILS

SAMPLE IDENTIFICATION	PARAMETER (UNITS OF MEASURE)			
	ORTHO-DICHLOROBENZENE (μg/g DRY)	META-DICHLOROBENZENE (μg/g DRY)	PARA-DICHLOROBENZENE (μg/g DRY)	% DRY
TP1-1'	–	–	–	–
TP1-7'	<0.5	<0.6	2.7	82.9
TP2-1'	1.4	2.0	<0.5	77.0
TP2-7.5'	0.6	<0.5	<0.5	85.8
TP3-1'	<0.5	<0.5	1.7	81.2
TP3-4'	30	1.9	7.4	70.9
TP3-8'-9'	4.4	<0.7	5.4	76.2
TP4-1'	<0.5	<0.5	0.6	92.3
TP4-8'	0.6	<0.5	<0.5	73.7
TP5-1'	4.5	1.6	<0.5	91.7
TP5-4.5'	<0.5	<0.5	<0.5	84.9
TP5-8'	<0.5	<0.5	<0.5	90.1
TP6-4'	<0.5	<0.5	1.3	78.9
TP6-7.5'	<0.5	<0.5	<0.5	82.1
TP7-4'	190	6.8	7.7	80.2
TP7-8'	13	2.8	4.7	73.5
TP8-1'	<0.5	<0.5	<0.5	92.2
TP8-4'	850	74	48	78.1

(Continued)

RECRA RESEARCH, INC.
I.D. #723

TABLE 9 (Cont'd.)

ANALYTICAL RESULTS

DOVER CHEMICAL CORPORATION
BUFFALO AVE. REMEDIAL ACTION

Report Date: 9/9/80
Samples Received: 7/30/80

TEST PIT SOILS

SAMPLE IDENTIFICATION	PARAMETER (UNITS OF MEASURE)			
	ORTHO-DICHLOROBENZENE (μg/g DRY)	META-DICHLOROBENZENE (μg/g DRY)	PARA-DICHLOROBENZENE (μg/g DRY)	% DRY
TP9-6'	<0.5	<0.7	<0.5	81.3
TP9-8.5'	8.1	7.1	4.6	83.7
TP10-3'	0.9	<0.6	1.3	80.0
TP10-6'	<0.5	<0.6	<0.5	87.4
TP11-2'	11	19	15	85.9
TP11-5'	370	<1	160	72.8
TP12-3'	200	170	240	67.7
TP12-5'	120	24	92	67.5
TP13-1'	8,500	3,400	2,000	88.1
TP13-4.5'	840	67	170	67.0
TP14-2'	1.6	41	42	85.0
TP14-4'	1,100	98	320	67.6
TP14-6'	100	11	20	80.8
TW2-2'	66	9.8	12	84.9
TW2-4'	<0.5	<0.5	1.0	86.1

COMMENTS: Sample labeled TP1-1' consisted of three rocks, analysis was therefore inappropriate.

FOR RECRA RESEARCH, INC. R. V. Firm

DATE 9/10/80

RECRA RESEARCH, INC.
I.D.#723

TABLE 10

ANALYTICAL RESULTS

DOVER CHEMICAL CORPORATION
BUFFALO AVE. REMEDIAL ACTION

Report Date: 9/9/80
Samples Received: 8/4/80 - 8/18/8

TEST PIT SOIL LEACHATES

SAMPLE IDENTIFICATION	PARAMETER (UNITS OF MEASURE)	
	pH (STANDARD UNITS)	CONDUCTANCE (µmhos/cm)
TP1-1'	9.84	308
TP1-7'	7.90	228
TP2-1'	7.90	2,150
TP2-7.5'	8.23	283
TP3-1'	7.52	1,160
TP3-4'	7.07	699
TP3-8'-9'	7.31	555
TP4-1'	7.89	164
TP4-8'	8.01	235
TP5-1'	8.81	560
TP5-4.5'	8.36	197
TP5-8'	7.45	181
TP6-4'	7.77	1,250
TP6-7.5'	7.81	720
TP7-4'	7.67	2,410
TP7-8'	4.55	579
TP8-1'	8.13	281
TP8-4'	6.65	425

(Continued)

RECRA RESEARCH, INC.
I.D. #723

TABLE 10 (Cont'd.)

ANALYTICAL RESULTS

DOVER CHEMICAL CORPORATION
BUFFALO AVE. REMEDIAL ACTION

Report Date: 9/9/80
Samples Received: 8/4/80 - 8/18/80

TEST PIT SOIL LEACHATES

SAMPLE IDENTIFICATION	PARAMETER (UNITS OF MEASURE)	
	pH (STANDARD UNITS)	CONDUCTANCE (µmhos/cm)
TP9-6'	7.42	415
TP9-8.5'	7.66	349
TP10-3'	8.08	345
TP10-6'	7.76	365
TP11-2'	7.24	250
TP11-5'	7.06	1,470
TP12-3'	7.16	3,050
TP12-5'	7.33	2,150
TP13-1'	7.64	2,490
TP13-4.5'	7.25	3,610
TP14-2'	7.79	680
TP14-4'	7.22	1,350
TP14-6'	5.55	860
TW2-2'	9.71	395
TW2-4'	7.84	292

(Continued)

RECRA RESEARCH, INC.
I.D.#723

TABLE 10 (Cont'd.)

ANALYTICAL RESULTS

DOVER CHEMICAL CORPORATION
BUFFALO AVE. REMEDIAL ACTION

Report Date: 9/9/80
Samples Received: 8/4/80 - 8/18/80

TEST PIT SOIL LEACHATES

SAMPLE IDENTIFICATION	PARAMETER (UNITS OF MEASURE)		
	ORTHO-DICHLOROBENZENE (μg/l)	META-DICHLOROBENZENE (μg/l)	PARA-DICHLOROBENZENE (μg/l)
TP1-1'	<2	<2	<2
TP1-7'	<2	<2	<2
TP2-1'	≤2	<1	<1
TP2-7.5'	<2	<1	<1
TP3-1'	2.9	<1	<1
TP3-4'	<2	<2	<2
TP3-8'-9'	<2	<1	<1
TP4-1'	<2	<3	<3
TP4-8'	<2	<3	<3
TP5-1'	<2	<2	<2
TP5-4.5'	<2	<1	<1
TP5-8'	<2	<1	<1
TP6-4'	12	<1	<1
TP6-7.5'	≤2	<2	<2
TP7-4'	<2	<1	<1
TP7-8'	7.3	<2	<2
TP8-1'	<2	<2	<2
TP8-4'	810	57	88

(Continued)

RECRA RESEARCH, INC.
I.D. #723

TABLE 10 (Cont'd.)

ANALYTICAL RESULTS

DOVER CHEMICAL CORPORATION
BUFFALO AVE. REMEDIAL ACTION

Report Date: 9/9/80
Samples Received: 8/4/80 - 8/18/80

TEST PIT SOIL LEACHATES

SAMPLE IDENTIFICATION	PARAMETER (UNITS OF MEASURE)		
	ORTHO-DICHLOROBENZENE (µg/l)	META-DICHLOROBENZENE (µg/l)	PARA-DICHLOROBENZENE (µg/l)
TP9-6'	4.2	<2	<2
TP9-8.5'	<2	<1	<1
TP10-3'	2.8	<2	<2
TP10-6'	<2	<1	<1
TP11-2'	≤2	<1	<1
TP11-5'	23	<5	10
TP12-3'	1,200	160	640
TP12-5'	260	63	<40
TP13-1'	6,700	<5	1,100
TP13-4.5'	6,200	210	810
TP14-2'	≤2	≤1	<1
TP14-4'	7,000	280	1,300
TP14-6'	2,600	220	430
TW2-2'	<2	<2	<2
TW2-4'	<2	<2	<2

COMMENTS: The test pit soils listed in Table VI were subjected to the NYS-DEC leaching potential test. The resulting leachates were analyzed for the requested parameters and results are presented in Table VII of this data report.

In many samples where the dichlorobenzenes (only) was requested, there were indications of significant levels of trichlorobenzenes even though the dichlorobenzenes were below the detection limit of the method.

Values reported as "less than or equal to" (≤) indicate that the particular compound may be present at trace levels relative to the detection limits reported.

FOR RECRA RESEARCH, INC. R. V. Finn

DATE 9/10/80

RECRA RESEARCH, INC.
I.D. #723

WATER QUALITY

Groundwater Quality in Lockport Dolomite

Wells W-2A, 3A, and 4A were constructed to sample the upper Lockport Dol and provide an indication of the quality of groundwater in the bedrock underl the site. However, as pointed out in the geologic section of this report, grc water flow in the bedrock beneath the site is complex. The investigation of t hydrogeologic conditions conducted to date, has not allowed all components of groundwater flow to be delineated. Until the movement of water in the bedrock is defined, the potential extent and impacts of the constituents of interest ca be completely evaluated.

Evaluation of groundwater quality is made more difficult by the absence of wells in areas upgradient to the site and the method of construction of the shal monitoring wells used in an earlier study. Although the results of geologic investigation and water sample analysis indicate the fill layer and bedrock aquifers may be hydraulicly connected, other sources and mechanisms of chemical migration cannot be ruled out, due to the limited data available. For example, some of the constituents detected beneath the site may be derived from off-site sources. Also, as mentioned elsewhere in this report, constituents from the fill layer on the Dover site may have migrated vertically downward along the annulus of the shallow monitoring wells and into the bedrock.

The levels of certain chemical constituents detected during this investigation may represent, at least in part, contaminants which migrated downward along the annulus of the shallow wells. If this migration did occur, there may be a localization of contamination around, and downgradient from, these wells. Therefore the quality of groundwater determined through the analysis of samples from wells W-2A, 3A, and 4A may not be representative of conditions in all portions of the bedrock aquifer beneath the Dover site.

The evaluation is further complicated by the fact that W-2A is a "cascading well, as discussed in the geologic section of this report. Since the cause of this phenomenon is uncertain, the actual aquifer being sampled cannot be accurately determined. Therefore, the samples taken from W2A may not be completely representative of bedrock groundwater quality in the eastern portion of the site. Due to all these considerations, the results of this phase of the study may be only giving an indication of the quality of groundwater in the Lockport Dolomite. Conditions beneath other portions of the site, especially those sections not directly downgradient from any of these wells may be different from what these data tend to suggest.

Of the parameters analyzed in this investigation, New York State Groundwater Quality Standards (6NYCRR 703) have been established for zinc, chloride, benzene, and ortho- and para dichlorobenzene. The levels of zinc detected in samples from wells W-2A, 3A, and 4A were within the limits set by the standards; both in water samples analyzed by Roy F. Weston in a previous study (see Table 11) and in those measured by Recra Research in this investigation. The standards for the other parameters were exceeded in all bedrock groundwater samples analyzed. However, even though the levels of chlorides exceeded the standards, the chloride concentrations measured are not unusual for groundwater in the Lockport Dolomite, as illustrated in Table 12.

The bedrock aquifer around wells W-2A, 3A, and 4A appears to be contaminated with benzene and chlorinated benzenes. The highest measured levels of benzene, monochlorobenzene, dichlorobenzenes, and trichlorobenzenes were identified at W-4A, in the southwest portion of the site. On the other hand, the lowest measured concentrations of benzene, monochlorobenzene and dichlorobenzenes were found at W-2A on the eastern side of the site. The lowest values for trichlorobenzene were detected at W-3A.

Table 11
Roy F. Weston (March, 1980)
DATA SUMMARY SHEET

Sample Description	Specific Conductance (micromos/sec)	TDS	NH_3N	TOC	Zn	Cl	Benzene	Monochloro Benzene	Dichloro Benzene	Trichloro Benzene
W1	910	539	8.4	15	0.07	56.7	.0316	<.100	<.100 .17	<.100 0.024
1A	2600	1581	19.6	27	<0.02	336.	0.700	.33	8.096 —	1.59 —
W2	1600	1106	12.6	20	0.17	150	0.594	<.100	<.100 .130	<.100 0.014
2A Bedrock	4100	2349	25.2	39	0.16	647	0.816	4.27	19.537 2.2	6.027 1.05
W3	4100	2374	11.2	161	1.71	261	0.310	8.373	11.126 10.5	0.072 2.02
3A Bedrock	3100	1716	12.6	80	0.19	457	1.264	6.957	14.596 6.46	3.555 0.750
W4	>5000	3660	33.6	28	0.22	3873	0.140	14.36	24.975 374.0	3.04 77.0
4A Bedrock	4300	2359	15.4	83	0.76	2365	4.005	7.936	19.46 26.1	8.52 2.86
W5	1450	751	12.6	78	0.18	240	<0.01	5.746	23.286 114.6	1.427 9.5
W6	>5000	5320	238	41	160	5993	0.956	.780	17.98 2.47	6.100 0.759

"A" Series - Bedrock Wells

All figures - milligrams per liter (Mg/L)

Table 12

WATER QUALITY DATA FOR THE
LOCKPORT DOLOMITE (Reck & Simmons, 1952)

PARAMENTER	AVERAGE VALUE	MAXIMUM	MINIMUM	NO. OF TESTS
Iron (mg/l)	3.3	16	.03	5
Sulfate (mg/l)	524	1320	87	7
Chloride (mg/l)	606	1200	18	6
Total Dissolved Solids (mg/l)	1490	3230	299	6
Total Hardness	858	2180	120	7

WATER QUALITY

Groundwater Quality in Lockport Dolomite (continued)

Based upon the analytical results of groundwater quality in the Lockport Dolomite as determined by Roy F. Weston and Recra Research, no definite statements can be made relative to any temporal changes which may or may not have occurred in the time span between the two studies. The data does indicate the possibility of changes (both increases and decreases) for specific parameters at various well locations. These results may also indicate, however, the differing rates of migration for chlorinated organics in soil/groundwater systems (Griffin and Chau, 1980).

The analytical results indicate contamination of the bedrock aquifer is occurring, at least in the area of these three wells. The construction and monitoring of additional bedrock wells would be needed to evaluate the magnitude, areal extent, and migration of the contamination.

