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HYDROGEOLOGIC INVESTIGATION

ALLTIFT LANDFILL

TIFFT STREET

BUFFALO, NEW YORK

Prepared By A Joint Venture Of

WEHRAN ENGINEERING CORPORATION

& RECRA RESEARCH, INC.

HYDROGEOLOGIC INVESTIGATION

ALLTIFT LANDFILL

ERIE COUNTY, BUFFALO, NEW YORK

Prepared for

Alltift, Inc.
P.O. Box 246
Buffalo, New York 14240

Prepared by

A Joint Venture of

WEHRAN ENGINEERING CORPORATION
and RECRA RESEARCH, INC.

December 4, 1978

Mr. Leonard Greenfield
Alltift, Inc.
PO Box 246
Buffalo, NY 14240

RE: Hydrogeologic Investigation
Alltift Landfill
Buffalo, New York
(WE/Recra Job No. 01338147/

Dear Mr. Greenfield:

In accordance with our proposal, we hereby submit the Hydrogeologic Investigation of the Alltift Landfill site.

As originally intended, this hydrogeologic study would have been incorporated into a broader-based engineering report, satisfying the requirements of the New York State Department of Environmental Conservation's Part 360 regulations governing solid waste management facilities. As described in the report's introduction, conditions encountered during the course of this investigation clearly necessitated a period of reevaluation and reconsideration of the landfill's future, prior to design and implementation of extensive environmental controls at the site. For this reason we have prepared this report, focusing upon the conditions encountered and their significance to continued operation at the landfill in accordance with all applicable regulations.

We have enjoyed working with you on this project and look forward to being of continued service in the future. If you have any questions, please do not hesitate to contact us.

Very truly yours,

Ken Malinowski
Vice-President
Recra Research

Robert D. Mutch, Jr.
Associate/Ground-Water Hydrologist
Wehran Engineering

KM/RDM/tf

FORWARD

This Hydrogeologic Investigation has been prepared as a joint venture of Wehran Engineering Corporation of Middletown, New York and Recra Research, Inc. of Tonawanda, New York. Wehran Engineering's responsibility focused upon the definition of the hydrogeologic conditions of the Alltift Landfill site. Recra Research, on the other hand, was responsible for all surface ground-water sampling, leaching tests and the analytical work. The complementary expertise of both firms was exercised in planning the study and assessing the extent of any environmental impact.

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INTRODUCTION

The Alltift Landfill lies in the highly-industrialized, southern portion of Buffalo, New York. It is an area characterized by the haphazard sprawl of heavy industry, rail yards, and warehouses. The landfill, as illustrated in Figure 1, lies within this industrial background, encompassing roughly 25 acres, south of Tiftt Street.

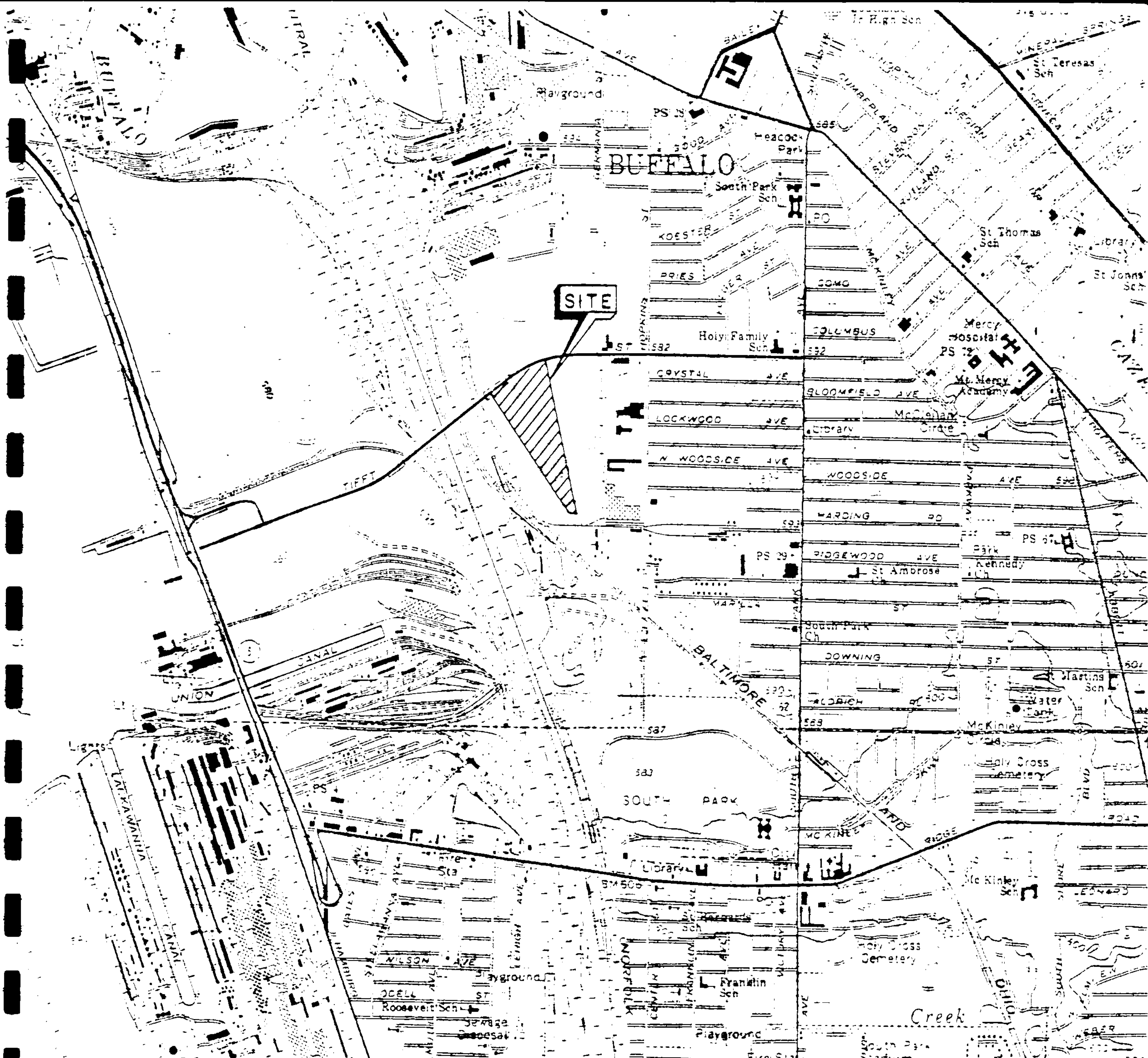
The original intention of Alltift Landfill, Inc. and Wehran Engineering/Recra Research, as their consultants, was to prepare an "Application for Approval to Construct a Solid Waste Management Facility", with all attendant engineering plans and reports, for submittal to the New York State Department of Environmental Conservation. During the course of the work undertaken pursuant to this effort, discoveries were made relative to existing conditions at the site which were of grave concern to the future operation of the landfill and warranted careful reevaluation on the part of Alltift. These anticipated factors which came to light as a result of the hydrogeologic study are as follows:

(1) The existing and previously terminated landfill over which the Alltift landfill operation was being conducted, had been the repository of a wide range of chemical wastes (hazardous and non-hazardous) which were now very evident in the leachate generated by the landfill.

(2) The leaching tests of the waste streams accepted by the current operation revealed that the impact associated with these materials would be minimal, particularly in comparison with the previously deposited wastes.

(3) The intimate physical relationship shared by the preceding and Alltift landfill operations, that is, one atop the other, meant that for all practical purposes, control of the current operation would necessitate equivalent control over the previously terminated, but considerably more hazardous, underlying wastes.

(4) The nature of the leachate generated by the previously-deposited wastes would also restrict the leachate management alternatives open to Alltift. Whereas, leachate generated solely from the current waste stream, would be more amenable to various modes of leachate treatment.



NOTE: TOPOGRAPHY TAKEN FROM
THE BUFFALO S.E. N.Y. (1965)
USGS QUADRANGLE

FIGURE 1

LOCATION MAP
OF THE
ALLTIFT LANDFILL
TIFFT STREET
BUFFALO, NEW YORK

SCALE: 1" = 2000'

PROJECT NO 01338147

Clearly, these factors warrant careful reconsideration and reevaluation by Alltift of the potential utility and liability of the landfill. Likewise, it is best that the DEC be fully-appraised of the situation before decisions relative to the future development of the property are made. Further complications, in both a technical and legal sense, are the facts that;

- Alltift, Inc. was not responsible for the disposal of any of the previously-landfilled, chemical, hazardous and non-hazardous wastes (neither were they apparently aware of the waste'spresence at the time the property was purchased)

- the lower, chemical waste landfill extends beyond the confines of the Alltift property onto a number of adjacent properties,

- all landfilling, conducted by Alltift, Inc. has been restricted to the northernmost end of the property. (See Map No. 1) (Alltift has been advised and has readily agreed to limit further landfilling to this same area for the time being.)

In view of these disturbing discoveries, further work toward preparation of engineering plans for the future expansion of the facility have been suspended until such time as the legal and technical difficulties can be sorted out and a logical course of action formulated.

HYDROGEOLOGIC FIELD INVESTIGATION

The hydrogeologic investigation was accomplished by the drilling of eight exploratory borings. Each boring was drilled under the close supervision of Wehran Engineering. The locations of each boring are depicted on Map No. 1 in the rear of this report. The specific objectives of the field work were as follows:

- to define the specific conditions under which the landfill interfaces with its geologic environment,

- to evaluate the nature of ground-water interplay within the geologic framework,

- to assess the present extent of any landfill-derived environmental impact to surface or ground waters, and

- to project the probable long-term effect of the landfill in terms of its impact on adjacent surface and ground-water resources.

Exploratory Borings B-1 through B-8

Test Borings B-1 through B-8 were drilled during June and July of 1978 by Empire Soils Investigations, Inc. of Orchard Park, New York, under the close supervision of Wehran Engineering. Split-spoon, soil samples were collected at five-foot intervals and are available for inspection by interested parties at the offices of Wehran Engineering. "Undisturbed", Shelby-tube samples were also collected from the glacial lake clays for laboratory permeability testing. For the most part, drilling was continued until refusal was met on the top of bedrock. The depth to bedrock varies from 65 feet in Boring No. 8 on the northern end of the landfill to 19 feet in Boring No. 4 on the southern end. In the case of Boring No. 4, drilling was extended into the rock by means of AX rock coring in order to more precisely characterize the rock.

Upon completion of the drilling, well points were constructed in each of the boreholes in order to monitor ground-water levels and also to permit sampling of ground-water (leachate) quality. In each case the well point was screened within the fill materials overlying the glaciolacustrine clay. The logs of each boring, describing the geologic conditions encountered are included in the Appendix. In all cases, the borehole was carefully sealed to prevent preferential migration of ground waters through the glacial lake clay aquiclude. Water levels have been regularly monitored in each of the well points since their construction. Water quality samples have also been collected from the well points. Water level data may be found in Table 2. Exact elevations of the ground surface and the top of the well casing were determined by field survey means. Gordan H. Soderholm, P. E. of Depew, New York was retained to complete this surveying work.

GEOLOGY

One of the major objectives of this investigation has been to establish the character, hydrologic properties, and areal extent of the various geologic strata and formations encountered on the property. Figure 2 illustrates the full range of the geologic conditions encountered on the property. Each of these strata are described in detail in the individual test boring logs and are graphically depicted on Geologic Sections A-A and B-B.

Bedrock

The Alltift Landfill is underlain, for the most part, by the Oatka Creek Shale member of the Marcellus formation of Devonian age. The Oatka Creek Shale has been characterized by Buehler as:

> "A dense, black fissile shale with a petroliferous odor. There are some beds of grey shale and several concretionary layers. Nodules of pyrite occur in the black shale near the base."[1]

The thickness varies from 30 to 55 feet in Erie County.[2] Figure 3 illustrates the bedrock geology of the area as taken from a map by Buehler.[3] As a result of the thickness of the surficial deposits in the area, there is a scarcity of exposures of bedrock. For this reason, the contacts between adjacent bedrock units are approximate. Evidence from the on-site drilling would seem to bear out Buehler's mapping of

1. Buehler, E. J. and I. H. Termer, Geology of Erie County, New York, p. 43.
2. Ibid, p. 42.
3. Ibid, map in rear of report.

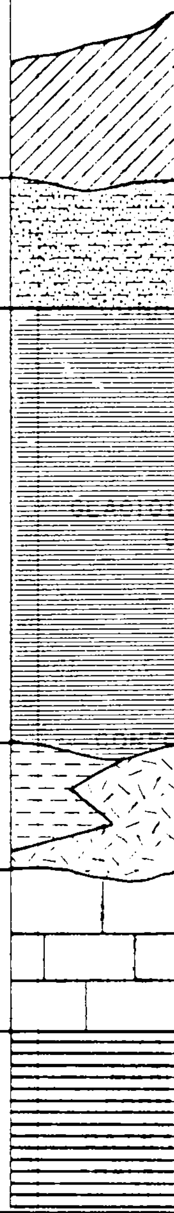
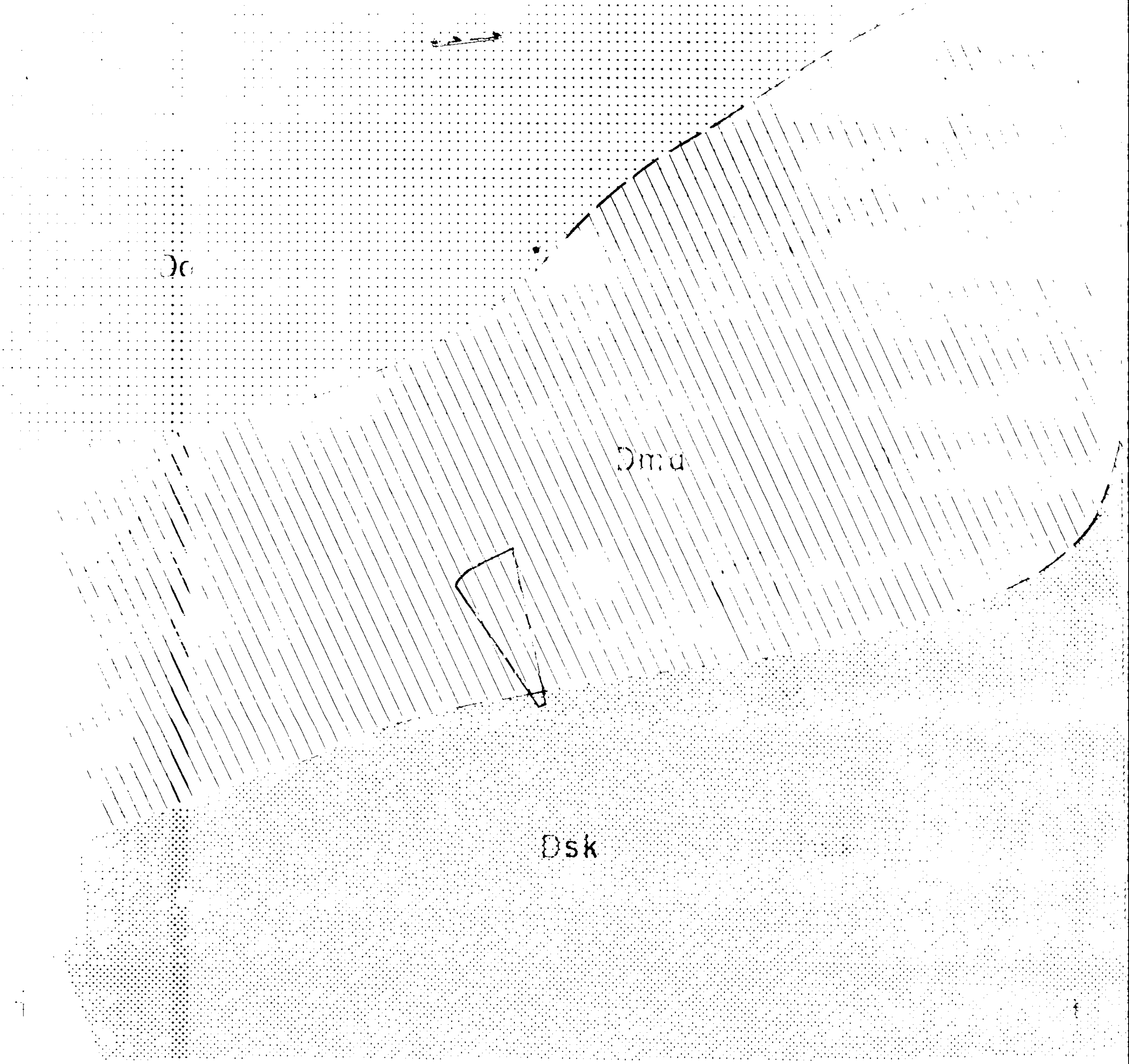
PERIOD	PERIOD	FORMATION	COLUMNAR SECTION	THICKNESS IN FEET	CHARACTER
QUATERNARY	RECENT	FILL		0 - 18	REFUSE, WOOD, CONCRETE, CINDERS, FLY ASH, DECOMPOSED VEGETATION, SAND, METAL FRAGMENTS; HIGHLY PERMEABLE
		UNCONFORMABLE			
		ALLUVIUM		0 - 6	FINE SAND, SILT; MARGINALLY PERMEABLE
		CONFORMABLE			
	PLEISTOCENE (WISCONSIN AGE)	GLACIOLACUSTRINE CLAY		6 - 43	GREY VARVED CLAY, OCCASIONAL LAMINATIONS OF SILT OR FINE SAND, STIFF AT UPPER CONTACT, SOFT TO VERY SOFT BELOW; HIGHLY IMPERMEABLE
		CONFORMABLE			
		BASAL GLACIOLACUSTRINE/ GLACIAL TILL		0 - 12.5	CLAYEY SILTS, SOME SAND AND GRAVEL; MARGINALLY PERMEABLE
		UNCONFORMABLE			
DEVONIAN		SKANEATELES FORMATION: STAFFORD LIMESTONE MEMBER		<15	GREY LIMESTONE
		MARCELLUS FORMATION: OATKA CREEK SHALE MEMBER		30 - 55	BLACK CALCAREOUS SHALE

FIGURE 2

GEOLOGIC COLUMN OF FORMATIONS ENCOUNTERED BENEATH THE ALLTIFT LANDFILL



LEGEND

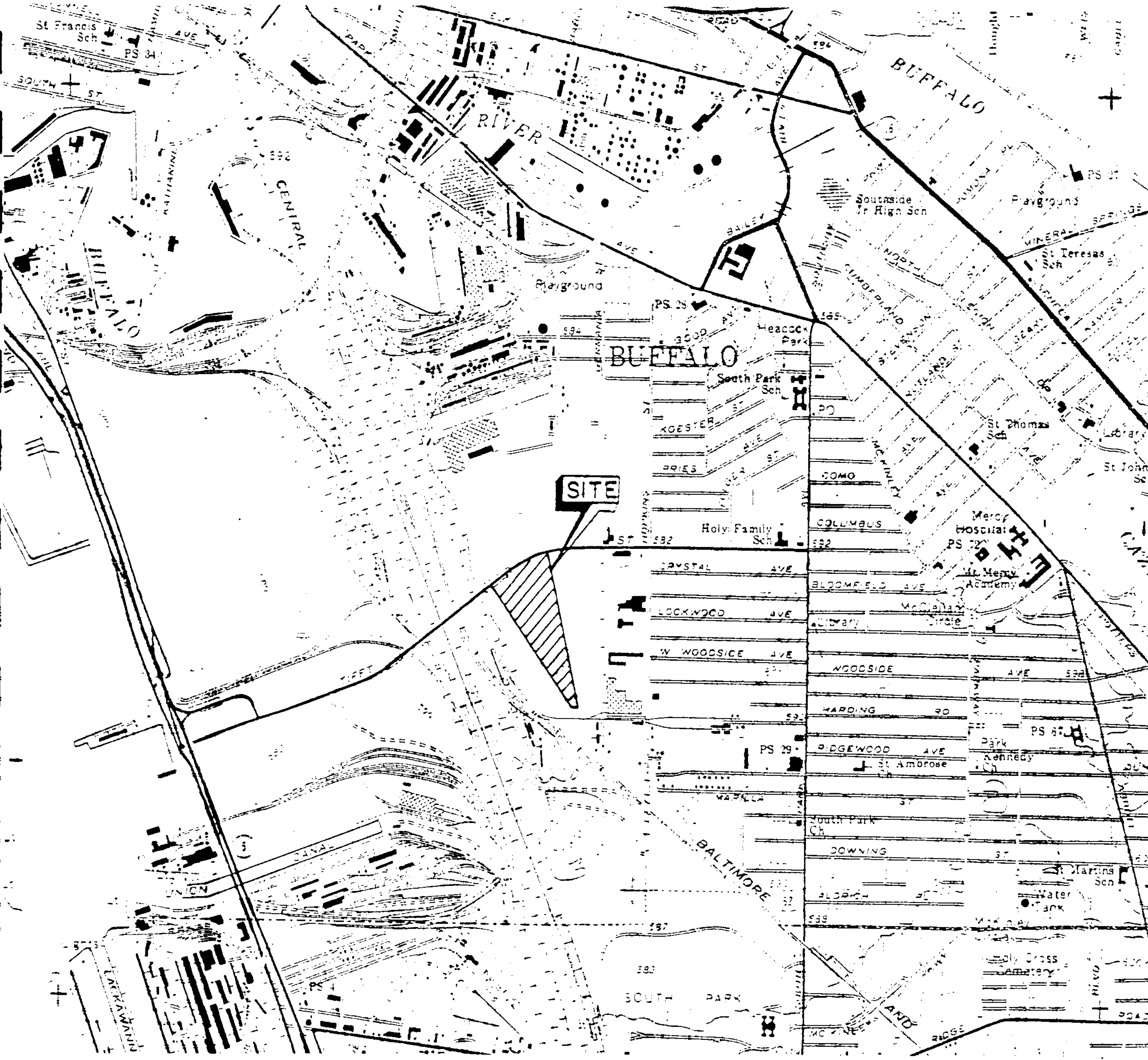
— — — — INFERRED CONTACTS

Dsk SKANEATELES FORMATION

Dma MARCELLUS FORMATION

Do ONONDAGA LIMESTONE

PROJECT NO. [illegible]



NOTE: TOPOGRAPHY TAKEN FROM THE BUFFALO S.E. N.Y. (1965) USGS QUADRANGLE GEOLOGY FROM BUEHLER (1963).

FIGURE 3

BEDROCK GEOLOGY
ALLTIFT LANDFILL

TIFFT STREET

BUFFALO, NEW YORK

SCALE: 1" = 2000'

PROJECT NO. 01338-4

the Marcellus/Skaneateles contact in the area. The rock encountered in Borings No. 3 and 4 on the southern end of the site bears a close resemblance to the description of the basal, Stafford Limestone member of the Skaneateles formation. Buehler describes the Stafford Limestone in the following manner:

> "The Stafford is a gray limestone which weathers chocolate brown. Bedding varies from massive to shaly."

Further evidence pointing to the correct position of the Marcellus/Skaneateles contact occurring near the southern end of the property is the amount of relief present in the top of bedrock. The top of bedrock in this area represents an ancient erosional surface, presumably modified by glacial action. It seems likely this relief is characteristic of a minor escarpment, consisting of a capping stratum of the more erosion-resistant Stafford Limestone overlying the less resistant Oatka Creek Shale. If this is indeed the case, the tendency would be for the escarpment to run in a generally east-west direction, parallel to the strike of the formations, just as in the case of the more prominent Niagara and Onondaga escarpments. Of course, this escarpment (presuming it does exist) has been buried and concealed from view by the deposition of glacial till and glacial lake deposits.

<u>Basal Glaciolacustrine/Glacial Till Stratum</u>

The bedrock is unconformably overlain by unconsolidated strata attributed to deposition directly by glacier ice (glacial till) and to deposition in an extinct glacial lake (glaciolacustrine deposits). The unconsolidated, glaciolacustrine deposits have been differentiated for the purpose of this study into two units. The lower unit, the Basal Glacio-lacustrine unit, consists of clayey silts and fine sand. It is interpreted as having been deposited in close proximity to the receding, glacial terminus, which formed the northern shore of the pro-glacial lake. Overlying this sandier phase in the glaciolacustrine deposits, lies the Glaciolacustrine Clay unit, characterized by varved clays and silts, which will be discussed subsequently. The glacial till and the basal (sandier) glaciolacustrine deposits are difficult to clearly differentiate in the subsurface, but since their hydrogeologic properties are quite similar, for the purposes of this study, they can be considered as one, composite unit. The thickness of this composite unit of marginally permeable clayey silts and sands varies from zero to 12.5 feet. The unit is thickest and most prevalent at the base of the inferred "escarpment".