Groundwater Quality in the Shallow Water Table

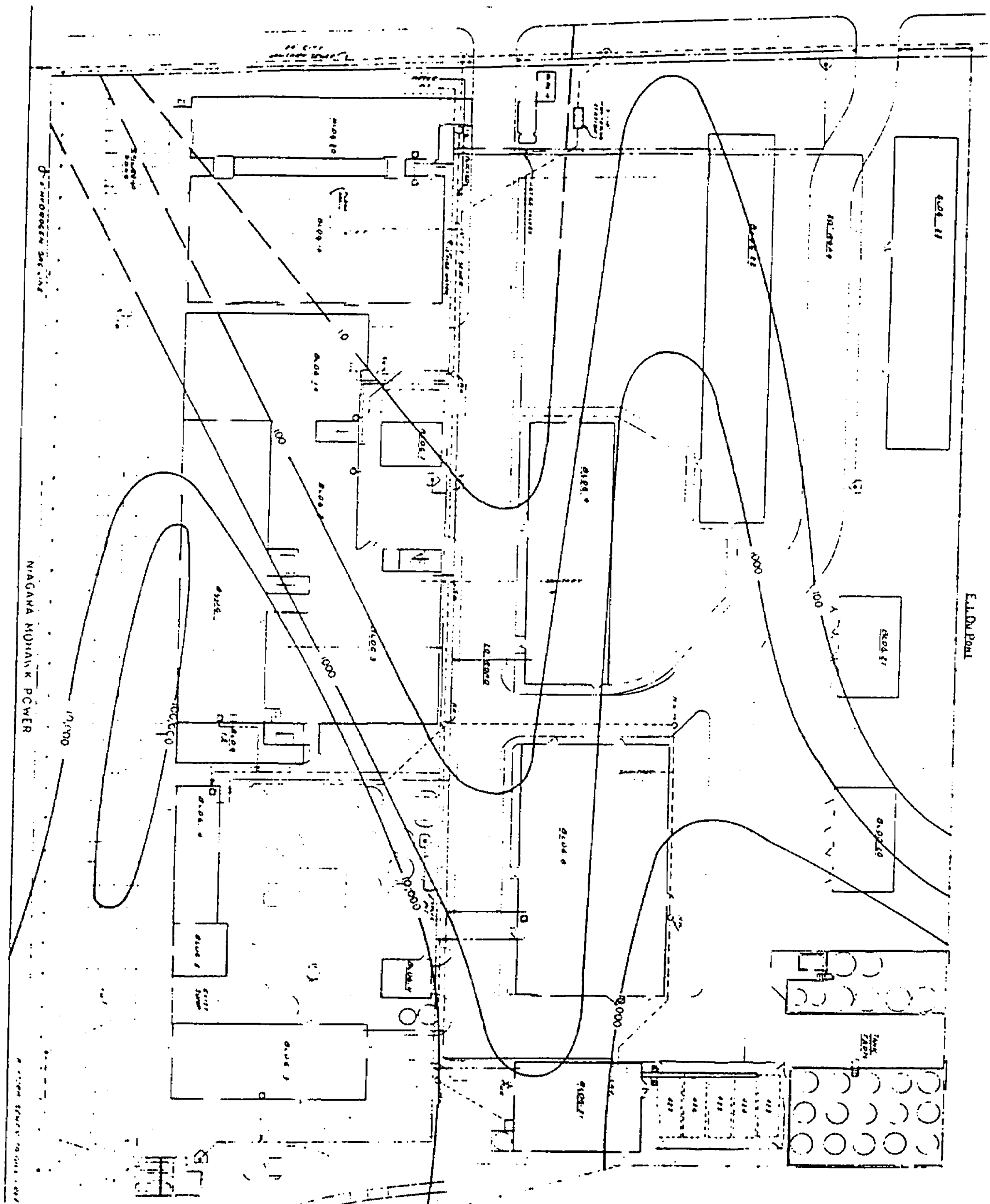
Water samples collected from piezometers placed in the test pits (TP1-TP14); test wells (TW1 and TW2) constructed by Wehran Engineering; and the shallow wells originally constructed by Roy F. Weston and reconstructed by Wehran Engineering (W1-W6) were used to evaluate groundwater quality in the shallow water-bearing zone. Results of the laboratory analysis of water samples performed by Recra Research are presented in Tables 4 and 5. The analytical results of samples taken by Roy F. Weston in their previous investigation using wells W1 through W6 are given in Table 11. The concentrations of zinc, chloride, benzene, and ortho- and para dichlorobenzene in the samples analyzed by Recra Research exceed the groundwater quality standards established by New York State (6NYCRR 703).

Parameter concentration contours interpolated from the analysis of water samples are presented in Figures 3 and 8. As these figures illustrate, a consistent trend of contamination exists in the shallow water-bearing zone. For the parameters of conductivity, total organic carbon, and the isomers of dichlorobenzene, the greatest concentrations are, in general, found in the southwest and southeast sections of the site. The concentration levels decrease in a distinctive pattern towards the northern and central portions of the site. Benzene, monochlorobenzene, and the isomers of trichlorobenzene appear to display similar distribution patterns. However, these parameters were not measured in all of the water samples, and this limited data base makes it difficult to delineate specific trends for these compounds.

These findings are similar to those reported in the Roy F. Weston study. Given the hydrogeologic characteristics of the site in general and the southwest section in particular, the concentrations of these constituents of interest in the southwest and southeast portions of the site pose a potential for contamination of the bedrock aquifer. As discussed in the geologic section of this report, a consideration of hydraulic gradients indicates that the magnitude of the vertical migration of groundwater from the fill into the bedrock is potentially as large as the horizontal flow in the fill. Also, the absence of confining beds, other than the Recent alluvium, to retard vertical migration beneath the southwestern portion of the site increases the potential for the degradation of the bedrock aquifer. The levels of certain parameters measured in the bedrock wells indicates that this vertical migration may be occurring.

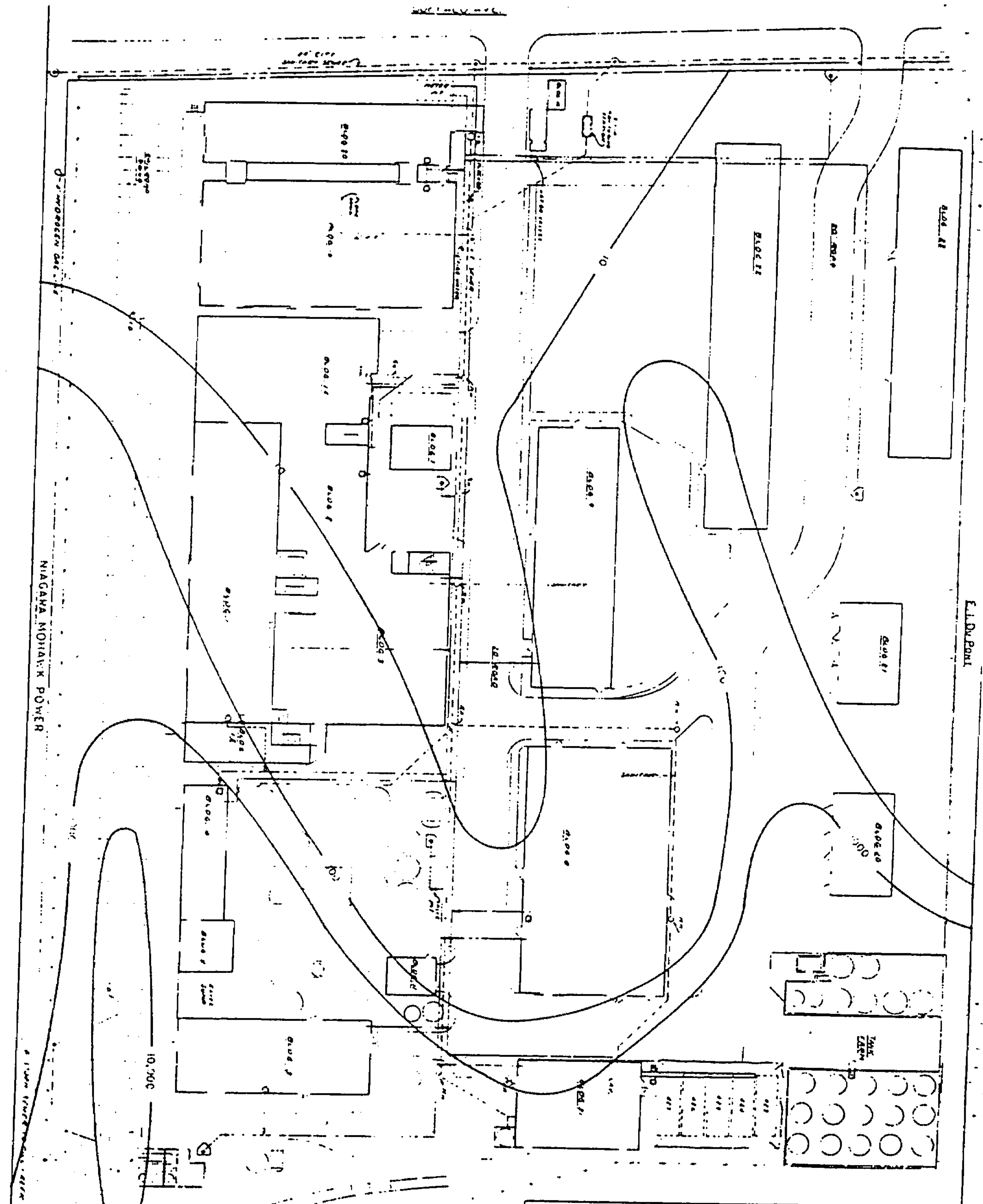
Besides the constituents discussed above, three other parameters were measured in groundwater samples collected from the reconstructed wells (W1-W6). These parameters were zinc, ammonia, and chloride. As was found in the Roy F. Weston study, the highest concentrations for these three parameters were detected at well W-6.

Values of pH ranged from 6.04 at TP-14 and 6.64 at W-6 to 12.41 at W-1.



DOVER CHEMICAL CORPORATION HYDROGEOLOGIC INVESTIGATION		
BUFFALO AVE SITE	NIAGARA FALLS, NEW YORK	
Figure 3 (µg/l)	DRAWN BY MJF	DATE NOV 1980
	CHECKED BY JEB	SCALE NONE
	APPROVED BY	
	o-DICHLOROBENZENE CONCENTRATIONS SHALLOW WATER BEARING ZONE	