Glaciolacustrine Clay Stratum

The glaciolacustrine Clay Stratum consists primarily of clay, Silty clay, and occasionally thin beds, or laminations of Silt and fine Sand, deposited in a Wisconsin Age (Pleistocene) glacial lake. These deposits are typically varved with occasional partings of Silt or fine sand ranging from 2 millimeters to 5 centimeters in thickness. The clay is of a high plasticity, with a consistency ranging from stiff in the upper portion of soft to very soft near the base. The unit is highly impervious, especially in regard to vertical permeability. The permeability of representative samples extracted from this unit were found to average 6.1×10^{-8} cm/sec. (See Table 5). The overall thickness of the clay ranges from about six to 43 feet, at the locations explored. The top of the glaciolacustrine clay unit is encountered at depths ranging from eight to 27.5 feet, principally as a result of the varying depth of overlying fill. The depth to the clay stratum and elevations of the top of the clay are presented in Table 1.

TABLE 1

ELEVATIONS OF THE TOP OF THE

GLACIOLACUSTRINE CLAY UNIT (Qlc)

Point	Elevation of Ground Surface (ft)	Depth to Qlc (ft)	Elevation of Qlc (ft)
Boring No. 1	593.2	21.0	572.2
Boring No. 2	591.2	23.0	568.2
Boring No. 3	604.7	27.5	577.2
Boring No. 4	593.0	13.0	580.0
Boring No. 5	584.3	8.0	576.3
Boring No. 6	591.2	17.5	573.7
Boring No. 7	600.2	26.0	574.2
Boring No. 8	590.0	21.0	569.0

Alluvial Deposits (Recent)

Overlying the glaciolacustrine clay there exists a thin, discontinuous veneer of Recent alluvial deposits. In terms of the geologic timescale, "Recent" refers to the time following closure of the glacial, or Pleistocene age, some 10,000 years ago. The alluvial deposits were usually less than six feet in thickness and in many areas were not encountered at all. It is possible that these deposits were excavated for use as cover material for the landfill or that they were never deposited in these specific areas. The unit typically consisted of marginally-permeable clayey silts, with occasional beds of fine- or medium-grained sands. In Boring No. 8, however, the stratum consisted of brown medium-to-fine-grained sand with only a trace of silt.

Fill (F)

The surface of the entire site has been filled in over the years, with the exception of the extreme southern tip of the property. By far the greatest percentage of the fill is that which was landfilled prior to operations of the Alltift landfill operation. It is this waste "stratum" which covers all but the southern tip of the property and extends beyond the Alltift property lines. It is difficult to fully assess the nature of previously deposited wastes since their heterogenous nature precludes representative sampling. In the drilling, the older wastes were described as follows:

Boring No. 2

"REFUSE, (Wood, brick, glass, plastic, partially decomposed vegetation) little mf Sand, trace fine Gravel, trace Silt.

"Oil coating sample @ 15'-0", becoming highly odorous 15'-0" to 23'-0" (base of fill)".

Boring No. 3

"Black and white mf SAND, and Refuse (paper, plastic, wood, brick, cloth, glass, concrete).

Some cinders, some flyash, some partially decomposed vegetation.

Samples were oily and very odorous at 20' to 26'-6" (base of fill)."

It has also been documented within the files of the New York State DEC that substantial quantities of chemical wastes were deposited in the landfill. In a memorandum from these files dated March 20, 1978, from Mr. Ferber of the National Aniline Division of Allied Chemical Co. to Mr. A. Roetzen of the South Buffalo District Office, Mr. Ferber lists the following materials which were disposed of monthly at the "Tifft Street Dump".

"200,000 lbs. - water.
15,000 lbs. - miscellaneous organic materials.
450,000 lbs. - inorganic materials (including filtering materials).
50,000 lbs. - chrome sludge
20,000 lbs. - copper sulfate.
100 lbs. - nitro benzene.
600 lbs. - mono chloro. benzene.
1,000 lbs. - napthalene. - U 165

A copy of this memorandum is included in the Appendix.

The waste being landfilled by the Alltift Landfill consists of core sands, flyash, and wastes from the shredding of automobile interiors. Further definition of the wastes and their leaching potential will be discussed in subsequent sections of this report. The Alltift waste covers only a small portion of the site, adjacent to Tifft Street.

GROUND WATER

The geology of the site has been discussed in preceding sections of this report. The following segment of this investigation will describe the interplay of ground water within this geologic framework.

(b) Heat Index I(h) - represents the monthly values of the Heat Index corresponding to monthly mean temperatures.

(c) Unadjusted Daily Potential Evapotranspiration (unadj PE) - represents the potential evapotranspiration for different mean temperatures and heat index values.

(d) Adjusted Potential Evapotranspiration (Adj PE) - represents the amount of potential water loss to the atmosphere through the evaporation from bare soil and the transpiration of the vegetation. The values are adjusted for month and day length corresponding to landfill latitudes (correction factor).

(e) Precipitation (P) - mean monthly values for Buffalo, New York[8] have been used.

(f) Surface Runoff R/O - represents the amount of precipitation that runs off the landfill surface before it can infiltrate into the cover soil. The amount of runoff is determined by applying the runoff coefficient (C) to the monthly precipitation. The runoff coefficient is assumed to be 15%, except during December, January, and February when it is assumed to be 20%.

(g) Infiltration (I) - represents the amount of precipitation that enters the surface of the cover material. It is simply the difference between precipitation and surface runoff.

(h) I-PE - to determine periods of moisture excess and deficiency in the soil, it is necessary to obtain the difference between infiltration and potential evapotranspiration. A negative value of I-PE indicates the amount by which the infiltration fails to supply the potential water needs of a vegetation-

8. Ibid.

covered area. A positive value of I-PE indicates the amount of excess water which is available during certain periods of the year for soil moisture recharge and percolation.

(i) Accumulated Potential Water Loss (Acc. Pot. WL) - equals the summation of the negative I-PE values.

(j) Soil Moisture Storage (ST) - represents the soil moisture retained in the soil after a given amount of accumulated potential water loss or gain has occurred.

(k) Actual Evapotranspiration (AE) - when the precipitation is greater than the potential evapotranspiration, the soil remains full of water and the actual evapotranspiration will equal the potential. When the precipitation drops below the potential evapotranspiration the soil begins to dry out and the actual evapotranspiration becomes less than the potential evapotranspiration.

(l) Moisture Deficit (D) - the amount by which the actual and potential evapotranspiration differ in the cover soil.

(m) Percolation (PERC) - after the soil moisture storage reaches the maximum water-holding capacity of the cover soil, any excess infiltration becomes percolation through the cover soil and into the underlying solid waste.

The water balance for the Alltift landfill, presented in Table 3, indicates that approximately 12.3 inches of water percolates into the landfill each year. Since, there is little doubt that whatever moisture-holding capacity the unsaturated zone of the waste may have had, has long been exhausted, percolation into the waste will become recharge to the ground-water table. In an average climatic year, the 12.3 inches of

TABLE 3

WATER BALANCE - ALLTIFT LANDFILL SITE

BUFFALO, NEW YORK (BUFFALO WSO DATA)

(All val es in inches)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEARLY
T °F	24.5	24.1	31.5	43.5	54.8	64.8	69.8	68.4	61.4	50.8	39.1	27.7	46.7
Ind	0	0	0	1.45	4.08	7.08	8.78	8.3	6.0	3.06	0.7	0	39.45
Unadj PE	0	0	0	0.04	0.08	0.12	0.14	0.13	0.10	0.06	0.02	0	
Correction Factor	24.3	24.6	30.6	33.6	37.8	38.4	38.7	36.0	31.2	28.5	24.3	23.1	
Adj PE	0	0	0	1.34	3.02	4.61	5.42	4.68	3.12	1.71	0.49	0	
P	2.84	2.72	3.24	3.01	2.95	2.54	2.57	3.05	3.13	3.00	3.60	3.00	35.65
CR/O	0.20	0.20	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.20	
R/O	0.57	0.54	0.49	0.45	0.44	0.38	0.39	0.46	0.47	0.45	0.54	0.60	
I	2.27	2.18	2.75	2.56	2.51	2.16	2.18	2.59	2.66	2.55	3.06	2.40	29.87
I-PE	2.27	2.18	2.75	1.22	-0.51	-2.45	-3.24	-2.09	-0.46	0.84	2.57	2.40	
Acc Pot - WL					-0.51	-2.96	-6.20	-8.29	-8.75				
ST	2.00	2.00	2.00	2.00	1.52	0.41	0.07	0.03	0.03	0.87	2.00	2.00	
Δ ST	0	0	0	0	-0.48	-1.11	-0.34	-0.04	0	0.84	1.13	0	
AE	0	0	0	1.34	2.99	3.27	2.52	2.63	2.66	1.71	.49	0	17.61
D	0	0	0	0	0.03	1.34	2.90	2.05	0.46	0	0	0	
PERC	2.27	2.18	2.75	1.22	0	0	0	0	0	0	1.44	2.40	12.26

percolation translates to 8,360,000 gallons of recharge, or correspondingly of leachate generation, on the 25.1 acre Alltift property. The following table illustrates the variability of leachate generation in response to highs and lows in yearly precipitation. Water balances, identical to that previously-described, were performed employing the record minimum and maximum annual precipitation rates for Buffalo to illustrate the potential range of leachate generation from the site.

TABLE 4

APPROXIMATE RATES OF LEACHATE GENERATION

FROM THE ALLTIFT LANDFILL

Climatic Conditions	Annual Precipitation (in)	Annual Percolation (in)	Annual Leachate Generation (gal)
Minimum Precipitation (1941)	22.16	6.0	4,090,000
Average	35.65	12.3	8,360,000
Maximum Precipitation (1977)	53.55	24.7	16,800,000

Leachate Discharge

The fact that on the average there is roughly 12.3 inches of leachate generation, or recharge, each year, necessitates that there be a near equivalent rate of annual discharge to maintain steady-state conditions. This discharge is accomplished by the lateral movement of ground water to periferal discharge points. The directions of groundwater, or leachate flow are illustrated on Map No. 2 at the rear of the report. The configuration of the ground-water table demonstrates that leachate flow is predominantly in a westerly direction where it ultimately discharges into the ponds and marshes which characterize the western edge of the landfill. The westerly flow of leachate is also graphically illustrated on Geologic Section B-B. Numerous leachate seeps, or springs were also observed along the landfill/marsh interface.

Glaciolacustrine Clay Aquiclude

Hydraulically separating the ground water within the surficial fill from the confined aquifer of the Oatka Creek Shale and Stafford Limestone lies the essentially impervious Glaciolacustrine Clay unit. In the seven borings which fully penetrated the stratum, its thickness was found to vary from greater than 42 feet under the northern portion of the site to six feet in the south. The permeability of this stratum of varved clay was determined by subjecting representative samples of the formation to precise laboratory testing. Woodward-Clyde Consultants were retained to perform the permeability testing in their Clifton, New Jersey laboratories. A special, constant-volume permeameter, designed specifically for extremely low permeability soils was utilized in the testing. The results of the permeability testing are presented in the following table.

TABLE 5

PERMEABILITY MEASUREMENTS OF

THE GLACIOLACUSTRINE CLAY STRATUM

Sample No.	Depth	Permeability
Boring No. 2-9U	34-36 ft.	6.4×10^{-8} cm/sec
Boring No. 5-5U	15-17 ft.	5.8×10^{-8} cm/sec

Based upon these measurements, the average permeability of the glaciolacustrine stratum is approximately 6.1×10^{-8} cm/sec. The permeability of the clay is sufficiently low, therefore, to essentially preclude any vertical migration of the upper water-table through the clay stratum to the bedrock aquifer.

The Confined Aquifer of the Oatka Creek Shale and Stafford Limestone

Although not considered a major aquifer system, water can be obtained from the Oatka Creek Shale and the Stafford Limestone in quantities sufficient to supply low yield wells. It has been reported that bedrock wells in the region south of the Buffalo River and Cayuga Creek yield an average of 55 gallons per minute (gpm) (for a sampling of 10 wells).[9] The lowest yield reported was 20 gpm, while the highest was 75 gpm. The average well depth was 70 feet. Although the preceeding data does not refer specifically to the Oatka Creek Shale or the Stafford Limestone, it indicates that, in general, limited, but adequate supplies of useable ground water can be obtained from most of the bedrock formations in the region.

WATER QUALITY

A surface and ground-water program was initiated at the Alltift, Inc. landfill site to provide both baseline water quality data and sufficient information to assess the impact of previous disposal operations at the site. This program involved sampling each of the well points installed for the hydrogeological investigation on a single occasion and five (5) surface water sample points on two different dates.

9. Reck, C. W. and E. T. Simmons, Water Resources of the Buffalo-Niagara Falls Region, map

Sampling Program

Personnel

Samples were collected at the Alltift, Inc. site by Recra Research, Inc. personnel on the following dates: July 5, 1978, July 17, 1978, and July 31, 1978. All samples were returned to Recra Research, Inc.'s laboratories on Tonawanda, New York for analysis.

Sample Points

The locations of all sample points are depicted on Map No. 1. Samples were collected from the well points (sample points B1 through B8) on a single occasion (July 31, 1978). Surface water samples were collected from the five (5) sampling points (sample points SS1 through SS5) on two separate occasions (July 5, 1978 and July 17, 1978). Event sampling was employed for the surface points in an attempt to ascertain if the impact of the site on the environment varied as weather conditions varied. The July 5, 1978 sampling occurred during a relatively dry period (greater than 120 hours since previous rainfall) while the July 17, 1978 sampling occurred within 48 hours after a rainfall.

Sampling Procedures

Prior to sampling the well points (sample points B1 through B8, Map No. 1), they were evacuated and allowed to recharge. A sufficient volume of water for testing was not obtained from well B-3. All pumping was done with an ISCO Model 1680 Sampler equipped with teflon sampling lines. To avoid cross-contamination between well points, the sampling lines were well rinsed before collecting the sample.

Surface water samples (sample points SS-1 through SS-5, Map No. 1) were grab sampled. Samples were taken approximately six (6) to eight (8) inches below the water surface.

Water samples were collected in both plastic and glass bottles. All sample bottles were scrupulously cleaned and rinsed. All glass bottles contained foil lined caps.

Analytical Program

Parameters

Both surface and ground-water samples were analyzed for the following variables:

1) pH
2) Conductivity
3) Dissolved Oxygen
4) BOD_5
5) COD
6) Total Coliform
7) Ammonia
8) Nitrate
9) Nitrite
10) TKN
11) Phosphate (Total)
12) Sulfate
13) Detergent
14) Phenols
15) Acidity
16) Alkalinity
17) Total Solids
18) Color
19) Hardness (Total)
20) Chlorides
21) Total Organic Carbon
22) Total Halogenated Hydrocarbons
23) PCB's
24) Total Aluminum
25) Total Arsenic
26) Total Chromium
27) Hexavalent Chromium
28) Total Copper
29) Total Lead
30) Total Mercury
31) Total Potassium
32) Total Sodium
33) Total Calcium
34) Total Silver
35) Total Iron

Analytical Methods

The analyses of surface and ground-water samples were performed according to either the 14th Edition of Standard Methods for the Examination of Water and Wastewater and/or the U. S. Environmental Protection Agency manual Methods for the Chemical Analysis of Water and Wastes (1974).

The total halogenated organic values expressed in ug/l as chlorine, Lindane Standard represent those organic constituents which are extractable via 15% methylene chloride in hexane, concentrated using Kuderna-Danish equipment. This concentrated extract is subjected to a

Florisil column clean-up procedure. The 6% ether in petroleum ether elution from the Florisil column is injected into a Gas Liquid Chromatograph equipped with a ^{63}Ni Electron Capture Detector and a 1.5% OV17/1.95% QF1 column.

Analytical Results

Analytical results for the ground waters are presented in Table 6, while surface water data can be found in Table 7.

Discussion

Ground Water

As discussed previously, because the site is underlain by highly impermeable clays, the possiblity of leachate reaching the bedrock aquifer and resulting in contamination is extremely remote. This fact coupled with the fact that previous landfill operations extended up to and in some cases exceeded the property boundaries of the site prompted the exclusion of the installation of bedrock wells. It was generally felt that aside from the question of impermeability, the installation of a bedrock well which would be located in part in waste deposits saturated with leachate, could provide a potential conduit for leachate to reach the bedrock aquifer. Such a situation would invalidate the protection afforded the bedrock aquifer by the subsurface impermeable clay deposits.

Because of the impermeable nature of the clay soils, a groundwater table has been created on top of the clay. This water table is contained within the previously deposited waste materials. Well points established on the site are screened in this water table and hence samples taken from the well points actually represent the leachate contained within the landfill. The following discussion presents specific and general

ANALYTICAL RESULTS
ALLTIFT COMPANY, INC. LANDFILL SITE
GROUND WATER SAMPLES

TABLE 6

Sampling Date: 7/31/78
Report Date: 9/26/78

PARAMETER	UNITS OF MEASURE	SAMPLING LOCATION B1	B2	B4	B5	B6
pH	Standard Units	7.28	7.47	6.43	7.10	7.34
Conductivity	µmhos/cm	6,000	21,000	11,000	4,000	5,400
Dissolved Oxygen	mg/l	5.8	4.3	7.2	4.2	6.2
BOD_5	mg/l	359	7,020	96.5	242	605
COD	mg/l	489	2,580	593	291	379
Total Coliform	MPN/100ml	130	24,000	230	130	24,000
Ammonia	mg N/l	77.6	1,930	73.9	61.2	107
Nitrate	mg N/l	<0.1	<0.5	<0.5	0.12	<0.1
Nitrite	mg N/l	0.05	<0.05	<0.05	0.08	0.05
TKN	mg N/l	91.9	1490	106	69.2	125
Phosphate (total)	mg P/l	0.556	1.29	0.044	0.086	0.130
Sulfate	mg/l	86.3	441	2,660	387	240
Detergent	MBAS mg/l	0.16	0.05	0.19	0.15	0.03
Phenols	mg/l	0.037	0.696	0.050	0.020	0.030
Alkalinity	mg/l as $CaCO_3$	2,280	8,270	915	1,530	1,760
Total Solids	mg/l	4,410	30,000	9,590	2,990	4,950
Color	True Pt-Co Units	500	-	200	150	200
Hardness (total)	mg/l	665	1,250	2,260	665	594
Chlorides	mg/l	3,630	8,450	3,880	730	1,010
Total Organic Carbon	mg/l	950	1,400	313	110	488
Total Halogenated Hydrocarbons	µg/l as Cl, Lindane Standard	8.42	38.4	1.32	1.24	3.33
PCB's	µg/l as 1254	<1.0	<1.0	<1.0	<1.0	<1.0
Total Aluminum	mg/l	0.26	0.05	0.24	0.06	<0.03
Total Arsenic	µg/l	6.3	131	<4	5.1	21.3
Total Chromium	mg/l	0.014	0.546	<0.003	0.010	0.006
Hexavalent Chromium	mg/l	<0.01	0.04	<0.01	<0.01	<0.01
Total Copper	mg/l	<0.003	0.026	0.015	0.21	0.005
Total Lead	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03
Total Mercury	µg/l	<1.3	3.8	<1.3	<1.3	<1.3
Total Potassium	mg/l	98	908	146	118	128
Total Sodmium	mg/l	1,060	3,080	2,020	840	1,140
Total Calcium	mg/l	214	54	760	146	190
Total Silver	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002
Total Iron	mg/l	0.28	2.43	5.08	0.16	0.03

COMMENTS: Samples were collected by Recra personnel and received on 7/31/78. Data not provided in these tables are a consequence of insufficient sample volume for completion of the required analyses. The determination of true color of samples from B2 and B7 were turbid after centrifugation and could not be matched with any standard Pt-Co Color Unit. Sample B2 exhibited higher NH_3-N than Total Kjeldahl Nitrogen (TKN). These results are believed to be due to the positive interferences in the NH_3-N analyses from amines and other nitroso compounds that would not effect the TKN results. This conclusion is supported by the presense of numerous nitrogen compounds as seen in the chromatographs for the total halogenated organics analyses.

FOR RECRA RESEARCH, INC. [signature]

DATE 9/26/78

RECRA RESEARCH, INC. 111 Wales Avenue/Tonawanda, New York 14150/(716) 692-7620
TOTAL CHEMICAL WASTE MANAGEMENT THROUGH APPLIED RESEARCH

ANALYTICAL RESULTS
ALLTIFT COMPANY, INC. LANDFILL SITE
GROUND WATER SAMPLES

TABLE 6

Sampling Date: 7/31/78
Report Date: 9/26/78

PARAMETER	UNITS OF MEASURE	SAMPLING LOCATION				
		B7	B8	-	-	-
pH	Standard Units	8.00	7.70	-	-	-
Conductivity	umhos/cm	7,900	6,000	-	-	-
Dissolved Oxygen	mg/l	-	-	-	-	-
BOD_5	mg/l	-	-	-	-	-
COD	mg/l	780	499	-	-	-
Total Coliform	MPN/100ml	-	-	-	-	-
Ammonia	mg N/l	259	113	-	-	-
Nitrate	mg N/l	<0.1	<1.0	-	-	-
Nitrite	mg N/l	0.07	0.12	-	-	-
TKN	mg N/l	-	-	-	-	-
Phosphate (total)	mg P/l	-	0.044	-	-	-
Sulfate	mg/l	-	299	-	-	-
Detergent	MBAS mg/l	-	0.03	-	-	-
Phenols	mg/l	0.089	0.071	-	-	-
Alkalinity	mg/l as $CaCO_3$	2,250	2,390	-	-	-
Total Solids	mg/l	6,100	6,100	-	-	-
Color	True Pt-Co Units	-	700	-	-	-
Hardness (total)	mg/l	-	536	-	-	-
Chlorides	mg/l	2,070	1,430	-	-	-
Total Organic Carbon	mg/l	-	538	-	-	-
Total Halogenated Hydrocarbons	µg/l as Cl, Lindane Standard	-	-	-	-	-
PCB's	µg/l as 1254	-	-	-	-	-
Total Aluminum	mg/l	<0.03	0.24	-	-	-
Total Arsenic	µg/l	15.4	12.2	-	-	-
Total Chromium	mg/l	0.016	0.012	-	-	-
Hexavalent Chromium	mg/l	0.01	0.01	-	-	-
Total Copper	mg/l	0.01	0.014	-	-	-
Total Lead	mg/l	<0.03	<0.03	-	-	-
Total Mercury	µg/l	10.7	-	-	-	-
Total Potassium	mg/l	182	118	-	-	-
Total Sodium	mg/l	1,560	1,300	-	-	-
Total Calcium	mg/l	56	18	-	-	-
Total Silver	mg/l	0.004	0.003	-	-	-
Total Iron	mg/l	0.46	0.02	-	-	-

COMMENTS: The analyses of PCB's included Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, and 1268. None of these Aroclors were found in detectable concentrations. For reporting purposes Aroclor 1254 was arbitrarily chosen for presentation of a working detection limit. The other Aroclors exhibit similar detection limits.