NOTE BASE MAP TAKEN FROM R.B MacMULLIN DRWG NO. E-7146-57



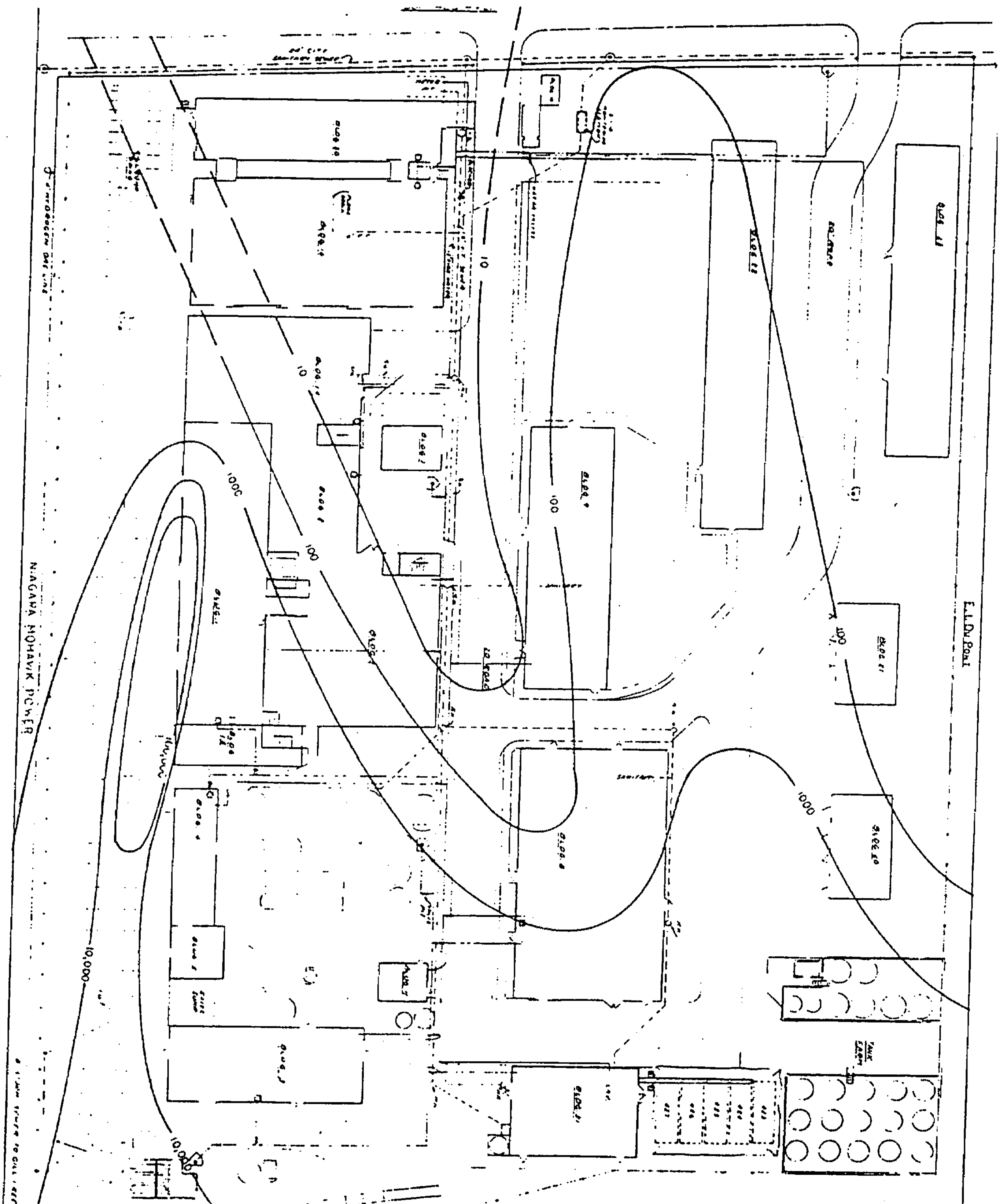
DOVER CHEMICAL CORPORATION
HYDROGEOLOGIC INVESTIGATION

BUFFALO AVE SITE — NIAGARA FALLS, NEW YORK

Figure 4 (ug/l)	DRAWN BY MJF	DATE NOV 1980
	CHECKED BY JEB	SCALE NONE
	APPROVED BY	

m-DICHLOROBENZENE CONCENTRATIONS
SHALLOW WATER BEARING ZONE

NOTE BASE MAP TAKEN FROM R.B. MacMULLIN DRWG NO E-7-46-10



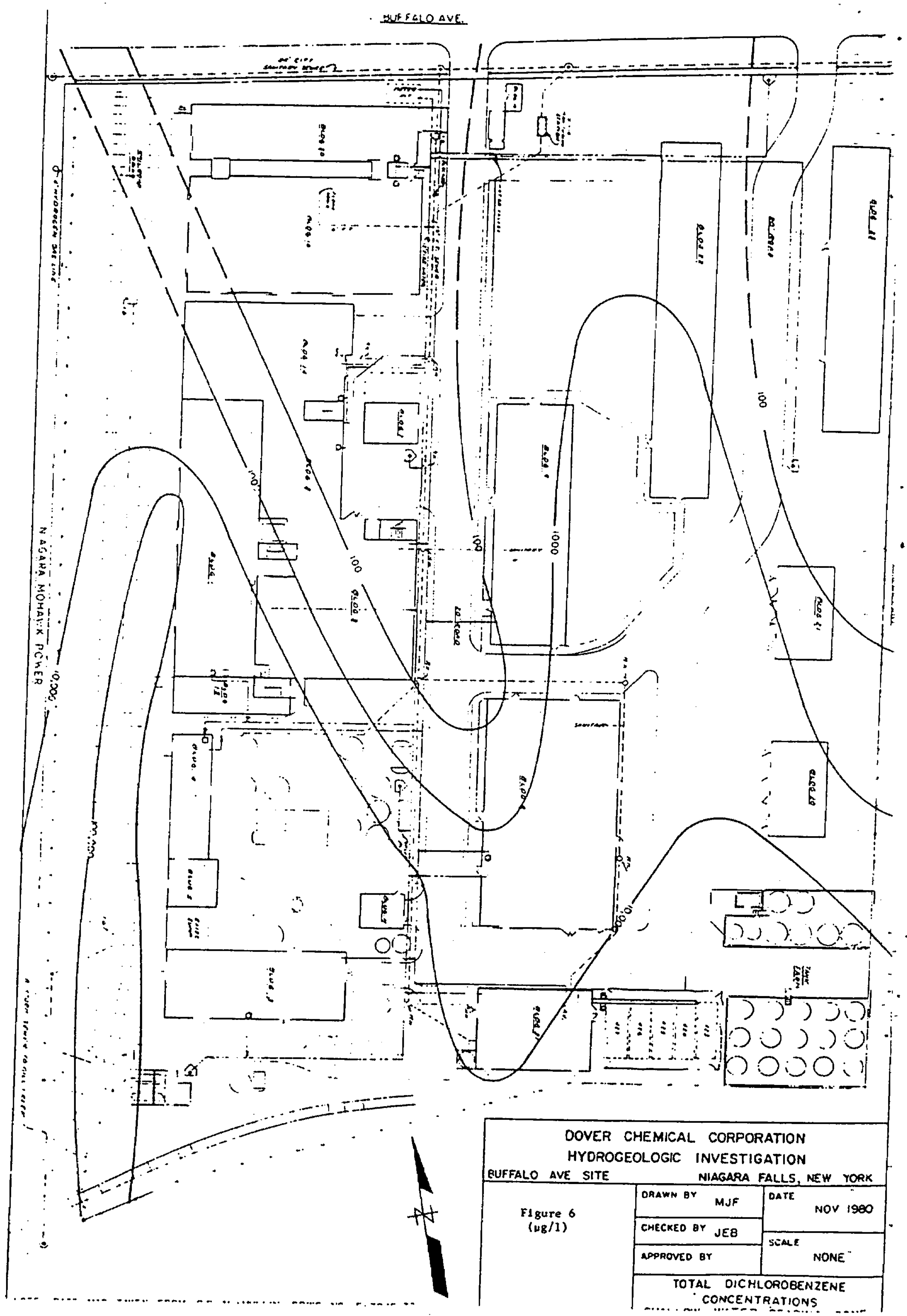
DOVER CHEMICAL CORPORATION
HYDROGEOLOGIC INVESTIGATION
BUFFALO AVE SITE NIAGARA FALLS, NEW YORK

Figure 5
(µg/l)

DRAWN BY	MJF	DATE	NOV 1980
CHECKED BY	JEB	SCALE	NONE
APPROVED BY			

p DICHLOROBENZENE CONCENTRATIONS
SHALLOW WATER BEARING ZONE

NOTE BASE MAP TAKEN FROM R.B. MacMULLIN DRWG NO. E-7946-32

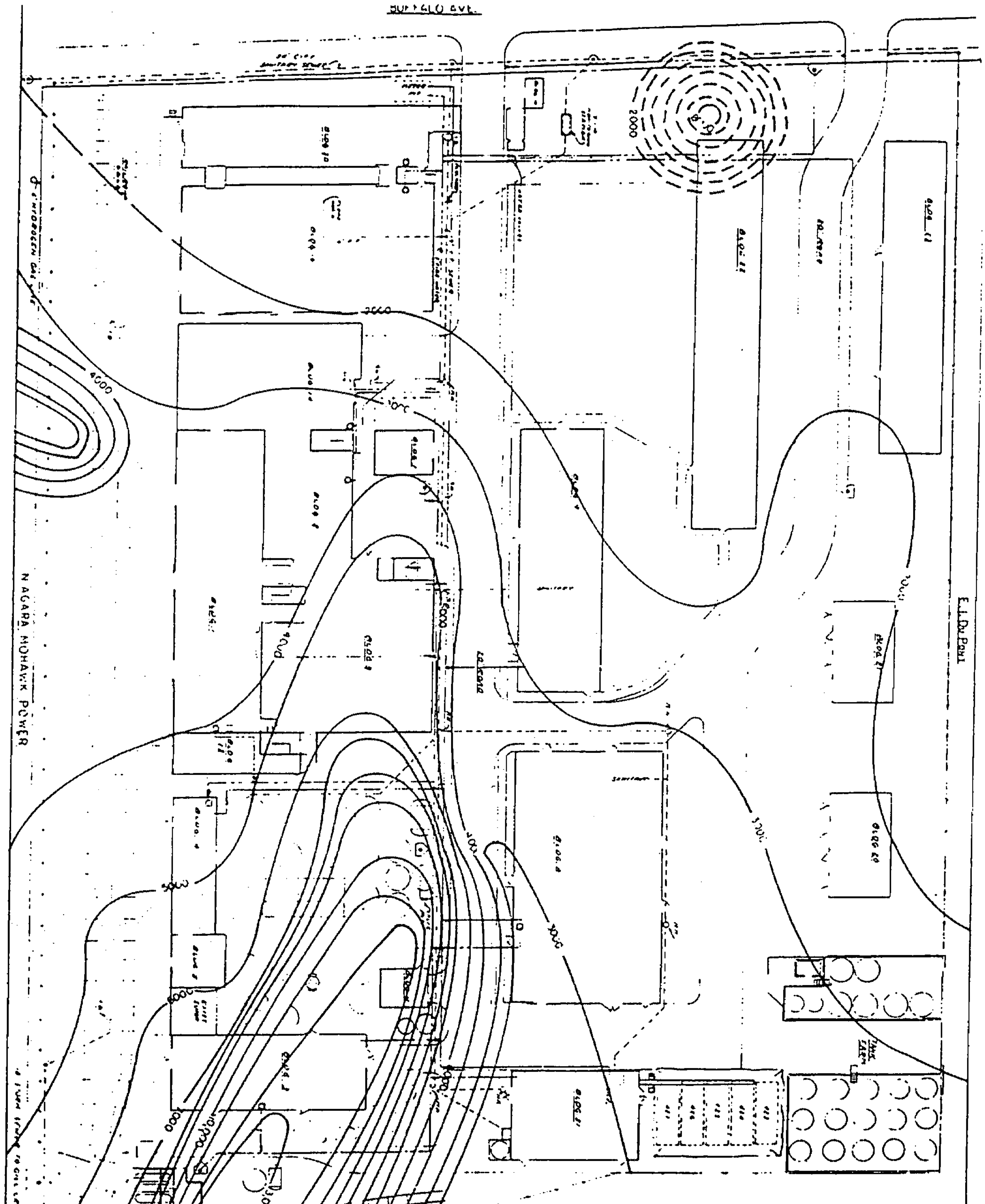


DOVER CHEMICAL CORPORATION
HYDROGEOLOGIC INVESTIGATION
BUFFALO AVE SITE NIAGARA FALLS, NEW YORK

Figure 6
(ug/l)

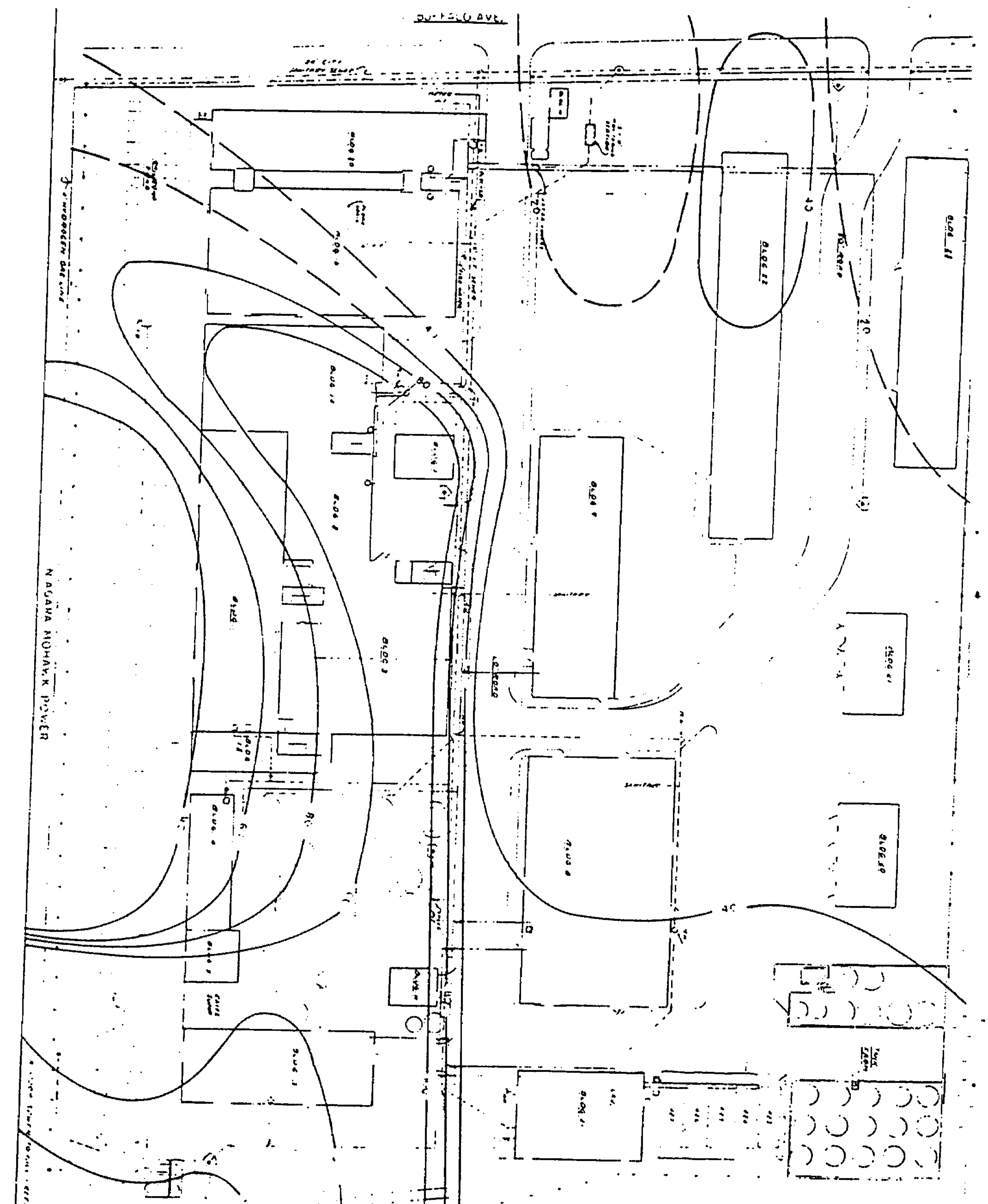
DRAWN BY MJF	DATE NOV 1980	
CHECKED BY JEB	SCALE NONE	
APPROVED BY		

TOTAL DICHLOROBENZENE CONCENTRATIONS



DOVER CHEMICAL CORPORATION
HYDROGEOLOGIC INVESTIGATION
BUFFALO AVE SITE NIAGARA FALLS, NEW YORK

Figure 7 (μmhos/cm)	DRAWN BY MJF	DATE NOV 1980
	CHECKED BY JEB	SCALE NONE
	APPROVED BY	
	CONDUCTIVITY READINGS SHALLOW WATER BEARING ZONE	



DOVER CHEMICAL CORPORATION
HYDROGEOLOGIC INVESTIGATION
BUFFALO AVE SITE NIAGARA FALLS, NEW YORK

Figure 8 (mg/l)	DRAWN BY MJF	DATE NOV 1980
	CHECKED BY JEB	SCALE NONE
	APPROVED BY	

... CONCENTRATIONS

WEHRAN ENGINEERING
CONSULTING ENGINEERS

PROJECT No. 01330187

TEST PIT LOGS

SHEET 1 OF 1

PROJECT: Dover Chemical Corporation
CLIENT: Recra Research, Inc., Tonawanda, N.Y.
CONTRACTOR:
EQUIPMENT:
DEPTH TO WATER: See Table
INSPECTOR: B. McClellan

LOG OF TEST PIT No. TP-3

Date: 7/22/80 Elevation: +568.56 ft

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	WELL CONSTRUCTION	REMARKS
		FILL Predominently Brick fragments and other debris (loose)		Rapid water inflow @2. Water level @2.7' upon completion
5				Mixed soil backfill
		8.0		1 1/4" Diameter Steel Casing
	S-1@ 9.0'	RECENT ALLUVIUM Dark grey organic Sandy SILT (soft)		Hole Caving @9.0'
10		9.0' Test Pit completed at 9.0 ft.		1 1/4"x18"x24" Johnson Redhead Well Screen
15				
20				

LOG OF TEST PIT No. TP-4

Date: 7/22/80 Elevation: +568.69 ft.

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	WELL CONSTRUCTION	REMARKS
		Black Cinder Fill (loose) 0.8'		Mixed soil backfill
		RECENT ALLUVIUM Mottled light brown and orange brown SILT, little to some fine Sand, (Dense)		1 1/4" Diameter Steel Casing
5		8.0'		1 1/4"x18"x24" Johnson Redhead Well Screen
	S-1@9'	LACUSTRINE CLAY Red-brown Silty CLAY (stiff)		Refused on tube Sample @10.0'
10		9.0' Test Pit completed at 9.0 ft.		
15				
20				

COMMENTS: Descriptions of relative density and consistency are based on visual observations made during excavation.

FIGURE

WEHRAN ENGINEERING
CONSULTING ENGINEERS

PROJECT No. 01330187

TEST PIT LOGS

PROJECT: Dover Chemical Corporation SHEET 1 OF 1

CLIENT: Recra Research, Inc., Tonawanda

CONTRACTOR: EQUIPMENT:

DEPTH TO WATER: See Table INSPECTOR: B. McClellan

LOG OF TEST PIT No. TP-1 Date: 7/22/80 Elevation: +568.69 ft.