FOR RECRA RESEARCH, INC. Robert K. Wyeth

DATE 9/26/78

RECRA RESEARCH, INC. 111 Wales Avenue/Tonawanda, New York 14150/(716) 692-7620
TOTAL CHEMICAL WASTE MANAGEMENT THROUGH APPLIED RESEARCH

ANALYTICAL RESULTS
ALLTIFT COMPANY, INC. LANDFILL SITE
SURFACE WATER SAMPLES

TABLE 7

Sampling Date: 7/5/78
Report Date: 9/26/78

PARAMETER	UNITS OF MEASURE	SAMPLING LOCATION				
		SS1	SS2	SS3	SS4	SS5
pH	Standard Units	1.95	1.93	7.78	7.30	7.52
Conductivity	umhos/cm	8800	8200	5700	5500	5000
Dissolved Oxygen	mg/l	1.40	0.75	3.60	1.60	2.80
BOD5	mg/l	8.09	21.6	150	212	191
COD	mg/l	60.6	70.7	495	495	404
Total Coliform	MPN/100ml	≤200	≤200	14,000	54,000	17,000
Ammonia	mg N/l	1.31	1.80	31.9	71.0	41.2
Nitrate	mg N/l	21	21	0.20	<0.10	<0.10
Nitrite	mg N/l	-	-	-	-	-
TKN	mg N/l	4.92	1.96	39.3	78.1	45.1
Phosphate (Total)	mg P/l	0.05	0.05	0.83	1.58	0.34
Sulfate	mg/l	5850	6130	592	578	769
Detergent	MBAS mg/l	<0.02	<0.02	0.13	0.16	0.14
Phenols	mg/l	0.034	0.027	0.039	0.094	0.071
Acidity	mg/l as $CaCO_3$	6290	5940	-	-	-
Alkalinity	mg/l as $CaCO_3$	-	-	1620	1980	1090
Total Solids	mg/l	10,200	9310	4470	4230	4060
Color	True Pt-Co Units	1400	1250	1250	750	1000
Hardness (Total)	mg/l	900	530	740	840	460
Chlorides	mg/l	18.7	18.0	1140	1080	1190
Total Organic Carbon	mg/l	39.0	27.0	415	470	490
Total Halogenated Hydrocarbons	µg/l as Cl, Lindane Standard	1.83	1.33	3.07	7.32	1.76
PCB's	ug/l as 1254	<1.25	<0.50	≤2.50	<0.25	<1.25
Total Aluminum	mg/l	2.92	2.64	0.27	0.26	0.27
Total Arsenic	µg/l	89	57	46	74	75
Total Chromium	mg/l	0.763	0.751	0.039	0.057	0.040
Hexavalent Chromium	mg/l	0.70	0.71	0.03	0.05	0.03
Total Copper	mg/l	6.89	1.71	0.130	0.440	0.360
Total Lead	mg/l	0.42	0.38	<2	<2	0.04
Total Mercury	µg/l	<1.0	<1.0	<1.0	<1.0	<1.0
Total Potassium	mg/l	26.9	20.0	182	331	256
Total Sodium	mg/l	440	68	1360	1010	1020
Total Calcium	mg/l	360	600	88	148	176
Total Silver	mg/l	0.017	0.021	0.006	0.007	0.005
Total Iron	mg/l	1832	1144	18.3	18.4	12.4

COMMENTS: Samples were collected by Recra personnel and received on 7/5/78. Nitrite nitrogen analyses could not be completed due to interferences present in the samples. Differences in detectabilities for PCB's is a result of different final volumes of the sample extracts. Sample SS3 was believed to contain PCB's but due to the low levels in the extract (<0.5 mg/µl) the exact amount in the original sample was not quantifiable. Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260 and 1268 were used for quantification purposes. Aroclor 1254 was arbitrarily selected for reporting purposes. These data are reported as less than the detection limit of 1254. The detection limits of the other Aroclors are approximately the same as for 1254.

FOR RECRA RESEARCH, INC. [signature] DATE 9/26/78

RECRA RESEARCH, INC. 111 Wales Avenue/Tonawanda, New York 14150/(716) 692-7620
TOTAL CHEMICAL WASTE MANAGEMENT THROUGH APPLIED RESEARCH

3/20/68

Chas. Infantino

A. Roetzer - South Buffalo District Office

Tifft Street Dump - dumping of toxic matter from National Aniline, Div. of Allied Chemical Co.

Approximate weights and types of chemicals being disposed of at the Tifft Street Dump by the National Aniline Division of Allied Chemical Co. as reported to Mr. Roetzer by Mr. Ferber - National Aniline.

Approximate weights per month

200,000 lbs. - water.

15,000 lbs. - miscellaneous organic materials.

450,000 lbs. - inorganic materials (including filtering materials).

50,000 lbs. - chrome sludge.

20,000 lbs. - copper sulfate.

100 lbs. - nitro benzene.

600 lbs. - mono chloro. benzene.

1,000 lbs. - napthalene.

1 - 3500 gallon tank disposed of daily.

For any further information regarding this matter contact Mr. Ferber - National Aniline, Division of Allied Chemical Co.

WEHRAN ENGINEERING

TEST BORING LOG

Project No. 8147 Client RECRA RESEARCH, INC. - TONAWANDA Boring No. 1

Project LANDFILL DESIGN - SUBSURFACE SOIL INVESTIGATION Date Start 6/19/78

Location TIFFT STREET, BUFFALO, NEW YORK Date Finish 6/19/78

Type of Rig TRUCK MOUNTED AUGER Driller EMPIRE SOILS, INC Inspector JHK

Depth	Elevation	Casing Blows/ft	Sample No.	Type	Spoon blows 6" Penetr.		Average Blows/ft	Log	Classification "O" Elev. = 593.2	Remarks
0			1	SS	2 / 3	3 / X			Fill: Black and white mf SAND and cf Gravel, some black Silt, some minus partially decomposed Vegetation, trace Refuse.	Loose, moist
5			2	SS	5 / 6	5 / X			(foundry sand, cinders, fly ash, wood rubber)	Medium moist
10			3	SS	5 / 25	40 / X			Becomes saturated @ 10.7'	Very dense moist
15			4	SS	1 / 2	1 / X				Very loose saturated
20			5	SS	2 / 5	3 / X			21'0"	Loose saturated
	CLAY CUTTINGS								Glaciolacustrine Deposits: Gray Silty CLAY to CLAY & SILT, laminations of f SAND and SILT. Saturated	Stiff saturated
25			6	SS	8 / 13	10 / X				
30			7	SS	1 / 3	2 / X		CH	Grading at 27'-0" to; Grey CLAY. Soft to very soft, occasional laminations and very thin beds of grey SILT, indistinct varving.	Soft saturated
35			8	SS	Weight of Hammer	of / X				Very soft saturated

WEHRAN ENGINEERING

TEST BORING LOG

Project No. 8147 Client RECRA RESEARCH, INC. - TONAWANDA Boring No. 1

Project LANDFILL DESIGN - SUBSURFACE SOIL INVESTIGATION Date Start 6/19/78

Location TIFFT STREET, BUFFALO, NEW YORK Date Finish 6/19/78

Type of Rig TRUCK MOUNTED AUGER Driller EMPIRE SOILS, INC Inspector JHK

Depth	Elevation	Casing Blows/ft	Sample No.	Sample Type	Sample Spoon blows 6" Penetr.		Average Blows/ft	Log	Classification "O" Elev. = 593.2	Remarks
			9	SS	Wt. of	Hammer				Very soft saturated
					2	X				
45										
			10	SS	1	1				
					2	X			Grey CLAY (as before)	Soft saturated
50										
			11	SS	Wt. of	Hammer		CH		Soft saturated
					2	X				
55	CLAY									
			12	SS	Wt.	of			Becoming alternating laminations of grey and red Silty CLAY @ 55'	Very soft saturated
					Rods	X				
60										Very soft saturated
			13	SS	Weight	of				
					Rods	X			63'8"	
			14	SS	100/R	X			Black LIMESTONE	Very dense
65									END OF BORING 63'9"	
70										
75										

ANALYTICAL RESULTS
ALLTIFT COMPANY, INC. LANDFILL SITE
SURFACE WATER SAMPLES

TABLE 7

Sampling Date: 7/17/78
Report Date: 9/26/78

PARAMETER	UNITS OF MEASURE	SAMPLING LOCATION				
		SS1	SS2	SS3	SS4	SS5
pH	Standard Units	2.38	2.36	7.95	8.01	7.51
Conductivity	umhos/cm	9400	9400	6600	7400	5500
Dissolved Oxygen	mg/l	0.5	0.5	3.20	5.06	5.16
BOD_5	mg/l	36.7	12.3	193	339	169
COD	mg/l	60.6	70.7	495	495	404
Total Coliform	MPN/100ml	≤200	≤200	1700	4900	35,000
Ammonia	mg N/l	1.42	2.10	31.8	72.9	40.1
Nitrate	mg N/l	18	18	0.16	<0.10	<0.10
Nitrite	mg N/l	-	-	-	-	-
TKN	mg N/l	5.22	3.99	59.4	86.5	40.7
Phosphate (Total)	mg P/l	0.05	0.05	1.17	7.40	0.15
Sulfate	mg/l	6050	5930	696	589	956
Detergent	MBAS mg/l	<0.02	<0.02	0.14	0.14	0.10
Phenols	mg/l	0.040	0.036	0.058	0.043	0.057
Acidity	mg/l as $CaCO_3$	6210	6480	-	-	-
Alkalinity	mg/l as $CaCO_3$	-	-	1880	2250	1140
Total Solids	mg/l	9970	10,400	4890	5540	4200
Color	True Pt-Co Units	1500	1500	1670	3500	1000
Hardness (Total)	mg/l	600	650	860	765	750
Chlorides	mg/l	11.6	13.1	1270	1570	1050
Total Organic Carbon	mg/l	30.0	30.5	785	805	505
Total Halogenated Hydrocarbons	µg/l as Cl, Lindane Standard	2.31	7.25	1.02	<0.75	<0.75
PCB's	µg/l as 1254	<2.50	<2.00	≤2.50	<1.0	<1.0
Total Aluminum	mg/l	4.91	4.87	0.11	0.15	0.06
Total Arsenic	µg/l	94	34	8	2	5
Total Chromium	mg/l	0.834	0.874	0.040	0.042	0.066
Hexavalent Chromium	mg/l	0.80	0.82	0.03	0.04	0.05
Total Copper	mg/l	1.0	1.3	0.017	<0.003	0.010
Total Lead	mg/l	0.51	0.51	<0.02	<0.02	<0.02
Total Mercury	µg/l	<1.0	<1.0	<1.0	<1.0	<1.0
Total Potassium	mg/l	3.5	4.8	286	289	246
Total Sodium	mg/l	340	70	1220	1100	1050
Total Calcium	mg/l	184	652	116	148	56
Total Silver	mg/l	0.008	0.008	<0.003	<0.003	<0.003
Total Iron	mg/l	2030	1770	2.00	0.80	1.20

COMMENTS: Samples were collected by Recra personnel and received on 7/17/78. Nitrite nitrogen analyses could not be completed due to interferences present in the samples. Differences in detectabilities for PCB's is a result of different final volumes of the sample extracts. Sample SS3 was believed to contain PCB's but due to the low levels in the extract (<0.5 mg/µl) the exact amount in the original sample was not quantifiable. Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260 and 1268 were used for quantification purposes. Aroclor 1254 was arbitrarily selected for reporting purposes. These data are reported as less than the detection limit of 1254. The detection limits of the other Aroclors are approximately the same as for 1254.

FOR RECRA RESEARCH, INC. [signature] DATE 9/26/78

RECRA RESEARCH, INC. 111 Wales Avenue/Tonawanda, New York 14150/(716)692-7620
TOTAL CHEMICAL WASTE MANAGEMENT THROUGH APPLIED RESEARCH

detail concerning the quality of this ground water (Refer to Table 6 for analytical data).

All ground-water samples exhibited pH values within the range of those normally found in the environment. Both conductivity and chloride were relatively high and are indicative of a leachate type water. The dissolved oxygen content in ground water from all well points was found to be within normally encountered ranges.

The BOD_5 of ground waters within the landfill were quite high, particularly the level found in Boring No. 2. The coliforms followed an identical pattern. B2 contained copious amounts of sulfide and was believed to contain heterotropic sulfur bacteria. Although B6 exhibited the high coliform count, it did not show the high sulfide content. This pattern of high BOD_5 and total coliforms was not unexpected in view of the fact that the site has, in the past, been used as a disposal point for putrescible waste.

Values for TOC and COD are in general elevated, especially for the well point at B2.

The NH_3-N levels in all well points were high and were believed to be indicative of the increased biological activity especially at well B2. As would be expected in this subterranean environment, NO_2-N and NO_3-N levels were all low or below analytical detectabilities. As was seen in the surface water data, the TKN levels in the ground water represent almost entirely the NH_3-N concentrations, implying low organic nitrogen content in the ground water. At well point B2, the NH_3-N value exceeded the TKN content. These results are believed to be due to positive interferences in the NH_3-N analyses from nitroso compounds possibly present.

Total phosphate levels, are in excess of normal ground-water levels, particularly those levels encountered in well points B1 and B2. Only well point B4 exhibited SO_4 levels beyond those normally encountered in ground waters from this area. Detergents as MBAS were also seen to be low in all the ground waters.

The phenol content of the ground-water samples although above normally expected levels, is relatively low and suggests that any phenolic contamination from deposited waste materials may be undergoing biological oxidation.

Both the total solids content and the alkalinities of the ground-water samples are high, particularly at B2. Values encountered are typical for sanitary landfill leachates in general.

Total halogenated hydrocarbons (total halogenated organics) are generally within the normal range of values found within similar environments. The only well point to exhibit high concentrations was B2. This well point also showed the possible presence of numerous organonitrogen compounds as exhibited by the GC electron capture chromatograph.

Correspondence examined at the Delaware Avenue offices of the New York State Department of Environmental Conservation indicate that this landfill site had been utilized in the past by the National Aniline Division of Allied Chemical Company. Among the materials previously disposed at this site are nitrobenzenes and monochlorobenzene. It is conceivable that well point B2 is located in one of these dumping areas.

The results of the metal analyses indicated intermittently high levels of some constituents. Of greatest concern are the levels of arsenic, mercury, and chromium. As indicated previously, industrial wastes have been disposed of at the Alltift site. These localized areas of high metal concentrations may reflect areas previously used for the disposal of industrial wastes.

Generally the quality of the water table situated on top of the clay at the Alltift site is poor. Parameters examined exhibit concentration levels typical of sanitary landfill leachate. This is not surprising in view of the fact that the site has, in the past, received typical sanitary landfill type waste. In addition to the presence of contaminants characteristic of sanitary landfill leachates, other contaminants are present that are indicative of industrial wastes. Examination of files in the possession of the New York State Department of Environmental Conservation concerning this site demonstrate its use as an industrial landfill. The following materials have been specifically identified as having been disposed of at the Alltift site: bulk loads of dyes, oil sludges, phenolic compounds, chrome sludge, copper sulfate, nitrobenzene, monochlorobenzene, and naphthalene. The presence of various constituents of these wastes in the water samples analyzed provides confimatory evidence for the presence of these materials in the landfill.

Surface Water

Ponded surface water surrounds the Alltift site on the south and west sides. Two distinct bodies of water are discernible. One extends along the southeast corner of the site, and the second is located along the western side of the site. Although on no occasion were these two ponds observed to be connected at the surface, it is highly probable that flow occurs from the south pond into the west pond through the subsurface. It is also probable that because of the low elevation of the land separating the two ponds that during periods of heavy precipitation, the south pond discharges over the land barrier into the west pond. Flow from the pond system is in a northerly direction under Tiftt Street, and into a drainage ditch. This ditch flows in an easterly direction along an access road for the South Buffalo Railroad that runs parallel to Tiftt Street. This drainage ditch empties into a storm sewer that purportedly flows into the Buffalo River.

As discussed in previous sections of this report, a ground-water mound exists within the landfill. This fact, as stressed previously, indicates that ground water is moving radially outward from the property to off-site discharge points. As the following discussion will show, the primary discharge point appears to be the pond system.

During the course of this investigation, it was discovered that there is a surface discharge into the south pond from a pipe that appears to have its origin from Ramco Steel, Inc. On both sampling dates, a discharge was noted emanating from the pipe. A review of pertinent records revealed that Ramco Steel, Inc. possesses a permit (Permit #74971) to discharge 50,000 gallons per day of an effluent consisting of sulphuric acid pickling liquor, and pickled steel rinse. As stated in the permit, discharge is through a lagoon, ponds, and ditches to the Buffalo River. Table 8 contains information relating to the effluent criteria contained in the permit. As the following discussion will make quite evident, this discharge has a significant impact on the quality of surface waters in the area.

Surface water samples were collected on two dates: July 5, 1978 and July 17, 1978. The location of the sample points is depicted on Map No. 1. Samples points 1 and 2 were located in the south pond while

TABLE 8

Ramco Steel, Inc.
110 Hopkins
Buffalo, N.Y.

Permit #74971
Effective: November 1, 1975
Expiration: November 1, 1980

EFFLUENT LIMITATIONS	MAXIMUM	
Flow	51,000 gallons/day	
Suspended Solids	29 lb/day	68 mg/l
Chemical Oxygen Demand	39 lb/day	91 mg/l
Iron	440 lb/day	1025 mg/l
Manganese	3.4 lb/day	8.0 mg/l
pH	1.5 - 9.5	

points 3 and 4 were located in the west pond. Sample point 5 was located under the Tiftt Street Bridge.

Generally, the results of analyses of samples collected on July 5, 1978 were insignificantly different from the results of samples collected on July 17, 1978. Samples from both dates could not be analyzed for NO_2-N due to the presence of unknown interferences.

The pH observed at SS1 and SS2 were indicative of highly acid conditions. Since ground-water analyses of samples collected from the well points yielded pH values in the range of 6.4 - 8.0, it is apparent that this low pH is due to another source. In this case it is, in all probability, a reflection of the Ramco Steel pickling liquor waste. This conclusion is supported by the high sulfate content also found at sample points 1 and 2. pH at the other sites (SS3, SS4, and SS5) was within normal ranges for surface waters while sulfate concentrations were slightly higher than values normally encountered.

Results for coliform analyses were low at SS1 and SS2. This is most likely a consequence of the acid conditions existing in the south pond. At the sampling sites, coliform counts, as well as BOD_5, were found to be elevated. The elevated values probably reflect infiltration of leachate from the landfill into the west pond.

Total organic carbon (TOC) and COD values were low at SS1 and SS2, presumably as a result of the influence of the Ramco discharge, which should be relatively low in organics. As was the case with BOD_5 and coliform data, the TOC and COD from the other sites were found to represent the high end of the range of values normally found in marshy environments. TOC contributed via the leachate from the landfill may be impacting the surface water quality at SS3, SS4, and SS5.

Ammonia (ionized plus unionized) levels at SS1 and SS2 were low, but nitrate values were high. At the SS3, SS4, and SS5 sites, these trends were reversed. Total Kjeldahl Nitrogen (TKN) at all sites mimicked the ammonia pattern as it was found that generally, TKN was essentially the same as the ammonia values. This suggests that the organic nitrogen content at all 5 sites is low. For sites SS3, SS4, and SS5, values obtained for NH_3-N and TKN are elevated when referenced to levels found in other similar environments. Since elevated values for these parameters were obtained for ground waters sampled from the landfill, it is again probable that landfill leachate is reaching the west pond. Since NO_3-N values were low in both ground-water samples and the surface water samples SS3, SS4, and SS5, the elevated NO_3-N values for SS1 and SS2 are probably related to the south pond discharge line.

Total phosphate was lowest at SS1 and SS2. All 5 sites, however, exhibited values which are within the range of normally encountered concentrations. Detergents (as MBAS) were lowest at SS1 and SS2, but were within normal ranges for all 5 sampling sites.

The phenol concentrations at all 5 sampling points were elevated in terms of the levels normally found in surface waters. Again, elevated phenol concentrations were found in ground-water samples implicating the landfill as one potential source. However, due to the limited information available relative to the discharge into the south pond purportedly from Ramco Steel, Inc., it is not ascertainable at this time to determine whether elevated phenol levels are due directly to either Ramco or Alltift, or both.

Acidity, because of the low pH's at SS1 and SS2, were found to be high at these sampling sites. The alkalinities at SS3, SS4, and SS5 were also very high. These elevated alkalinities are attributed more to the high suspended solids content at these sampling points rather than as a direct influence of the landfill. The solids at all sample points may well be naturally occurring suspended humic acid substances. However, in view of the permit discussed previously, it is possible to account for the high solids at SS1 and SS2 on the basis of the discharge associated with this permit. Chloride concentrations were high at SS3, SS4, and SS5 and are believed to be a function of leachate infiltration from the landfill.

All sites exhibited low total halogenated organic levels and undetectable PCB's. The samples from SS3 from both dates may contain trace levels of PCB's, but quantitation was not possible. As regards the question of potential PCB contamination, it should be noted that the South Buffalo Railroad runs along the west side of the pond system. Railroads have historically oiled their rails for vegetation control and as part of normal maintenance. Since waste oils are often used for this process, it is conceivable that they may have contained PCB's. Since runoff from the rail line area is probably flowing into the pond system, this may be an additional source of contamination.

All surface water sampling points showed metals concentrations above those normally found. These elevated metals concentrations were subsequently seen in the hardness results as well. For sample points SS3, SS4, and SS5, concentrations found relate quite closely to those found for the ground-water samples. Although leachate from the landfill may account in part for the concentrations observed, it is felt that the discharge entering the south pond is having a greater impact on surface water quality relative to metal concentrations. Metal concentrations are particularly high at sample points SS1 and SS2. Of particular concern is the high concentration of hexavalent chromium. The adverse health effects of hexavalent chromium are, of course, well documented. The high concentration of metals in the south pond is, however, not surprising in view of the fact that the discharge into this pond is purported to be a pickled steel rinse. Movement of water from the south pond to the west pond will contribute to the metal loading found in this pond.

Surface water quality at all five (5) sampling points was found to be depressed. Although the discharge of landfill leachate into the surface water, particularly the west pond, is impacting the quality of this water it is felt that the most significant factor depressing water quality is the discharge entering the south pond. This is particularly true in the case of metals (t-Cr, Cr^{+6}, Pb, Cu) and solids loading to the surface water system. It should also be noted that the low pH of the surface water in the south pond renders this water toxic to both faunal and flora constituents of the fresh water community. An additional contamination source not considered in this report, is runoff from the rail lines of the South Buffalo Railroad. The influence of this contamination source may also be significant.

INDUSTRIAL WASTE DISPOSAL

The environmental impact of solid waste disposal can range from insignificant to catastrophic. Care must be taken, particularly in the case of industrial waste, to minimize the impact of disposal on the environment and public health. Improper management of these wastes can lead to deleterious effects, felt not only immediately but far into the future.

The New York State Department of Environmental Conservation in view of these potential impacts, has instituted under the powers availed to them by Part 360 of the Codes, Rules, and Regulations of the State of New York a program to control and regulate the disposal of industrial wastes. Under this program, industrial wastes can be accepted only at facilities which have received special approval from the New York State Department of Environmental Conservation. To obtain approval, as a minimum, the following must be submitted for each waste to be handled at the facility:

(a) Hazardous Waste Disposal Application Form

(b) Leaching Potential Test Reporting Form

This section of the report will present the data to be utilized in the preparation of these forms. In addition, an attempt will be made to ascertain the impact, if any, of disposal of the wastes desired to be handled. The industrial wastes proposed for disposal are: flyash, sand waste, core sand waste, and shredder waste.

Sampling Program

Prior to the initiation of work on characterization of wastes proposed for disposal, a sampling and analysis program was developed and presented to the New York State Department of Environmental Conservation. This program has been approved by Mr. Paul Counterman of the Albany office of the New York State Department of Environmental Conservation.

Three samples of the flyash and sand wastes were collected on three different days from loads delivered to the Alltift Site for disposal. The three samples for each waste were returned to Recra Research, Inc.'s facility where they were composited. This composite was utilized in all subsequent analyses. A single sample of shredder waste was collected for subsequent analysis.

Analytical Program

Parameters

All waste samples were analyzed for the following variables:

a) Density
b) Total Solids (104°C)
c) Volatile Solids (600° C)
d) Ash Weight (600° C)
e) Aluminum
f) Arsenic
g) Total Chromium
h) Copper
i) Lead
j) Mercury
k) Selenium
l) Zinc
m) Iron
n) Cadmium
o) Phenols
p) Total Grease and Oils
q) Hydrocarbon Grease and Oils
r) Total Halogenated Hydrocarbon as Cl (GC/ECD)
s) Total Organic Scan as C (GC/FID)
t) Total Aromatic Hydrocarbons as Benzene (IR)

Following performance of the New York State Leaching Potential Test (Section 5.2.d, of the "Content Guidelines for Plans and Specifications Publication"), all elutriates were analyzed for the following variables:

a) pH
b) Hexavalent Chromium
c) Soluble Aluminum
d) Soluble Arsenic
e) Soluble Chromium (Total)
f) Soluble Copper
g) Soluble Lead
h) Soluble Mercury
i) Soluble Selenium
j) Soluble Zinc
k) Soluble Iron
l) Soluble Cadmium
m) TOC
n) COD
o) Chlorides
p) Fluorides
q) Free Cyanide
r) Phenol

Analytical Methods

The analyses of the waste samples and elutriates were performed according to either the <u>14th Edition of Standard Methods for the Examination of Water and Wastewater</u> and/or the U. S. Environmental Protection Agency manual <u>Methods for the Chemical Analysis of Water and Wastes (1974)</u>.

The total organic Scan values expressed in $\mu g/g$ (dry wt.) as chlorine, Lindane Standard, represent those organic constituents which are extractable via 15% methylene chloride in hexane, concentrated using Kuderna-Danish equipment and will respond to Gas Liquid Chromatography using a Flame Ionization Detector with a 3% SE-30 column.

The total halogenated organic values, as reported and expressed in $\mu g/g$ (dry wt.) as chlorine, Lindane Standard, were determined as above except that the concentrated extracts were cleaned up via a Florisil column. The 6% ether in petroleum ether elution from the Florisil column, was injected into a Gas Liquid Chromatograph equipped with a ^{63}Ni Electron Capture Detector and a 1.5% OV17/1.95% OF1 column.

Total aromatics concentrations are analytically derived in the same fashion as the Total Grease and Oils concentration except that benzene is used as a standard and the analytical wavelength upon which the quantification is based is 1500 cm^{-1}.