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	WELL CONSTRUCTION	REMARKS
0–1.5		FILL Black Cinders and Rubble (loose) 1.5'		Fill & Alluvium Backfilled 1 1/4" Diameter Steel Casing 1 1/4"x18"x24" Johnson Redhead Well Screen Clay Backfill
5	S-1@ 5.0' S-2@ 7.0'	RECENT ALLUVIUM Mottled light brown and orange brown SILT, some fine sand (Dense) 6.5'		
10		LACUSTRINE CLAY Red-brown, laminated silty CLAY Occasional gray filled joints (Stiff to hard) 8.0'		
		Test Pit completed at 8.0 ft.		
15				
20				

LOG OF TEST PIT No. TP-2 Date: 7/22/80 Elevation: +568.81 ft.

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	WELL CONSTRUCTION	REMARKS
0–5.0		FILL Black Cinders and Debris mixed with silty brown soil. (loose) 5.0'		Fill & Alluvium Backfill 1 1/4" Diameter Steel Casing 1 1/4"x18"x24" Johnson Redhead Well Screen
5	S-1@ 7.0'	RECENT ALLUVIUM Dark gray organic SILT (soft) 6.0'		
10		GLACIAL TILL Red-brown Clayey SILT, some c-f sand, trace c-f gravel, occasional cobbles. (dense) 9.0'		Glacial Till Backfill Minor seepage at top of glacial till
		Test Pit completed at 9.0 ft.		
15				
20				

COMMENTS: Descriptions of relative density and consistency are based on visual observations made during excavation.

FIGURE

KEY TO SOILS IDENTIFICATION

Granular Soils - Particle Size Classification

Material		Fractions	Passing	Retaines On
BOULDERS	Material retained on the 9 in. sieve			9 in.
COBBLES	Material passing the 9 in. sieve and retained on the 3 in. sieve		9 in.	3 in.
GRAVEL	Material passing the 3 in. sieve and retained on the No. 10 sieve	coarse (c) medium (m) fine (f)	3 in. 1 in. 3/8 in.	1 in. 3/8 in. No. 10
SAND	Material passing the No. 10 sieve and retained on the No. 200 sieve	coarse (c) medium (m) fine (f)	No. 10 No. 30 No. 60	No. 30 No. 60 No. 200
SILT	Material passing the No. 200 sieve that is non-plastic in character and exhibits little or no strength when air-dried		No. 200	

Clay Soils - Plasticity Classification

Material*	Degree of Overall Plasticity	Overall Plasticity Index Sand - Silt - Clay Components
Clayey SILT	Slight	1 to 5
SILT & CLAY	Low	5 to 10
CLAY & SILT	Medium	10 to 20
Silty CLAY	High	20 to 40
CLAY	Very High	40 and greater

*Soils passing the No. 200 sieve which can be made to exhibit plasticity and clay qualities within a certain range of moisture content, and which exhibits considerable strength when air-dried.

Penetration Resistance and Soil Properties on Basis of the Standard Penetration Test (After Peck, Hanson and Thornburg, 1974)

Sands (Fairly Reliable)		Clays (Rather Unreliable)	
Number of Blows per ft, N	Relative Density	Number of Blows per ft, N	Consistency
		Below 2	Very Soft
0-4	Very Loose	2-4	Soft
4-10	Loose	4-8	Medium
10-30	Medium	8-15	Stiff
30-50	Dense	15-30	Very Stiff
Over 50	Very Dense	Over 30	Hard

Terms Identifying Composition of Soil

Written*	Defining Range of Percentage by Weight
and	35 to 50
some	20 to 35
little	10 to 20
trace	0 to 10

*Plus (+) or minus (-) sign used after identifying term denotes extremes of range; e.g., "some (-) Gravel" indicates 20 to 24 percent Gravel; "some (+) Gravel" indicates 31 to 35 percent Gravel.

Sewer Water Quality

Water and sediment samples were collected for analysis from the sewer system at five manholes on the Dover site. The manhole designated as MH-1 is on the main city sewer line along Buffalo Avenue. Manholes MH-2 and MH-3 are on the sewer line that passes beneath the central portion of the site. Manhole MH-5 is at the southern terminus of this line. Due to its position, this manhole provides some information on background levels before the sewer passes through the main section of the site. Manhole MH-1 is at the junction of this central line and the main city sewer line. Manhole MH-4 is in the southwestern portion of the site on a sewer line which passes beneath the western section of the site. The analysis of water samples from the sewer line gives an indication of the concentrations of constituents moving through the sewer system at the time of sampli The constituents in the sludge represent compounds which could potentially be moved off-site by solution processes or suspension of the sediments in the water column. The location of the sampling points is depicted in Figure 2.

Water Quality

Samples from manholes MH-1 and MH-5 exhibited the lowest concentrations for all parameters relative to the other sewer sampling locations. Both sections have near neutral pH. The sample from MH-1 had the lowest levels of ortho- and para dichlorobenzene, the second lowest measurements for conductance and meta-dichlorobenzene, and a relatively low concentration of total organic carbon. The sample from manhole MH-5 had the lowest conductance reading and total organic carbon measurement, and the second lowest levels of ortho- and para dichlorobenzene. The meta-dichlorobenzene concentration at MH-5 was only slightly higher than that at MH-1. As stated previously, MH-5 is at the southern terminus of the sewer line traversing the central portion of the site and hence gives some indication as to background concentrations.

The highest concentration for measured parameters is found at manholes MH- and MH-3 in the center of the site and at MH-4 at the southwest corner of the property. Since these stations are on portions of sewer lines which pass benea the Dover site only, the property appears to be the source of the measured constituents. The high conductivity measurements and concentrations of the dichlorobenzene isomers measured at these monitoring points indicate that contam are being transported through the sewer system. The high concentrations of the constituents of interest detected at MH-4 indicates these constituents are movin off-site in that sewer line. The reduced readings at MH-1, however, suggest tha at least on the day of the sampling, that the levels of constituents found at MH and MH-3 were reduced before the water in this sewer line reached the Niagara Falls city sewer system. This reduction may represent dilution by the waters in the city sewer.

Sediments

The sludges or sediments collected from the five manholes were analyzed for dichlorobenzene isomers. The sludges at all sampling stations contained high concentrations of these chlorinated organic compounds, indicating that all portic of the sewer system have been exposed to these constituents. Although other sour cannot be totally eliminated, the levels measured in the sediments at manholes MH-1 and MH-4 suggest that dichlorobenzene isomers are transported into the city sewer system by the lines traversing the site. In addition, as mentioned previously, constituents in the sediments may become reintroduced into the water, further degrading the quality of the water, and becoming available for transport off-site. The highest concentrations of dichlorobenzenes were found at MH-4, whe the western sewer line leaves the property.

Soils

Soil samples were obtained for analysis from the test pits (TP1 through TP14) and one test well (TW2). In addition to being analyzed for dichlorobenzene isomers, the soils were also subjected to the New York State leaching potential test. The synthesized leachates were then analyzed for pH, conductivity, and isomers of dichlorobenzene. Results of the laboratory analysis are presented in Tables 9 and 10.

In general, the highest concentrations of the various constituents were found in the southwest and southeast portions of the Dover site. This distribution pattern reflects the trends identified from the analysis of samples taken from the shallow water-bearing zone. The data indicates that high levels of dichlorobenze are associated with the soil fraction. The results of the leaching potential tests suggest that these constituents are susceptible to leaching. Therefore, continued degradation of the groundwater from on-site soils is possible.

The analysis of samples from test pits TP2, TP3, and TP5 and test well TW2 in the eastern portion of the site and test pits TP7 and TP14 in the southwest section, supports the contention that the Recent alluvium is acting to restrict the migration of constituents from the fill into the underlying bedrock. At these stations, the highest levels of the constituents of interest are found in the fill above the Recent alluvium. The concentrations in the soils below the fill-alluvium interface are lower than those above the interface. However, as discussed elsewheres in this report, the Recent alluvium only retards the movement of groundwater; the movement is not precluded. Therefore, despite the presence of this layer constituents still have the potential for migrating vertically from the fill layer, albeit at a slower rate.

Leaching potential tests demonstrate that constituents associated with the soils are capable of being leached. In general, the highest levels of constitue in the leachate were found for soil samples that in turn demonstrated high constituent concentrations (TP12; TP13; TP14). Similarly groundwater samples from these same test pits (TP12; TP13; TP14) also generally demonstrated the hig concentrations for measured constituents over the course of this study.

From a consideration of the analysis of the soil and groundwater samples fr the fill and the samples collected from the sewer system, it appears that ground waters from the Dover site may in part be responsible for the constituents ident in the sewer system. However, prior direct discharge into the sewer system of waters containing the monitored constituents could have also provided a route of entry.

CONCLUSIONS

1. The surficial geologic formations and conditions which were found to be present throughout the site area during this investigation differ significantly from what was previously reported for the site and vary somewhat from what is reported in the existing geologic literature.

The encountered geologic conditions of the overburden materials have a direct role in interpreting the site ground-water hydrology. Of major importance to the problem at hand is the fact that there was no continuous geologic formation encountered during this investigation which can serve as a confining layer or aquiclude between the two water-bearing zones. At best, there exists a semi-confining layer or aquitard in the Recent Alluvium soils. This stratum is of a low enough permeability to form a shallow water-bearing zone in the overlying fill. However, observed hydraulic gradients between the shallow water-bearing zone and the bedrock aquifer is sufficient enough to allow the significant migration of water from the shallow zone to the bedrock aquifer. Also, based on a comparison of vertical and horizontal hydraulic gradients and probable permeabilities observed on site, migration of water vertically, down through the semi-confining layer, is the prevailing situation as opposed to significant lateral flow through the more permeable fill soils.

2. In addition to the naturally occurring geologic conditions, human activities on the site have and continue to effect the

occurrence and migration of ground water in the shallow water bearing zone; specifically, the reported 30,000 to 40,000 gpd leakage from the site water supply system. This reported leakage has a number of effects:

A. It increases the quantity of water present in the shallow zone, over what might be present under natural conditions, where recharge would be limited to precipitation over the site area

B. It accelerates the flushing of contaminants which are trapped in the surficial fill soils; and

C. It maintains a significant vertical hydraulic gradient permitting enhanced migration of water and contaminants from the shallow zone to the deeper bedrock aquifer.

The installation of foundations for support of site structures could cause deflection in horizontal ground water flow directions. Penetration of the Recent Alluvium stratum or other confining layers by foundation structures would further lessen any containment afforded by these layers. The observed heterogenous nature of man-placed fill soils, in which the shallow water bearing zone is contained, will cause ground water flow to occur under anisotropic conditions. As a result, precise predictions of ground water flow directions are difficult.

3. Recharge to the shallow water bearing zone within the fill soils occurs by both artificial means through subsurface leakage and naturally by percolation of meteoric water over the site area. Also, ground water level elevations give some indication that recharge

to the site ground water from an off-site source occurs along the southeastern portion of the site. Discharge of the shallow water bearing zone occurs horizontally throughout the fill soils along the western limit of the site. Also, an equal or greater amount of discharge occurs vertically down through the underlying Recent Alluvium soils.

4. The regional significance of this shallow water bearing zone as a portable water supply is believed to be of little or no importance. However, it is apparent that these ground waters probably discharge into the surrounding surface water drainage systems after existing the site. A suspected point of discharge is Gill Creek located to the west of the subject site.

5. The bedrock aquifer encountered during our investigation exhibited drastically differing hydraulic characteristics within the site area. The differing hydraulic characteristics observed were the extend and the manner of ground water occurrence as well as basic hydraulic properties such as permeability, storage coefficients, and transmissivity. The observed hydraulic characteristics strongly illustrate the anisotropic conditions regarding ground water occurrence and movement within the bedrock. These observed conditions reflect the complex nature of ground water flow in the bedrock at this site, which is not consistent with what has been reported for the region and which will hinder the development and construction of any remedial measure.

6. When compared to New York State Groundwater Standards for Class GA waters, groundwater in the Lockport Dolomite beneath the Dover site contains elevated concentrations of chloride, benzene, and ortho- and para-dichlorobenzene. The levels of chlorides measured are not unusual for natural groundwater in this formation. The concentrations of zinc did not exceed groundwater quality standards.

7. In addition to the previously mentioned parameters, the bedrock groundwater in the vicinity of the monitoring wells also contain monochlorobenzene, meta-dichlorobenzene, and trichlorobenzene.

8. The highest concentration of measured constituents in the bedrock aquifer appears beneath the southwest portion of the site. However, due to the limited data base and the lack of upgradient and downgradient wells, a number of factors cannot be evaluated. These factors include the areal extent and magnitude of constituent concentrations; potential contributions from off-site sources; and the transport of constituents in the groundwater from the Dover site to other locations within the Lockport Dolomite aquifer.

9. When compared to New York State Groundwater Standards for Class GA waters, groundwater in the shallow water bearing zone within the fill layer beneath the Dover site contains elevated concentrations of zinc, chloride, benzene, and ortho- and para-dichlorobenzene.

10. In addition to the previously listed parameters, the groundwater in the shallow water bearing zone in certain sections of the site also contains elevated levels of meta-dichlorobenzene, monochlorobenzene, trichlorobenzene isomers, and total organic carbon.

11. A number of parameters display similar pattern of distribution in the shallow water-bearing zone. These parameters include conductivity, total organic carbon, dichlorobenzenes, benzene, monochlorobenzene, and trichlorobenzenes. In general, the greatest concentrations of these parameters are found in the southwest and southeast sections of the site. The concentration levels decrease towards the northern and central portions of the site.

12. The presence of elevated concentrations of constituents in the fill and the absence of a natural aquiclude to prevent the vertical migration of groundwater, increases the potential for contamination of the Lockport Dolomite aquifer especially beneath the southern portion of the Dover Site.

13. The highest concentrations of zinc, chloride, and ammonia in the shall water bearing zone were found on the western portion of the property.

14. Analysis of soil samples, including their potential for leaching dichlorobenzene isomers, produced results similar to those obtained from groundwater samples of the shallow water bearing zone. For the soils and their generated leachates, the highest levels of dichlorobenzenes were found in the southwestern and southeastern sections of the site. The concentrations decrease towards the northern and central portions of the site.

15. The dichlorobenzenes which are associated with the soil particles in the fill layer are susceptible to leaching. Continued degradation of groundwater by constituents leached from on-site soils is therefore possible.

16. Chemical analysis of the soil samples support the conclusions of the hydrogeologic investigation, i.e. that the Recent alluvium is serving as a barrier restricting the movement of constituents verticall downward into the bedrock aquifer. However, the Recent alluvium is act as an aquitard and not an aquiclude. Therefore, vertical groundwater migration is slowed but not prevented.