Analytical Results

Analytical results for the waste analyses is presented in Table 9 while results of the leaching potential test are presented in Table 10.

Results

Total organic content was relatively low for all of the wastes. In terms of the leachable fraction, organic concentrations were, as anticipated, extremely low. Because of the nature of the wastes themselves, it was expected that most of the organics including the grease and oils would be insoluble. The values obtained for the shredder waste although somewhat elevated, pose no problem of environmental contamination. The organic content of the shredder waste consists primarily of polymeric compounds, fabric, and other similar inert materials.

Chlorides were detected in the elutriate analysis in very small quantities from all waste materials. This concentration, however, is insufficient to affect either surface or ground-water quality.

ANALYTICAL RESULTS
ALLTIFT COMPANY, INC. LANDFILL SITE
WASTE ANALYSES

Sample Date: 7/5/78

TABLE 9

Report Date: 9/26/78

VARIABLE	UNITS OF MEASURE	SOLID WASTE MATERIAL			
		FLY ASH	SAND WASTE	CORE SAND	SHREDDER WASTE
Density	gm/cm^3	1.538	2.391	2.500	0.552
Total Solids	%	100	100	97.3	86.0
Volatile Solids	%	11.9	6.1	1.2	41.9
Fixed Solids	%	88.1	93.9	98.8	58.1
Total Aluminum	μg/g (dry)	7360	4000	5020	4680
Total Arsenic	μg/g (dry)	1.4	2.3	0.3	3.8
Total Chromium	μg/g (dry)	32.0	57.4	30.8	109
Total Copper	μg/g (dry)	51.0	56.3	14.8	81.1
Total Lead	μg/g (dry)	230	160	260	1620
Total Mercury	μg/g (dry)	0.41	0.10	<0.06	2.3
Total Selenium	μg/g (dry)	<0.1	<0.1	<0.1	<0.1
Total Zinc	μg/g (dry)	700	439	1350	7300
Total Iron	μg/g (dry)	71,800	37,400	7550	103,000
Total Cadmium	μg/g (dry)	<0.3	3.6	1.6	60.8
Phenols	μg/g (dry)	0.485	6.76	1.73	8.78
Total Grease & Oils	mg/g (dry)	0.018	5.98	5.56	187
Hydrocarbon Grease & Oils	mg/g (dry)	0.018	5.14	1.44	109
Polar Grease & Oils	mg/g (dry)	<0.001	0.84	4.12	78.0
Total Halogenated Organics	μg/g (dry) as Cl, Lindane Standard	18.2	2.20	1.58	44.6
Total Organic Scan	μg/g (dry) as Cl, Lindane Standard	38.1	3.83	3.08	104
Total Aromatics	mg/g (dry) as Benzene	0.009	2.13	0.62	40.7

FOR **RECRA RESEARCH**, INC. Robert K Wyatt

DATE 9/26/78

RECRA RESEARCH, INC. 111 Wales Avenue/Tonawanda, New York 14150/(716)692-7620
TOTAL CHEMICAL WASTE MANAGEMENT THROUGH APPLIED RESEARCH

ANALYTICAL RESULTS
ALLTIFT COMPANY, INC. LANDFILL SITE
D.E.C. LEACHATE ANALYSES

Sample Date: 7/5/78

Report Date: 9/26/78

TABLE 10

PARAMETER	UNITS OF MEASURE	SOLID WASTE MATERIAL			
		FLY ASH	SAND WASTE	CORE SAND	SHREDDER WASTE
pH	Standard Units	3.74	3.21	7.04	8.11
Total Organic Carbon	mg/l µg/g (dry)	4.6 18.4	<1.0 <4.0	183 752	263 1220
COD	mg/l µg/g (dry)	20.4 81.6	<0.1 <0.4	694 2850	939 4370
Chloride	mg/l µg/g (dry)	<0.01 <0.04	0.124 0.496	0.325 1.34	34.9 163
Fluoride	mg/l µg/g (dry)	0.144 0.576	2.35 9.40	0.703 2.89	5.60 26.0
Cyanide (free)	mg/l µg/g (dry)	0.01 0.04	0.02 0.08	0.12 0.49	0.04 0.19
Phenols	mg/l µg/g (dry)	0.033 0.132	0.046 0.184	0.123 0.506	1.89 8.79
Hexavalent Chromium	mg/l µg/g (dry)	0.012 0.048	<0.010 <0.040	<0.010 <0.041	<0.010 <0.047
Soluble Al	mg/l µg/g (dry)	0.06 0.24	0.24 0.96	0.15 0.62	0.09 0.42
Soluble As	µg/l µg/g (dry)	6.0 0.024	<1.5 <0.006	<1.5 <0.006	<1.5 <0.007
Soluble Cr	mg/l µg/g (dry)	0.016 0.064	<0.003 <0.012	<0.003 <0.012	<0.003 <0.014
Soluble Cu	mg/l µg/g (dry)	<0.003 <0.012	<0.003 <0.012	0.006 0.025	0.530 2.47

(CONTINUED)

FOR RECRA RESEARCH, INC. [signature]

DATE 9/26/78

RECRA RESEARCH, INC. 111 Wales Avenue/Tonawanda, New York 14150/(716) 692-7620
TOTAL CHEMICAL WASTE MANAGEMENT THROUGH APPLIED RESEARCH

ANALYTICAL RESULTS
ALLTIFT COMPANY, INC. LANDFILL SITE
D.E.C. LEACHATE ANALYSES

Sample Date: 7/5/78

TABLE 10

Report Date: 9/26/78

PARAMETER	UNITS OF MEASURE	SOLID WASTE MATERIAL			
		FLY ASH	SAND WASTE	CORE SAND	SHREDDER WASTE
Soluble Pb	mg/l µg/g (dry)	<0.02 <0.08	<0.02 <0.08	0.03 0.12	0.04 0.19
Soluble Hg	µg/l µg/g (dry)	36.6 0.146	10.8 0.043	26.7 0.110	<6.0 <0.028
Soluble Se	µg/l µg/g (dry)	<2 <0.008	<2 <0.008	<2 <0.008	<2 <0.009
Soluble Zn	mg/l µg/g (dry)	0.759 3.04	0.023 0.092	2.05 8.43	0.093 0.433
Soluble Fe	mg/l µg/g (dry)	<0.01 <0.04	<0.01 <0.04	2.49 10.2	1.09 5.07
Soluble Cd	mg/l µg/g (dry)	<0.003 <0.012	<0.003 <0.012	<0.003 <0.012	<0.003 <0.014

COMMENTS:

D.E.C. Leachate preparation based upon 250 gram of waste in 1 liter of deionized water, shaken for 48 hours, undisturbed settling for 72 hours and filtered through 0.45 µm filter paper. This table list the concentration of the parameters in mg/l or µg/l and the amount of the parameter leachable under these conditions per gram of waste (µg/g) on a dry weight basis.

Differences in detectabilities for the leachate variables for various samples is a consequence of expressing the results of a dry weight basis.

FOR RECRA RESEARCH, INC. [signature]

DATE 9/26/78

RECRA RESEARCH, INC. 111 Wales Avenue/Tonawanda, New York 14150/(716) 692-7620
TOTAL CHEMICAL WASTE MANAGEMENT THROUGH APPLIED RESEARCH

Cyanide was detected in the leachate at insignificant concentrations. Any cyanide present in the waste can be expected to be tied up as iron cyanide complexes and hence will exert little or no concern beyond the immediate landfill environment.

Fluoride concentrations in the leachate were low. It is expected that excess calcium in the landfill environment will react with the fluoride and produce insoluble calcium fluoride. The source of calcium in the system will be those natural levels present in cover materials normally used in cover management. To insure the presence of excess calcium, the landfill operator need only occasionally incorporate a waste such as carbonate dust or lime tailing into the cover material. This will provide additional alkalinity to maintain fluoride insolubility.

Analysis of all waste materials for metals indicate their presence at concentrations that could cause possible contamination of surface and ground waters. However, the analysis of the elutriates indicated that the metals found in the wastes are in an insoluble form and are not leached to any great degree. Chemically, the forms of the metals are probably partitioned between the actual metal forms and very insoluble hydroxides, oxides, and perhaps sulfides and carbonates. In their insoluble forms, these metals pose no threat of ground or surface water contamination.

Total halogenated organic concentrations in all the wastes were low. On the average, levels detected were less than those found in digested activated sludge.

Phenol was present in all the wastes at relatively low levels. Leachate analyses revealed that this phenol is released to some degree. However, concentrations are sufficiently low that they should be amenable to biological oxidation and not present any significant environmental problem.

Discussion

All waste materials pose the same environmental concern though to varying degrees. This concern centers around the potential of any waste to produce contaminated leachates that could adversely affect the quality of surface and ground waters in the immediate environs of their disposal or storage site. In assessing this impact as regards the wastes examined in this report, the major potential contaminants that warrant consideration are phenol, organic carbon, and metals.

Phenol is a readily mobile water soluble organic contaminant. Its impact on the environment proper in general ranges from being a nuisance to being an aquatic toxin. Phenol concentrations encountered for the wastes considered are sufficiently low that they should be amenable to biological oxidation. Even if concentrations encountered were not reduced in the landfill environment, there should be no problem assimilating this material into the environment proper. Hence phenol as regards the wastes considered should present no significant environmental problem.

In terms of leachable organics, concentrations for all wastes considered were low. These values are particularly low when compared to the organic content of leachates resulting from putrescible wastes. As stated previously, most of the organics contained in the wastes are insoluble and hence are in a non-leachable form. The highest values for leachable organics were obtained for the shredder waste. However, it must be pointed out, that the organic content of the shredder waste consists of relatively innocuous, inert materials such as polymers, foam rubber, and fabric. Again, these values are insignificant when compared to concentrations obtained for putrescible waste.

Leachate tests conducted on the wastes considered in this report clearly demonstrate that the metals found are of an insoluble nature and are not readily leached. This significantly reduces the potential for any negative impact on ground and surface waters.

Although the fact that metallic forms present are insoluble simplifies the total waste management picture by allowing one to evaluate landfill disposal directly without pretreatment, it does not eliminate the need for prudent disposal management. The criteria that becomes important in landfill disposal of insoluble metal bearing wastes involves maintaining a burial environment that will prevent solubilization of the contained metal contaminants and thus greatly reduce the possibility of soluble metals eventually making their way to surface and ground waters. This criteria must evaluate not only the metal forms of the waste itself, but also the waste's physical, chemical and biochemical interactions with the co-inhabitors of its burial environment.

One major concern that must be addressed is the maintenance of neutral or slightly alkaline pH conditions within the landfill. A drop in pH or a drastic change of redox potential could produce metal solubility. Such a situation can occur as a result of anaerobic degradation of waste materials. Analysis of wastes for organic content demonstrated low levels. Consequently biological activity should be low. In addition, the types of organics present do not normally undergo rapid degradation. With a low rate of decay, it will be possible for the landfill itself to buffer any pH changes. Ground-water analyses indicate that water presently contained in the landfill is alkaline and that there is some degree of excess alkalinity present. However, to further guard against a biologically initiated pH change, it is recommended that (a) putrescible wastes not be handled at the site and (b) waste lime composed mainly of carbonate be included in the cover material. Two waste sources for these alkaline materials would be waste carbonate dust and lime tailing. Care must be taken, however, to prevent too much excess alkalinity. Under such conditions, amphoteric metals such as zinc and aluminum could become solubilized. It is recommended that this chemical cover represent only about 0.5% or less of the total cover used.

Conclusions

1. Landfill disposal of the four wastes described in this report is acceptable provided the following two conditions are met:
   (a) putrescible wastes are not co-disposed
   (b) an alkaline cover composed mainly of carbonate is periodically added to the normal cover material (0.5% or less of total cover)
2. Under the conditions of the test performed, all wastes exhibited very low leachability of contained components.
3. The minor mobile contaminants that may be leached from the waste materials will be attenuated through:
   (a) insitu chemical reactions
   (b) anaerobic decomposition
   (c) biological oxidation

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APPENDIX

KEY TO VISUAL SOILS IDENTIFICATION

A. Granular Soils - Particle Size Classification

Material		Symbol	Fractions	Sieve Limit	
				Upper	Lower
BOULDERS	Material retained on the 9 in. sieve	Bldr			9 in.
COBBLES	Material passing the 9 in. sieve and retained on the 3 in. sieve	Cbl		9 in.	3 in.
GRAVEL	Material passing the 3 in. sieve and retained on the No. 10 sieve	G	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	S	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	

D. Terms Identifying Composition of Soil

Written*	Symbol	Defining Range of Percentage by Weight
and	a	35 to 50
some	s	20 to 35
little	l	10 to 20
trace	t	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.