17. Constituents identified in the soil-groundwater system have also been detected in the sewer lines which pass beneath the site.

18. Dichlorobenzene is apparently being transported off-site via the sewer system. Water samples collected during this study indicate contaminated water is present in the sewer line which passes beneath the western portion of the site. Although water in the main city sewer line along Buffalo Avenue had relatively low levels of the constituents of interest on the day the samples were taken, the high level of measure constituents in the sewer sediments from this location (MH-1) indicate that contaminants are being discharged from the sewer line passing beneath the Dover site.

19. The sediments in all portions of the sewer system sampled contained dichlorobenzenes. These sediments may be responsible for the poor quality of the water found in the sewers from the Dover propert

20. It has not been determined whether the dichlorobenzenes found in the sewer waters are a result of direct infiltration, are attributable to the sewer sediments, or are a combination of the two.

RECOMMENDATIONS FOR REMEDIAL MEASURES

Conditions observed at the former Buffalo Avenue Dover Chemical site indicate the need for remedial action. The following text outlines recommended measures appropriate to collect contaminated ground waters and provide reasonable containment of such ground water to the site proper. In view of existing subsurface data, the site may be conducive to a number of conventional ground modification and ground water manipulation measures. The following measures are recommended for the subject site.

(1) Excavate and dispose of all subsurface storage facilities which have been used for storage of benzene or chlorobenzenes. Also any highly contaminated soils immediately surrounding such facilities should be excavated and disposed of in an approved manner. The purpose of this excavation would be to eliminate contamination "hot spots" and thereby reduce potential sources of continual leaching of contaminants.

(2) Eliminate leakage from the site water supply system. This should remove a significant amount of the recharge to the ground-water system. The effect of removing this recharge would be to: (A) diminish the volume of ground water which may have to be pumped from the shallow water bearing zone and treated; and, (B) decrease the presently observed hydraulic gradient, which promotes the dispersal of ground water and contaminants both vertically and horizontally off the site.

(3) A perimeter collection trench should be installed along the eastern, southern and western site boundaries. The collection trench would permit the withdrawal of contaminated ground waters from the shallow water bearing zone contained in the encountered fill soils. The construction of this collection system would consist simply of a continuous trench about 18 inches in width and extending through the fill soils to the top of the semi-confining Recent Alluvium Stratum or other confining strata. The trench should be backfilled with a clean, granular aggregate, wrapped in a filter fabric envelope. At selected points along the trench, sumps should be installed to permit pumping from the system. Along the northern site limit, no fill soils containing a perched water table were encountered and, therfore, collection does not appear necessary.

(4) In conjunction with the perimeter collection system, it is recommended that a perimeter cut-off wall be constructed along all four sides of the site, outside the collection system. The intent of cut-off wall would be to: (A) afford reasonable horizontal confinement of contaminated, shallow ground waters and (B) limit the amount of water to be withdrawn from the shallow water bearing zone, during pumping from the perimeter collection system, by preventing the migration of ground waters from off-site sources. It is recommended that the

construction of the cut-off wall be in the form of a bentonite slurry trench. This construction should provide the necessary degree of containment because such material has the capability of achieving permeabilities of less than or equal to 1×10^{-7} cm/sec. Also, this method of construction seems to be best suited to the existing site conditions, i.e., excavation below the water table. The cut-off wall would consist of an excavated trench approximately 12 inches in width, backfilled with a bentonite slurry. The cut-off wall should extend vertically down to the top of bedrock or into the upper two feet of lacustrine clay or glacial till where present.

(5) Based on the results of chemical analysis, ground waters contained in the bedrock aquifer are contaminated. Therefore, it is recommended that collection and confinement of such ground waters be conducted.

Concerning collection, it is anticipated that withdrawal of ground water from the bedrock aquifer will be possible via conventional dewatering well systems. However, given the diversity of manners of ground water occurrence observed in the bedrock aquifer during this investigation, additional information should be obtained to provide specific well and pump design parameters. Such additional information would best be obtained as part of the detailed design and construction activities which would be necessary to implement such a system. The design and construction work could be staged such that well installations and pumping programs could be modified where necessary as additional information becomes available. It is presently envisioned that to effectively drawdown the existing water levels in the southwestern portion of the site, large diameter wells (six inch min.) and large capacity pumps (400 gpm) should be considered. Also, more than one of this type of well may be required in the south western portion of the site.

In terms of containing the contaminated ground water, in the bedrock aquifer, to the site, the following options are available for consideration:

(A) The movement of ground water in and out of the site limits can be modified by a well dewatering system. Such a system would consist of installing a sufficient number of wells to develop a depressed ground water level within the site limits. This condition should provide a positive flow of ground water into the site area and effectively diminish the possibility of ground water flowing outward from the site.

(B) An alternative method for providing containment would be to construct a cut-off wall in the bedrock by means of a pressure injected grout curtain. The grout curtain would be installed by injecting a cement grout into the bedrock through boreholes. This method was used during the construction of the Robert Moses Power Plant project to prevent ground water from entering the conduit excavation at its point of intersection with the Niagara River. A successful grout curtain was installed through boreholes drilled 15 feet on center. Given the proximity of the subject site to the conduit excavation, it is anticipated that conditions in the bedrock are similar enough to permit a comparable borehole spacing. In the case of the subject site, it appears that it may be necessary to install such a grout curtain to a depth of from 20 to 40 feet below the upper surface of bedrock. Such a grout curtain would almost insure cut-off of horizontal flow in the bedrock aquifer within the site limits. However, it is possible that some recharge to the bedrock aquifer within the grout curtain may occur through the vertical component of ground water movement within the bedrock.

Both of the alternative methods appear suitable for the site conditions. However, keeping in mind that all ground water withdrawn will probably have to be treated and disposed of, the pumping method appears to be the more open-ended in terms of long term cost, given anticipated large volume. On the other hand, confinement by means of a grout curtain will have a significant initial installation cost, but limits the volume and duration of ground water withdrawn and associated treatment. Also, given the permanent nature of a grout curtain and reasonable assurance of non-horizontal flow off-site through the section grouted, withdrawal and treatment may not be necessary beyond an initial clean up phase.

A general estimate of cost for both systems of confinement is presented in the following section, "Summary of Cost Estimates for Remedial Measures". Whichever of the methods is selected for containment of the bedrock aquifer, additional specific information on bedrock fracturing and ground-water flow will be necessary to develop an exact engineering design. Once again, it is anticipated that such information could be obtained during the initial construction phase.

(6) To further diminish the volume of ground water which must be handled during pumping and treatment, it is essential to limit the amount of recharge to the ground water system which occurs via precipitation over the site area. It is recommended that the site surface be modified to encourage surface runoff of precipitation rather than percolation into the subsurface. This can be accomplished by providing impervious cover, such as asphalt paving, over areas which presently have stone surfaces. Also, regrading of existing surfaces should enhance surface water flow to collection points avoiding localized ponding of water for extended periods of time at the surface. Also, roof drains should be checked and improved as necessary to insure discharge to the site storm sewer system.

(7) Finally, to preclude contamination of waters discharged by the sewer system and to prevent resuspension and subsequent transport of contaminated solids, it is recommended that all on-site sewer lines and manholes be cleaned to remove accumulated solids.

SUMMARY OF COST ESTIMATES FOR REMEDIAL MEASURES

(1) Installation of Perimeter Collection Trench - It is estimated that the total cost for the trench installation would be on the order of $10,000.00, not including pumping equipment.

(2) Installation of Slurry Trench Cut-Off Wall - Using a unit price of $5.00 per square foot of trench face, which assumes the excavated site soils can be incorporated into the construction, the total estimated cost would be on the order of $90,000.00.

(3) Installation of Bedrock Aquifer Dewatering Wells - Based on our experience in the area, it is estimated that, including the necessary rock coring for further evaluation of rock fracturing and ground water flow, well installation cost per foot could range from $30.00 to $40.00 for a six-inch diameter well. Given an anticipated average depth of 30 feet, the cost per well could range from $900.00 to $1,200.00, not including pumping equipment.

(4) Installation of a Perimeter Grout Curtain - Assuming that a curtain could be satisfactorily installed in the upper 40 feet of bedrock using a line of boreholes at a 15-foot spacing, it is anticipated that the total cost would be on the order of $300,000.00.

The estimated costs outlined above are presented only for general comparison of various ground modification and ground water manipulation methods available. In evaluating these costs, it is important to keep in mind that by providing containment of ground water to the site proper via ground modifications, rather than ground water manipulations, the following can be accomplished:

(a) significantly reduce the volume of ground water to be pumped and treated.

(b) possibly put a time limit on the duration of pumping and treatment because the ground water to be withdrawn would be essentially limited to that ground water contained within the site area;

(c) avoid drawing ground water and possible contaminants from off-site sources into the site area; and

(d) provide a means of permanent containment of contaminated ground water within the site limits.

REFERENCES

Cedergren, Harry, R., 1967, Seepage, Drainage, and Flow Nets, John Wiley & Sons, Inc., New York.

Griffin, R. A. and S. J. Chou, 1980, Disposal and Removal of Halogenated Hydrocarbons in Soils. Ill. State Geolog. Survey, Urbana, Illinois.

Johnston, Richard H., 1964, Ground Water in the Niagara Falls Area, New York - with Emphasis on the Water-Bearing Characteristics of the Bedrock, Bull. GW-53, State of New York, Conservation Department Water Resources Commission.

Kindle, E. M. and Taylor F. B., 1914, Geologic Atlas of the Unites States - Niagara Folio, Folio 190 - Field Ed. Department of Interior, U.S. Geological Survey.

Lohman, S. W., 1972, Ground-Water Hydraulics, U.S. Geological Survey Professional Paper 708, U.S. Government Printing Office, Washington, D.C.

Reck, C. W. and E. T. Simmons, 1952. Water Resources of the Buffalo-Niagara Falls Region. Wash., D.C. Geol. Surv. Circular 173.

Roy F. Weston - Environmental Consultants - Designers, 1980 Report, Hydrogeologic Investigation of Former Solvent Chemical Corporation Property on Buffalo Avenue, Niagara Falls, New York.

Appendix

List of Appendicies

Key to Soils Identification

Wehran Engineering Soils Logs

Grain-Size Distribution Charts

Roy F. Weston Soils Logs

Recra Research, Inc. Field Reports

WEHRAN ENGINEERING
CONSULTING ENGINEERS

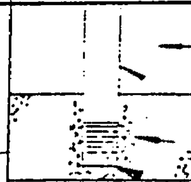
TEST BORING LOG

BORING No. TW-2

PROJECT	Dover Chemical
CLIENT	Recra Research, Inc., Tonawanda, N.Y.
BORING CONTRACTOR	Empire Soils Investigation, Inc.
GROUND WATER	See Table

SHEET No.	1 of 1
JOB No.	01330187
ELEVATION	+568.50 ft.
DATUM	
DATE START	7/23/80
DATE FINISHED	7/23/80
DRILLER	Genovese
INSPECTOR	MacMillin

DATE	TIME	DEPTH	CASING		CAS.	SAMP.	CORE	TUBE
				TYPE				
				DIA.				
				WT.				
				FALL				

DEPTH FEET	SAMPLE No.	TYPE		DEPTH	CLASSIFICATION	WELL CONSTRUCTION	
0	1		@ 0.5'		FILL Dark gray to brown, granular debris & cinder fill, occasional gravel (loose) 5.0'		Cement & Bentonite Grout 1 1/4" diameter steel casing Sand Pack 1 1/4"x18"x24" Johnson Redhead well screen
5	2		@ 6.0'		RECENT ALLUVIUM Light brown SILT, little sand (stiff) 6.0' Test well completed at 6.0 ft.		
10							
15							
20							
25							
30							
35							
40							
45							

FIGURE

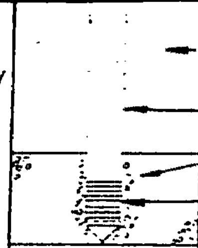
WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

BORING No. TW-1

PROJECT Dover Chemical Corporation	SHEET No. 1 of 1
CLIENT Recra Research Inc., Tonowanda, N.Y.	JOB No. 01330187
BORING CONTRACTOR Empire Soils Investigations, Inc.	ELEVATION +568.42 ft.
GROUND WATER See Table	DATUM
	DATE START 7/23/80
	DATE FINISHED 7/23/80
	DRILLER Genovese
	INSPECTOR MacMillin

DATE	TIME	DEPTH	CASING		CAS.	SAMP.	CORE	TUBE
				TYPE				
				DIA.				
				WT.				
				FALL				

DEPTH FEET	SAMPLE No.	TYPE		DEPTH	CLASSIFICATION	WELL CONSTRUCTION	REMARKS
0	1		@ 0.5'		FILL Dark gray, granular, debris intermixed with dark gray sandy SILT (medium dense) 8.0		Cement & Bentonite Grout 1 1/4" diameter steel casing Sand Pack 1 1/4"x18"x24" Johnson Redhead well screen
5	2		@ 8.0'		Test well completed at 8.0 ft.		
10							
15							
20							
25							
30							
35							
40							
45							

FIGURE

WEHRAN ENGINEERING
CONSULTING ENGINEERS

PROJECT No. 01330187

TEST PIT LOGS

PROJECT: Dover Chemical Corporation — SHEET 1 OF 1
CLIENT: Recra Research, Inc., Tonawanda, N.Y.
CONTRACTOR: — EQUIPMENT:
DEPTH TO WATER: See Table — INSPECTOR: B. McClellan

LOG OF TEST PIT No. TP-5 — Date: 7/22/80 — Elevation: +568.64 ft.

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	WELL CONSTRUCTION	REMARKS
		FILL Black Cinders and Debris (loose) 4.5'		Water seepage at 3.5' Mixed soil backfill 1 1/4" Diameter Steel Casing
5	S-1@5.0'	RECENT ALLUVIUM Mottled gray and brown clayey SILT, little (-) fine sand (medium) 6.0'		
	S-2@8.0'	GLACIAL TILL Red-brown clayey SILT some f-c sand, little fm gravel (dense) 8.5'		1 1/4"x18"x24" Johnson Redhead Well Screen Glacial Till Backfill
10		Test Pit completed at 8.5 ft.		
15				
20				

LOG OF TEST PIT No. TP-6 — Date: 7/23/80 — Elevation: 568.62 ft.

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	WELL CONSTRUCTION	REMARKS
		FILL Predominently (loose)black cinder fill 5.5'		Water seepage through fill Mixed soil backfill
5		RECENT ALLUVIUM Dark gray organic SILT (soft) -grading at 6.0' to gray clayey SILT Little m-f sand (soft) 6.5'		1 1/4" Diameter Steel Casing 1 1/4"x18"x24" Johnson Redhead Well Screen Glacial Till Backfill
10		GLACIAL TILL Red-brown clayey SILT, some sand, trace gravel (dense) 7.5'		
		Test Pit completed at 7.5 ft.		
15				
20				

COMMENTS: Descriptions of relative density and consistency are based on visual observations made during excavation.

FIGURE

WEHRAN ENGINEERING
CONSULTING ENGINEERS

PROJECT No. 01330187

TEST PIT LOG

PROJECT: Dover Chemical Corporation
CLIENT: Recra Research, Inc., Tonawanda, N.Y.
SHEET 1 OF 1
CONTRACTOR:
EQUIPMENT:
DEPTH TO WATER: See Table
INSPECTOR: B. McClellan

LOG OF TEST PIT No. TP-7

Date: 7/23/80 Elevation: +568.56 ft.

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	WELL CONSTRUCTION	REMARKS
		FILL Rubble Fill, predominently brick, cinders and wood (loose) 4.2'		Heavy water seepage at 4.0'
5		RECENT ALLUVIUM Dark grey organic SILT, with roots (soft) grading @ 4.9' to Gray-Brown Clayey SILT, little sand (stiff) 8.0'		Hole caving at 7.5' Mixed soil backfill 1 1/4" diameter steel casing 1 1/4"x18"x24" Johnson Redhead well screen
10		Test Pit mpleted at 8.0 ft.		
15				
20				

LOG OF TEST PIT No. TP-8

Date: 7/23/80 Elevation: +568.14 ft.

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	WELL CONSTRUCTION	REMARKS
		Rubble Fill 4.0'		Mixed soil backfill
5	S-1@5.0'	RECENT ALLUVIUM Black Organic SILT (soft) grading @ 4.5' to Gray-brown SILT, little f. sand with roots. (stiff) 6.5		1 1/4" diameter steel casing 1 1/4"x18"x24" Johnson Redhead well screen
10		Test Pit completed at 6.5 ft.		Refusal to further penetration at 6.5 ft. Water Seepage 4.0 ft.
15				
20				

COMMENTS: Descriptions of relative density and consistency are based on visual observations made during excavation

FIGURE

WELL	EVAC LEVEL	TIME DATE	SAMP LEVEL	TIME DATE	COMMENTS
TP-1	0	10:25 7/30/80	0	10:10 7/31/80	no measureable water in well - 7/30/80 no measureable water in well - 7/31/80
TP-2	7'2"	10:35 7/30/80	7'¼"	10:50 7/30/80	continuos recharge/sampled
TP-3	5'5½"	13:05 7/30/80	5'5½"	13:10 7/30/80	continuous recharge/sampled
TP-4	7'11"	10:05 7/30/80	8'1½" 7/31/80	10:35	evacuated dry/sampled
TP-5	6'10½"	11:00 7/30/80	7'3½"	10:40 7/31/80	evacuated dry/organic sample on 7/31/80
TP-6	6'½"	11:30 7/30/80	6'4"	11:40 7/30/80	continuous recharge/sampled
TP-7	5'½"	15:30 7/30/80	5'1½"	14:45 7/31/80	evacuated dry/sampled
TP-8	3'11"	12:45 7/31/80	4'5½"	10:10 8/1/80	evacuated dry/sampled
TP-9	0	15:30 7/31/80	0	10:25 8/1/80	no measurable water in well - 7/31/80 no measurable water in well - 8/1/80
TP-10	8'7½"	15:00 7/31/80	8'7½"	15:55 7/31/80	continuous recharge/sampled
TP-11	7'2½"	15:35 7/31/80	7'3"	15:45 7/31/80	continuous recharge/sampled
TP-12	4'2"	15:50" 7/30/80	4'2"	12:15 7/31/80	evacuated dry
TP-13	7'3½"	13:50 7/30/80	7'4½"	14:00 7/30/80	continuous recharge/sampled
TP-14	6'5½"	14:15 7/30/80	6'5"	12:05 7/31/80	evacuated dry/sampled
TW-1	5'2½"	13:25 7/30/80	8'8½"	13:30 7/30/80	continuous recharge/sampled
TW-2	6'10" 7/30/80	11:20	6'9" 7/31/80	11:05	evacuated dry/7'4¼" second sample 8/1/80 9:55
W-1	8'6" 7/30/80	9:50	9'4½" 7/31/80	10:20 7/31/80	evacuated dry/incomplete sample 8/11/80 9'4" second sampling 10:00 8/1/80
W-1A	0	9:45 7/30/80	0	10:20 7/31/80	No measureable water in well 7/30/80 no measureable water in well 7/30/80

WEHRAN ENGINEERING
CONSULTING ENGINEERS

PROJECT No. 01330187

TEST PIT LOGS

PROJECT: Dover Chemical Corporation

CLIENT: Recra Research, Inc., Tonawanda, N.Y.

SHEET 1 OF 1

CONTRACTOR:

EQUIPMENT:

DEPTH TO WATER: See Table

INSPECTOR: B. McClellan

LOG OF TEST PIT No. TP-13

Date: 7/23/80 Elevation: +568.47 ft.

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	WELL CONSTRUCTION	REMARKS
		FILL Dark Brown Soils and Debris 4.5'		Heavy water flow @ 2.0' Mixed soil backfill 1 1/4" diameter steel casing 1 1/4"x18"x24" Johnson Redhead well screen
		RECENT ALLUVIUM Dark gray organic SILT (soft) grading @ 5.0' to mottled gray-brown and orange brown fine Sandy SILT (medium) 5.6		
		Test pit completed at 5.6 ft.		

LOG OF TEST PIT No. TP-14

Date: 7/23/80 Elevation: +568.42 ft.

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	WELL CONSTRUCTION	REMARKS
		FILL Dark Brown silty soils and Debris (loose) 5.0'		Heavy water flow @ 3.0 - 4.0' 1 1/4" diameter steel casing 1 1/4"x18"x24" Johnson Redhead well screen Mixed soil backfill
		RECENT ALLUVIUM Dark brown organic SILT (soft) grading @ 5.5' to gray and dark gray sandy SILT (medium) 8.0'		
		Test pit completed at 8.0 ft.		Refusal to further penetration @ 8.0'

COMMENTS: Descriptions of relative density and consistency are based on visual observations made during excavation

FIGURE

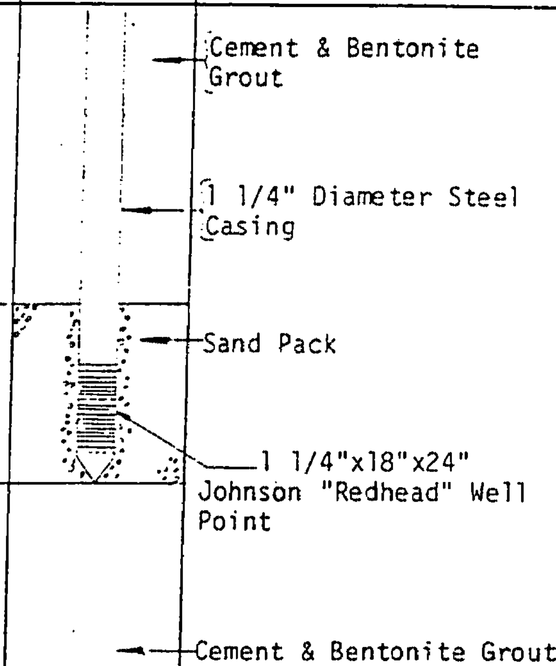
WEHRAN ENGINEERING
CONSULTING ENGINEERS

PROJECT No. 01330187

WELL LOG NO. B-1

PROJECT: Dover Chemical Corporation	SHEET 1 OF 1
CLIENT: Recra Research, Inc., Tonawanda, N.Y.	
CONTRACTOR: Empire Soils, Genovese	EQUIPMENT: Truck Mounted Auger
DEPTH TO WATER: See Table	INSPECTOR: MacMillin
Date: 7/21/80	Elevation 568.92

DEPTH FT.	SAMPLE No. DEPTH		WELL CONSTRUCTION	
5		5.0'		
		8.0'		
10				
		12.5'		
15				
20				



Notes:
1) Existing well pulled. Existing hole reamed and backfilled to top of clay at 8.0' with cement and bentonite grout.
2) New well installed in existing well to top of clay. Top of clay depth as per log prepared for Well 1, 1A by Roy F. Weston, Inc. (12/6/79)

COMMENTS:

FIGURE

WEHRAN ENGINEERING
CONSULTING ENGINEERS

PROJECT No. 01330187

WELL LOG NO. B-2

SHEET 1 OF 1

PROJECT: Dover Chemical Corporation

CLIENT: Recra Research, Inc., Tonawanda, N.Y.

CONTRACTOR: Empire Soils, Genovese

EQUIPMENT: Truck Mounted Auger

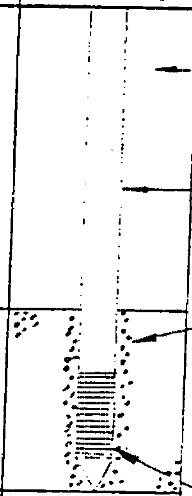
DEPTH TO WATER: See Table

INSPECTOR: MacMillin

Date: 8/22/80

Elevation 568.52

DEPTH FT.	SAMPLE No. DEPTH		WELL CONSTRUCTION
5		5.0'	
		8.0'	
10			
15			
20			



NOTES:
1) Existing well pulled. Well screen remained in hole. Existing hole reamed and back-filled to surface with Cement and Bentonite Grout.
2) New well installed on top of clay. Top of clay depth as per log for Well 2, 2A prepared by Roy F. Weston, Inc. (12/6/79)

COMMENTS:

FIGURE

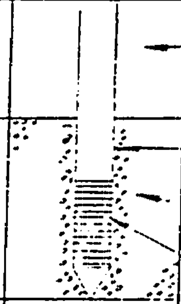
WEHRAN ENGINEERING
CONSULTING ENGINEERS

PROJECT No. 01330187

WELL LOG NO. B-3

PROJECT: Dover Chemical Corporation	SHEET 1 OF 1
CLIENT: Recra Research, Inc., Tonawanda, N.Y.	
CONTRACTOR: Empire Soils, Genovese	EQUIPMENT: Truck Mounted Auger
DEPTH TO WATER: See Table	INSPECTOR: Macmillin
Date: 7/21/80	Elevation 568.55

DEPTH FT.	SAMPLE No. DEPTH		WELL CONSTRUCTION	
		2.0'		Cement and Bentonite Grout
				1 1/4" diameter casing
				Sand Pack
5		5.0'		1 1/4"x18"x24" Johnson "Redhead" well screen
10				
15				
20				



Notes:
1) Existing well pulled. Well screen remained in hole. Existing hole reamed and backfilled to surface with Cement and Bentonite Grout.
2) New well installed on top of clay. Top of clay depth as per log for Well 3, 3A prepared by Roy F. Weston, Inc. (12/6/79)

COMMENTS:

FIGURE

WEHRAN ENGINEERING
CONSULTING ENGINEERS

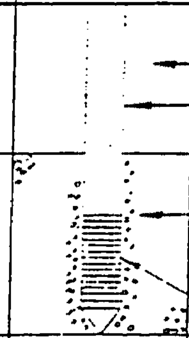
PROJECT No. 01330187

WELL LOG NO. B-4

SHEET 1 OF 1

PROJECT: Dover Chemical Corporation
CLIENT: Recra Research, Inc., Tonawanda, N.Y.
CONTRACTOR: Empire Soils, Genovese — EQUIPMENT: Truck Mounted Auger
DEPTH TO WATER: See Table — INSPECTOR: MacMillin

Date: 7/23/80 Elevation 567.68

DEPTH FT.	SAMPLE No. DEPTH		WELL CONSTRUCTION	
		2.5'		Cement & Bentonite Grout; 1 1/4" Diameter Steel Casing
5		5.5'		Sand Pack; 1 1/4"x18"x24" Johnson "Redhead" Well Screen
10				
15				
20				

Notes:
1) Existing well pulled. Well screen remained in hole. Existing hole reamed and backfilled to surface with Cement and Bentonite Grout.
2) New well installed on top of clay. Top of clay depth as per log for well 4, 4A prepared by Roy F. Weston, Inc. (12/7/79)

COMMENTS:

FIGURE

WEHRAN ENGINEERING
CONSULTING ENGINEERS

PROJECT No. 01330187

WELL LOG NO. B-5

PROJECT: Dover Chemical Corporation — SHEET 1 OF 1

CLIENT: Recra Research, Inc., Tonawanda, N.Y.

CONTRACTOR: Empire Soils, Genovese — EQUIPMENT: Truck Mounted Auger

DEPTH TO WATER: See Table — INSPECTOR: MacMillin

Date: 7/22/80 Elevation 567.15

DEPTH FT.	SAMPLE No. DEPTH		WELL CONSTRUCTION	
		1.5'		
		4.5'		
5				
10				
15				
20				

Notes:
1) Existing well pulled. Well screen remained in hole. Existing hole reamed and backfilled to surface with Cement and Bentonite Grout.
2) New well installed on top of clay. Top of clay depth as per log for well 5, 5A prepared by Roy F. Weston, Inc. (12/10/79)

COMMENTS:

FIGURE

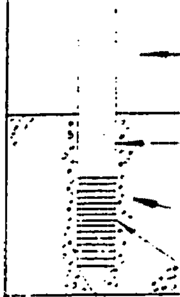
WEHRAN ENGINEERING
CONSULTING ENGINEERS

PROJECT No. 01330187

WELL LOG B-6

SHEET 1 OF 1

PROJECT: Dover Chemical Corporation
CLIENT: Recra Research, Inc., Tonawanda, N.Y.
CONTRACTOR: Empire Soils, Genovese
EQUIPMENT: Truck Mounted Auger
DEPTH TO WATER: See Table
INSPECTOR: MacMillin
Date: 7/22/80
Elevation 567.45

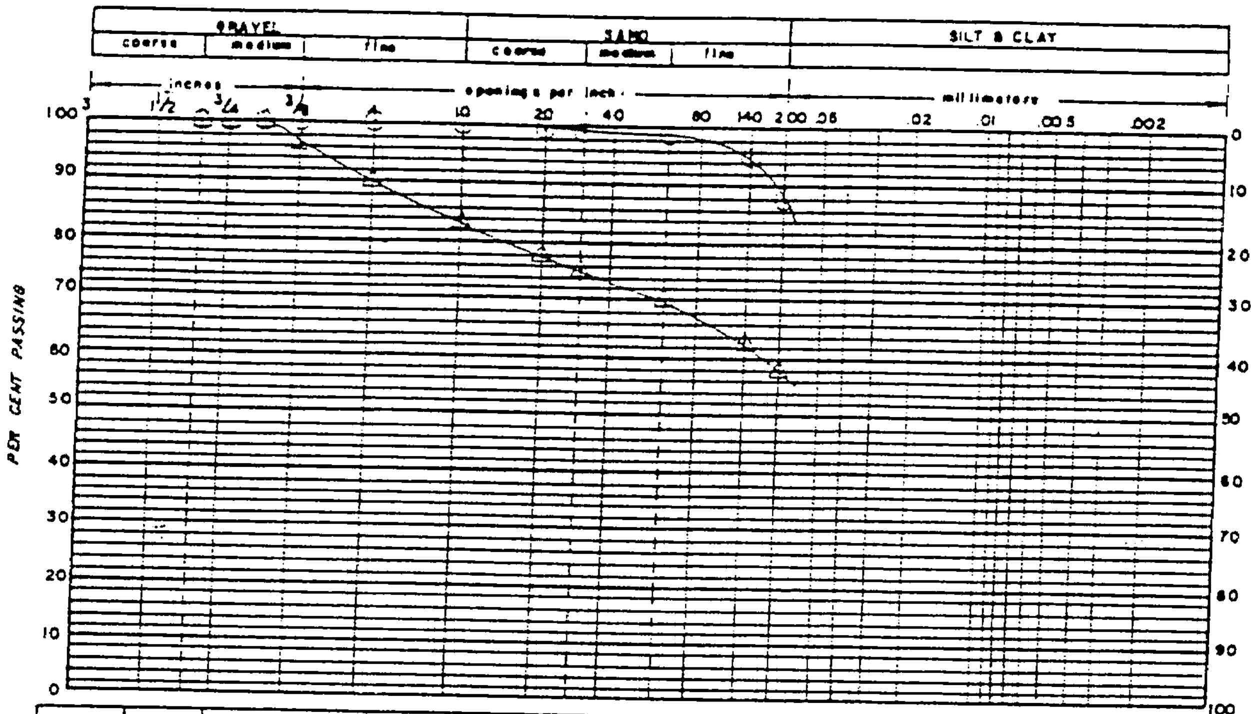
DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	WELL CONSTRUCTION	
		2.0'		Cement & Bentonite Grout 1 1/4" Diameter Steel Casing Sand Pack 1 1/4"x18"x24" Johnson "Redhead" well screen
5				
10				
15		Notes: 1) Existing well pulled, well screen remained in hole. Existing hole reamed and backfilled to surface with Cement and Bentonite Grout. 2) New well installed on top of clay. Top of clay depth, as per log for well 6, 6A prepared by Roy F. Weston, Inc. (12/19/79)		
20				

COMMENTS:

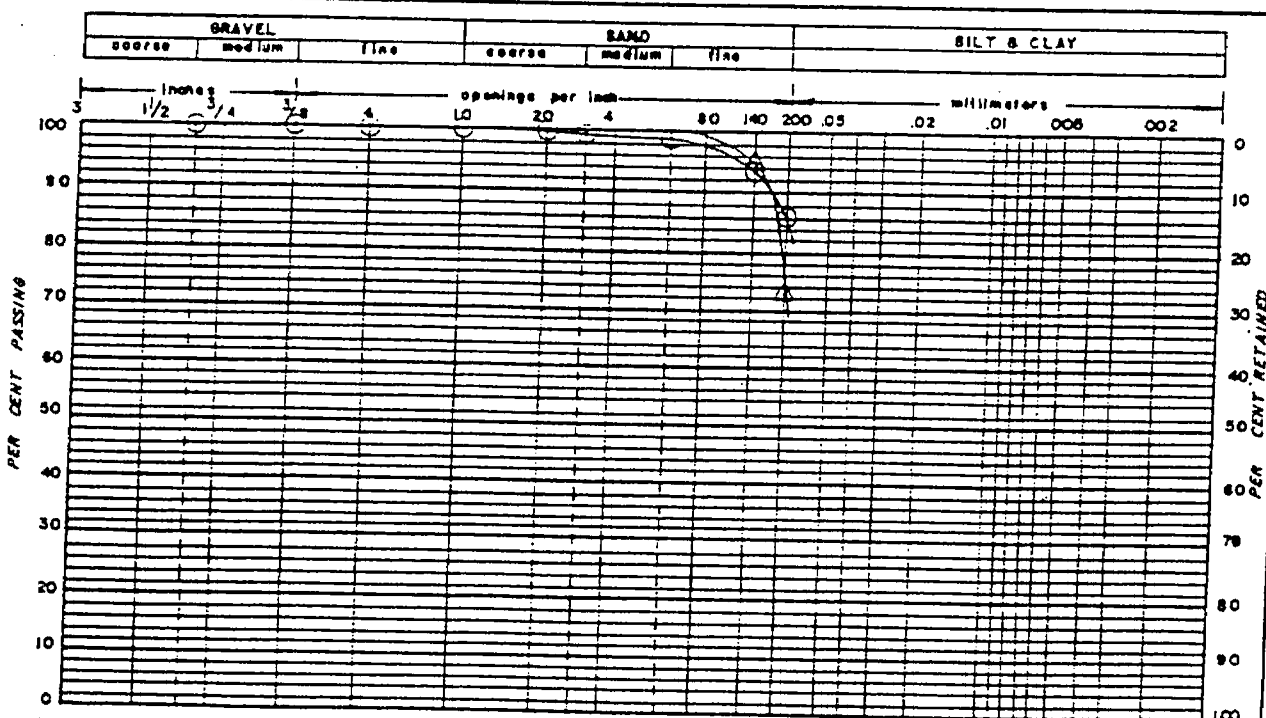
FIGURE

WEHRAN ENGINEERING
CONSULTING ENGINEERS

GRAIN-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH	SYMBOL	CLASSIFICATION	MC	LL	PL
TP-5	1	5.0 ft.	⊙	SILT, little fine sand	20.6%		
TP-5	2	8.0 ft.	△	SILT, some f-c sand, little fm gravel	11.25%		

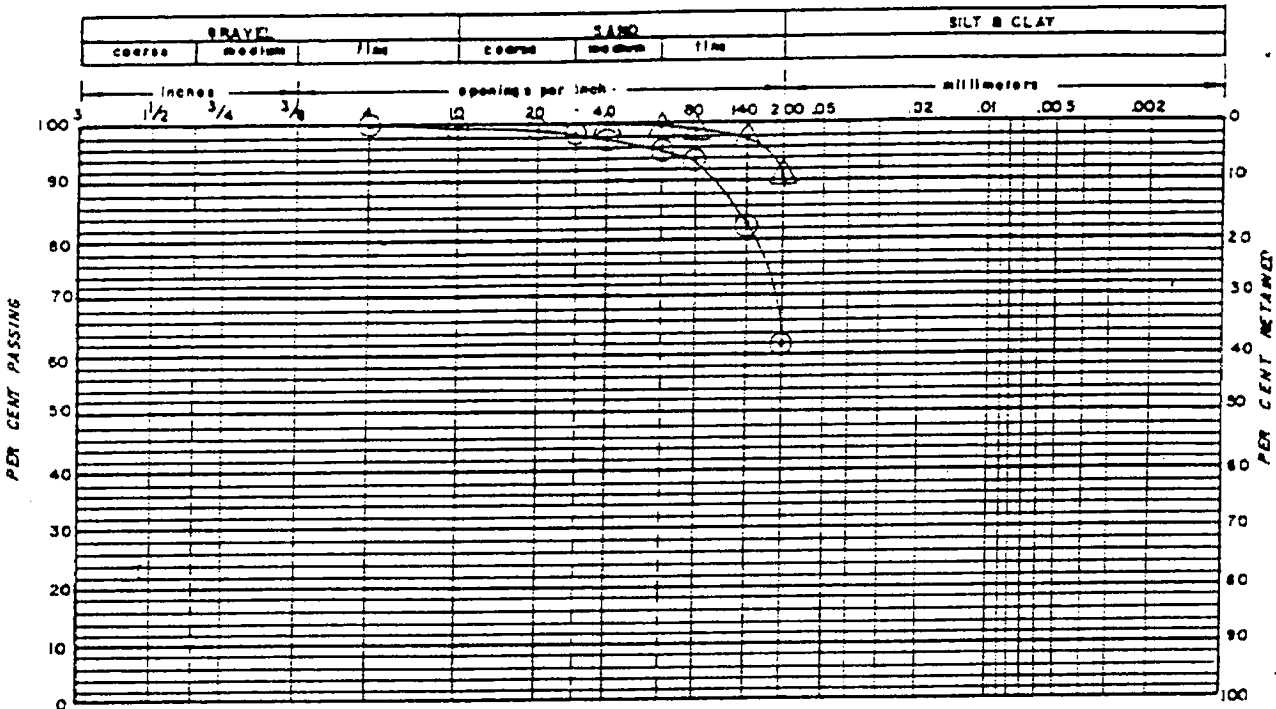


BORING	SAMPLE	DEPTH	SYMBOL	CLASSIFICATION	MC	LL	PL
TP-8	3	5.0 ft.	⊙	SILT, little fine sand	29.33%		
TP-5	1	5.0 ft.	△	SILT, some fine Sand	18.9%		

FIGURE

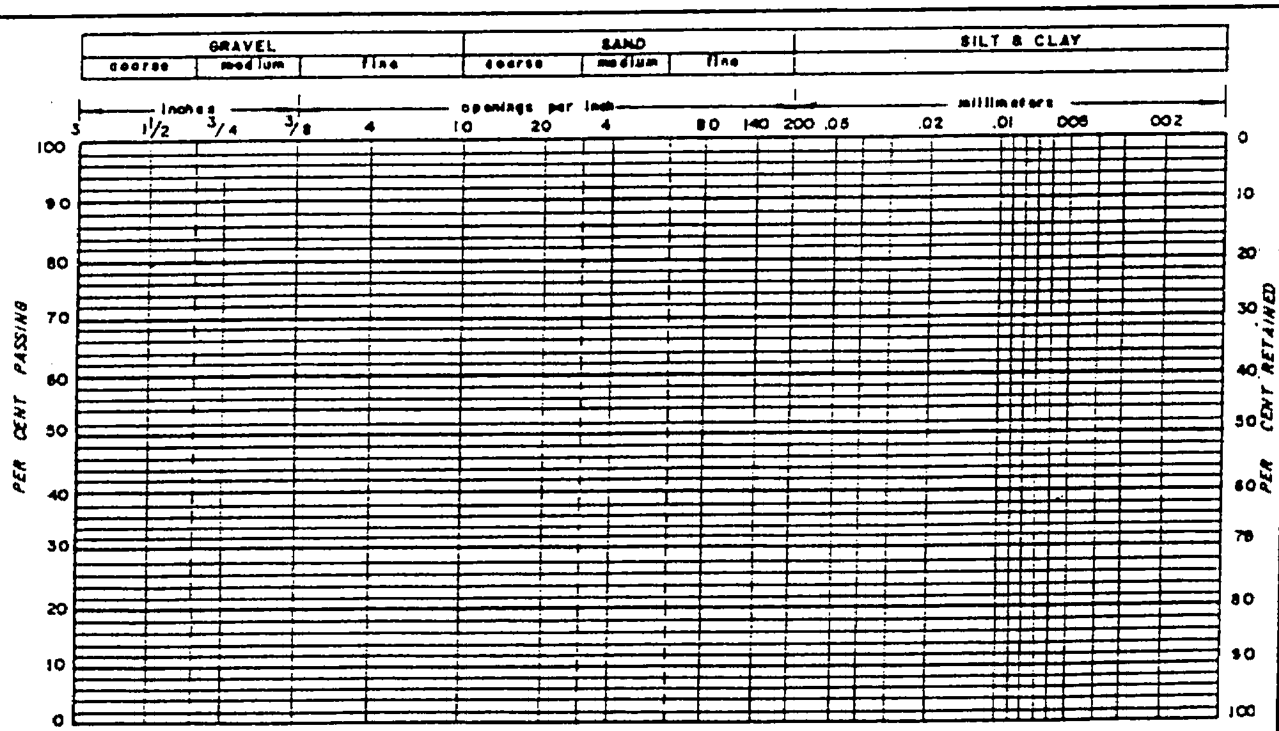
WEHRAN ENGINEERING
CONSULTING ENGINEERS

GRAIN-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH	SYMBOL	CLASSIFICATION	MC	LL	PL
TP-12	1	5.5 ft.	△	Clayey SILT, trace (+) fine Sand	30.0	41.0	22.6
TP-12	1	6.5 ft.	⊙	SILT and (-) fine to medium SAND	22.1		

FIGURE



BORING	SAMPLE	DEPTH	SYMBOL	CLASSIFICATION	MC	LL	PL

WESTON

DRILLING LOG

WELL NUMBER: 1, 1A
OWNER: Dover Chemical
LOCATION: Buffalo Avenue
ADDRESS:
TOTAL DEPTH
SURFACE ELEVATION:
WATER LEVEL:
DRILLING COMPANY: Empire
DRILLING METHOD: Auger/ Air Rotary
DATE DRILLED: 12/14/79
DRILLER: Jensen
HELPER:
LOG BY: Duffy

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
.0					Black Top Soil
1.0					~~Light Brown Silty Clay~~
8.0					Red/Brown Tight Clay
12.5					End #1 @ 12.5 5' Screen and Casing
					#1A (Cont)
12.5					Dolomite (roller bit)
14.0					Dolomite (air rotary
34.0					End @ 34' 14' Casing
					Water entry @ 16'
					* Methane produced after drilling
					Estimated water yield ≈ 30 gpm

WESTON

DRILLING LOG

WELL NUMBER: 2, 2A
LOCATION: Buffalo Ave.
OWNER: Dover Chemical
ADDRESS:
TOTAL DEPTH:
SURFACE ELEVATION:
WATER LEVEL:
DRILLING COMPANY: Empire
DRILLING METHOD: Auger/ Air Rotary
DATE DRILLED: 12/6/79
DRILLER: Jensen
HELPER:
LOG BY: Duffy

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					
					Unconsolidated material - saturated
					Black silt, rock, brick
8.0					Red Brown Clay to Bedrock
					5' Screen and Casing
11.5					End at 11.5
					2A (cont.)
11.5					Dolomite (Roller Bit)
14.0					Dolomite (Air Rotary)
					End at 34. Casing to 14'
					Water Entry at 16.5'
					Estimated water yield - 30 gpm

*ASTM D1586

WESTON

DRILLING LOG

WELL NUMBER: 3, 3A
OWNER: Dover Chemical
LOCATION: Buffalo Avenue
ADDRESS:
TOTAL DEPTH:
SURFACE ELEVATION:
WATER LEVEL:
DRILLING COMPANY: Empire
DRILLING METHOD: Auger/ Air Rotary
DATE DRILLED: 12/6/79
DRILLER: Jensen
HELPER:
LOG BY: Duffy

SKETCH MAP

NOTES

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					Unconsolidated fill
					Black silt & fill material
					Strong benzene odor
5.0					Red/Brown Clay to Bedrock
9.0					End at 9' 5' screen and casing
					3A (cont.)
9.0					Dolomite (Roller bit)
11.0					Dolomite (Air rotary)
31.0					End at 31' Casing to 11'
					Water entry @ 13'
					Estimated water yield - 35 gpm

* A.S.T.M. D1586

SHEET __ OF __

WESTON

DRILLING LOG

SKETCH MAP

WELL NUMBER: 4, 4A

OWNER: Dover Chemical

LOCATION: Buffalo Avenue

ADDRESS:

TOTAL DEPTH:

SURFACE ELEVATION:

WATER LEVEL:

DRILLING COMPANY: Empire

DRILLING METHOD: Auger/ Air Rotary

DATE DRILLED: 12/7/79

DRILLER: Jensen

HELPER:

LOG BY: Duffy

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					Stone ballast for tracks
1.0					Unconsolidated black material
6.0					Red/Brown clay to bedrock
7.0					End @ 7' 3' Screen & casing
					4A (cont.)
7.0					Dolomite (Rotary Bit)
9.0					Dolomite (Air Rotary)
29.0					End at 29' Casing to 9'
					Water entry @ 12'
					Estimated water yield - 40 gpm
					* Methane produced after drilling

* ASTM D1586

WESTON

DRILLING LOG

WELL NUMBER: 5

OWNER: Dover Chemical

LOCATION:

ADDRESS:

TOTAL DEPTH

SURFACE ELEVATION:

WATER LEVEL:

DRILLING COMPANY: Empire

DRILLING METHOD: Auger

DATE DRILLED: 12/10/79

DRILLER: Jensen

HELPER:

LOG BY: Duffy

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					Stone ballast
1.0					Black silt fill
4.5					Red/Brown clay to bedrock @ 6.5
6.5					End at 6.5' 3' Screen & casing

WESTON

DRILLING LOG

WELL NUMBER: 6 | OWNER: Dover Chemical

LOCATION: Buffalo Avenue | ADDRESS:

TOTAL DEPTH:

SURFACE ELEVATION: | WATER LEVEL:

DRILLING COMPANY: Empire | DRILLING METHOD: Auger | DATE DRILLED: 12/19/79

DRILLER: Jensen | HELPER:

LOG BY: Duffy

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS *	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					Stone ballast
1.5					Black silty material
5.0					Red/brown clay to bedrock
7.0					End at 7.0' 3' Screen & casing

SHEET

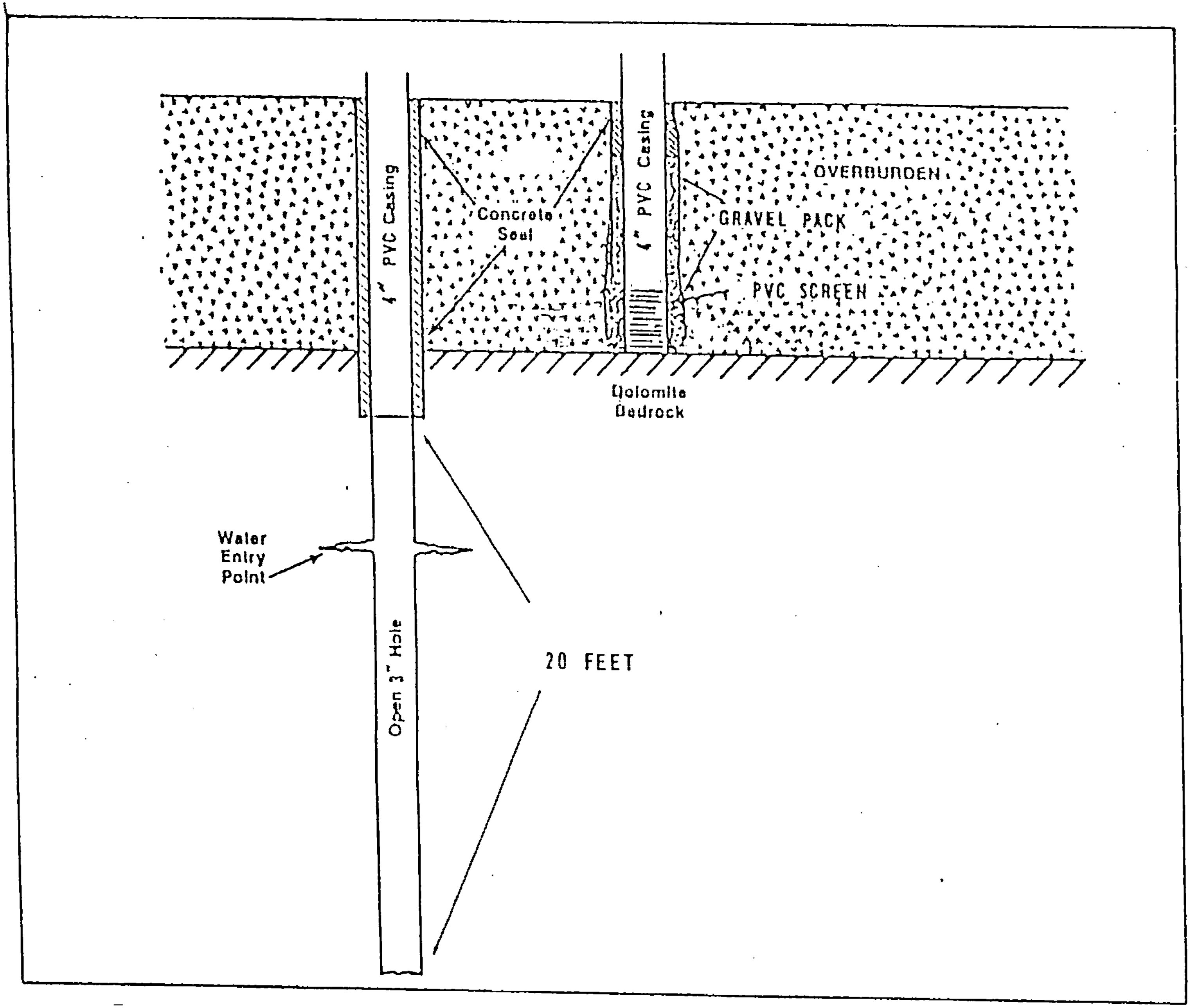


Figure 1-1 MONITOR WELL CONSTRUCTION

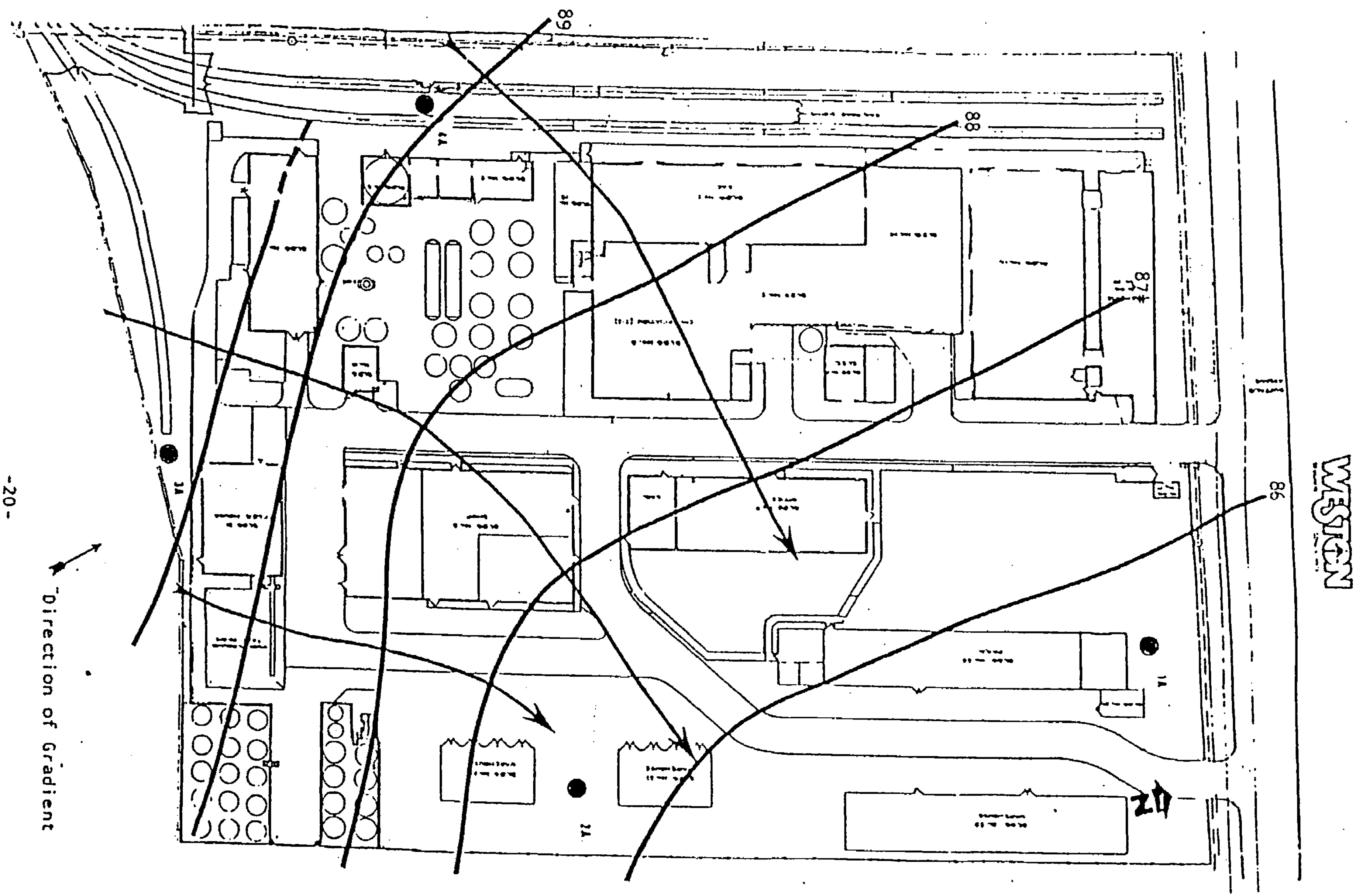


Figure 2-3 PIEZOMETRIC SURFACE 12/18/79
BEDROCK AQUIFER

INTER-OFFICE MEMO

TO: Robert K. Wyeth

DATE: 8/22/80

FROM: G. Moretti

CLIENT'S NAME: Dover Chemical

RE: Field Report

PROJECT CODE: OC223108

TEMPERATURE:

WEATHER:

WIND:

CLOUD COVER:

CREW:

DISCUSSION Dover Chemical Sampling

MANHOLES

Manholes 1→5 were collected for water and sediment on Monday 7/21/80.

TEST PITS (Sediments)

Test Pits 1→14 dug with backhoe and TW 1→2 (augered Test Pits) were dug on 7/22/80 and 7/23/80. Sediment samples (see table) were collected at various depths for NYS Leachate Test. (No sample from TW-1)

TEST PITS (Waters)

Groundwaters from piezometers were collected on 7/30/80 ——> 8/1/80. (TP 1 ——> 14 TW1, TW2).

WELLS (Waters)

Existing wells 1A,2A,3A,4A and new wells 1,2,3,4,5,6 were sampled on 7/30/80 ——> 7/1/80.

TEST PITS - DOVER CHEMICAL - SEDIMENT COLLECTIONS

TEST PITS	DEPTHS	COMMENTS
TP 1	1' 7'	Benzene or chlorobenzene odor was detectible to one degree or another in every test pit on property. The degree of contamination seemed to grade from North (least) to South (most). The southern most test pits such as TP 13, TP TP 8, TP 12, etc. required the use of a respirator by the field technicians when sampling.
TP 2	1' 7.5'	
TP 3	1' 4' 8.9'	
TP 4	1' 8'	TW-1 and TW-2 were augered because of their close proximity to buildings that were in use. It was decided that the backhoe would cause too much damage to sidewalks and roads.
TP 5	1 4.5' 8'	
TP 6	4' 7.5'	
TP 7	4' 8'	
TP 8	1' 4'	
TP 9	6' 8.5'	
TP 10	3' 6'	
TP 11	2' 5'	
TP 12	3' 5'	
TP 13	1' 4.5'	
TP 14	2' 4' 6'	
TW 2	2' 4'	augered test pit
TW 1	No samples collected	

15 (12/75)

New York State Department of Environmental Conservation

MEMORANDUM

TO: P. Buechi
FROM: Y. Erk Y. Erk
SUBJECT: Dover Chemical Corporation - Remedial Action Investigation, Hydrogeological Investigation
DATE: September 20, 1982

The subject report was reviewed. The report consists of copies of a few pages of the original report, therefore, it may not reflect the total picture at the site. My comments are as follows:

1) *The highest concentration of chlorinated benzene is located at the railroad yard, west of Building 1. Here, the finished products were shipped out. Apparently, large quantities of finished products were spilled into the ground during filling operations of railroad tank cars.*

2) *Finished products were also stored in the Tank Farm, located at the southeast corner of the plant. Ground contours of the chlorinated benzene concentration also indicate that spills occurred in this area as well.*

3) *The area is basically fill (0-4') underlain by recent alluvium and glacial till. Bedrock, on the average, is found 8' from the ground.*

4) *The groundwater surface elevation in the bedrock is lower than that in shallow water bearing zone, suggesting the existing downward hydraulic pressure.*

5) *There are six (6) wells at the site, installed by Wehran Engineering utilizing the existing wells installed by Weston. In addition, there are 16 test pit piezometers.*

6) *The shallow groundwater flow in the northern portion of the plant seems to be towards Buffalo Avenue, probably intercepted by the street utility lines. In the southern portion, the groundwater flow pattern is not clearly defined and suggests a stagnation pattern.*

7) *The plant sewer line located approximately in the middle of the site and running in a north-south direction seems to have a dramatic effect on the contamination plume migration in the site. This was also confirmed by the Niagara Falls WWTP's samples from the main sewer connection point which showed high levels of chlorinated solvents.*

8) *A recent site visit confirmed that Buildings 20, 21, and 23 were all demolished.*

9) The conductivity reading test shows complicated patterns, particularly at the north-east corner of Building 22. According to Mr. Dick Hoffman who was the president of the company from 1976-1977, Building 22 was used for a zinc metal storage area. Since the contamination is obvious and the levels are so high (only for one compound and its isomers) a meeting is necessary in order to discuss the existing problems in the site.

YE:cag