E. Miscellaneous Descriptive Terms

Color	Soil Deposition	Size	Miscellaneous
rd - red	vvd - varved	lge - large	veg - vegetation
br - brown	ptg - parting	sm - small	Ss - sandstone
bk - black	pkt - pocket	thk - thick	Sh - shale
gy - gray	lyr - layer	thn - thin	fr - fragment
or - orange	lns - lens		jnk - junk
tn - tan	mtld- mottled		F - fill
yl - yellow			org - organic
dk - dark			Ts - topsoil
lt - light			occ - occasional
			desic-desiccated

NOTE: In writing soil description, the primary soil component is placed first and is capitalized; lesser components have first letter only capitalized; e.g., "rd br fm S, l $, t G, occ Bldr" indicates red-brown fine to medium SAND, little Silt, trace Gravel, occasional Boulder.

B. Clay Soils - Plasticity Classification

Material*	Symbol	Degree of Over-all Plasticity	Overall Plasticity Index Sand - Silt - Clay Components
Clayey SILT	Cy $	Slight	1 to 5
SILT & CLAY	$ & C	Low	5 to 10
CLAY & SILT	C & $	Medium	10 to 20
Silty CLAY	$y C	High	20 to 40
CLAY	C	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.

C. Terms Identifying Gradation of Sand & Gravel Soils

Written	Symbol	Defining Proportions by Weight
No modifier		Approximately equal amounts of coarse, medium, and fine components
medium to fine	mf	Somewhat more medium than fine, less than 10 percent coarse
fine to medium	fm	Somewhat more fine than medium, less than 10 percent coarse
coarse to medium	cm	Somewhat more coarse than medium, less than 10 percent fine
medium to coarse	mc	Somewhat more medium than coarse, less than 10 percent fine
fine	f	Predominantly fine, less than 10 percent medium and coarse
medium	m	Predominantly medium, less than 10 percent fine and coarse
coarse	c	Predominantly coarse, less than 10 percent fine and medium

WEHRAN ENGINEERING

TEST BORING LOG

Project No. 8147 Client RECRA RESEARCH, INC. - TONAWANDA Boring No. 2

Project LANDFILL DESIGN - SUBSURFACE SOIL INVESTIGATION Date Start 6-20-78

Location TIFFT STREET, BUFFALO, NEW YORK Date Finish 6-20-78

Type of Rig TRUCK MOUNTED AUGER Driller EMPIRE SOILS, INC Inspector JHK

Depth	Elevation	Casing Blows/ft	Sample No.	Sample Type	Spoon blows 6" Penetr.		Average Blows/ft	Log	Classification "O" Elev. = 591.2	Remarks
			1	SS	4	2			Fill: REFUSE, (wood, brick, glass, plastic, fabric, partially decomposed vegetation) little mf Sand, trace fine Gravel, trace Silt.	Loose, dry
					3	X				
5			2	SS	4	4				Loose, moist
					4	X			becomes saturated @ 6.4'	
10			3	SS	2	1			(foundry sand, cinders, fly ash)	Medium, saturated
					10	X				
15			4	SS	2	2			Oil coating sample @ 15'0" becoming highly odorous 15'0" to 23'0"	Loose, saturated
					3	X				
20			5	SS	7	4				
					1	1				Loose, saturated
			6	SS	1	1				
					2	3			23'0"	
25			7	SS	2	3			Glaciolacustrine Deposits:	Medium, saturated
					3	4		CL	Gray Silty CLAY to CLAY & SILT	
									Saturated	
30			8	SS	1	1				Very soft, saturated
					1	X		CH	Occasional very thin beds of fine SAND and Clayey SILT (ml)	
35			9	U	Press.	24"				Very soft, saturated
					Rec.	24"				
40			10	SS	Wt. of Hammer				Becoming red brown Silty CLAY @ 40'0"	Very soft

SHEET 1 OF 2

WEHRAN ENGINEERING

TEST BORING LOG

Project No. 8147 Client RECRA RESEARCH, INC. - TONOWANDA Boring No. 2

Project LANDFILL DESIGN - SUBSURFACE SOIL INVESTIGATION Date Start 6-20-78

Location TIFFT STREET, BUFFALO, NEW YORK Date Finish 6-20-78

Type of Rig TRUCK MOUNTED AUGER Driller EMPIRE SOILS, INC. Inspector JHK

Depth	Elevation	Casing Blows/ft	Sample No.	Sample Type	Spoon blows 6" Penetr.		Average Blows/ft	Log	Classification "O" Elev. = 591.2	Remarks
40			10	SS						
								CH	As before, becoming alternating laminations of grey and red Silty CLAY @ 44'	
45			11	SS	Weight of Rods	X				Soft
									47'6"	
								ML	Basal Glaciolacustrine Deposits: Grey Clayey SILT, some mf Sand, some mf Gravel.	Unacceptable Shelby tube
50			12	SS	Press. 24"	Rec. 8"				
									END OF BORING @ 51'0"	
55										
0										
5										
0										
5										

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TEST BORING LOG

Project No. 8147 Client RECRA RESEARCH, INC. - TONAWANDA Boring No. 3

Project LANDFILL DESIGN - SUBSURFACE SOIL INVESTIGATION Date Start 6-20-78

Location TIFFT STREET, BUFFALO, NEW YORK Date Finish 6-20-78

Type of Rig TRUCK MOUNTED AUGER Driller EMPIRE SOILS, INC Inspector JHK

Depth	Elevation	Casing Blows/ft	Sample No.	Sample Type	Spoon blows 6" Penetr.		Average Blows/ft	Log	Classification "O" Elev. = 604.7	Remarks
									Fill:	
			1	SS	3	3				
					4	X			Black and white mf SAND and REFUSE, (paper, plastic, wood brick, cloth, glass, concrete)	Loose, dry
5			2	SS	2	1				
					9	X				Loose, moist
10									Some cinders, some fly ash, some partially decomposed vegetation	
			3	SS	12	5				loose, moist
					5	X				
15			4	SS	25	30				Very dense @ 16'0"
					100/1"	X			Very dense wood encountered 16' to 18'6"	Difficult drilling @ 18'6"
20			5	SS	16	10			Samples were oily and very odorous @ 20' to 26'6"	Medium, moist
					4	X			becomes saturated @ 23'	
25			6	SS	6	9				
					7	X			27'6"	Medium saturated
									Glaciolacustrine Deposits:	
30			7	SS	3	6		CH	Grey and brown varved CLAY	Stiff, saturated
					8	X			34'0"	
35			8	SS	45	100/3"		CH	Grey residual? CLAY grading to laminated limestone @ 35'6" becoming very dense; Black LIMESTONE @ 36'1"	Very dense
			9	SS	100/1"					
									END OF BORING @ 36'2"	
40										

SHEET 1 OF 1

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TEST BORING LOG

Project No. 8147 Client RECRA RESEARCH, INC. - TONAWANDA Boring No. 4

Project LANDFILL DESIGN - SUBSURFACE SOIL INVESTIGATION Date Start 6-21-78

Location TIFFT STREET, BUFFALO, NEW YORK Date Finish 6-21-78

Type of Rig TRUCK MOUNTED AUGER Driller EMPIRE SOILS, INC. Inspector JHK

Depth	Elevation	Casing Blows/ft	Sample No.	Sample Type	Spoon blows 6" Penetr.		Average Blows/ft	Log	Classification "O" Elev. = 593.0	Remarks
			1	SS	8	9			Fill: Gray fine SAND, and Refuse (wood rubber, metal, coal, brick, glass, partially decomposed vegetation)	Medium, moist
					6	X				
5			2	SS	2	1				Very loose, moist
					1	X				
10			3	SS	2	30				GWT @ 12.2
					2	X			becomes saturated @ 12'-0" 13'0"	Dense, moist
15			4	SS	3	2		CH	Glaciolacustrine Deposit: Brown and grey mottled CLAY & SILT, little cf Sand	Soft, saturated
					2	X				
			5	SS	100/.1	100/R			Saturated 19'0"	
20			R1	C	4 min	4 min			Dark grey fine-grained, fossiliferous LIMESTONE.	Very dense 16 pieces
					4 min	4 min				
					2 min	2 min				
									END OF BORING 21'6"	
25										
0										
5										

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TEST BORING LOG

Project No. 8147 Client RECRA RESEARCH, INC. - TONAWANDA Boring No. 5

Project LANDFILL DESIGN - SUBSURFACE SOIL INVESTIGATION Date Start 6-22-78

Location TIFFT STREET, BUFFALO, NEW YORK Date Finish 6-22-78

Type of Rig TRUCK MOUNTED AUGER Driller EMPIRE SOILS, INC. Inspector JHK

Depth	Elevation	Casing Blows/ft	Sample No.	Type	Spoon blows 6" Penetr.		Average Blows/ft	Log	Classification "O" Elev. = 584.3	Remarks
			1	SS	2 / 3	1 / X			Fill: Brown cf SAND, some mf Gravel, some Refuse (brick, glass, wood) some Silt	Very loose
5									becomes saturated @ 1'-6"	
			2	SS	2 / 1	1 / X			8'0"	Very loose saturated
10									Glaciolacustrine Deposits: Brown and grey Clayey SILT,	Firm, saturated
			3	SS	3 / 4	4 / X		MH		
			4	SS	6 / 11	7 / X			14'	
15			5	U	Press / Rec.	24" / 24"			TRANSITION	Stiff, saturated
									Grey varved CLAY. Occ. lamination of Silt	
20			6	SS	1 / 1	1 / X				Soft, saturated
								CH		
25			7	SS	1 / 3	3 / X				Soft, saturated
30			8	SS	Wt. / Hammer	of / X			31'-6"	Very soft
									END OF BORING	
35										
40										

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TEST BORING LOG

Project No. 8147 Client Recra Research, Inc. - Tonawanda Boring No. 6

Project Landfill Design - Subsurface Soil Investigation Date Start 7/24/78

Location Tifft Street, Buffalo, New York Date Finish 7/24/78

Type of Rig Truck Mounted Auger Driller Empire Soils, Inc Inspector JHK

Depth	Elevation	Casing Blows/ft	Sample No.	Type	Spoon blows 6" Penetr.	Average Blows/ft	Log	Classification "O" Elev. = 591.2	Remarks
0			1	SS	6 7 / 9 11			Fill: Black and white mf SAND, some Refuse, some Silt, trace minum partially decomposed vegetation.	Medium, dry GWT @ 7.3'
5			2	SS	2 1 / 2 1			becoming saturated @ 7'-0"	Very Loose, saturated
10			3	SS	1 3 / 3 4			(foundry sand, cinders, flyash, metal cinders, wood, glass)	Loose, saturated 16'-0"
15			4	SS	1 3 / 4 7		ML	Brown Clayey SILT and f Sand	Loose 17'-6"
20			5	SS	2 5 / 6 10			Glaciolacustrine Deposits: Grey Silty CLAY to CLAY & SILT	Stiff, saturated
25			6	SS	3 4 / 4 4			Occasional thin beds of Silt	Medium, saturated
							CH	Grading at 27'-0" to; Grey CLAY	
30			7	SS	HAM 3 / 4 5				Medium, saturated
35			8	SS	3 3 / 4 4				Medium, saturated

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TEST BORING LOG

Project No. 8147 Client Recra Research, INc. - Tonawanda Boring No. 6

Project Landfill Design - Subsurface Soil Investigation Date Start 7/24/78

Location Tifft Street, Buffalo, New York Date Finish 7/24/78

Type of Rig Truck Mounted Auger Driller Empire Soils, Inc Inspector JHK

Depth	Elevation	Casing Blows/ft	Sample No.	Sample Type	Spoon blows 6" Penetr.		Average Blows/ft	Log	Classification "O" Elev. =	Remarks
			9	SS	WT.	HAM			Becoming alternating laminations and beds of grey and red Silty CLAY	Soft
					2	2				
45			10	SS	ROD	WT.				Very Soft
					HAM	2				47'-6"
50			11	SS	3	5			Basal Glaciolacustrine Deposits: Grey Clayey SILT, some mf Sand, some mf Gravel	Stiff, saturated
					5	7				
55			12	SS	12	27			Saturated ML	very dense
					51	56				
									Black LIMESTONE	
60			13	SS	150/	2 inch			END OF BORING 60'-2"	Very dense
5										
0										
5										

WEHRAN ENGINEERING

TEST BORING LOG

Project No. 8147 Client Recra Research Inc. - Tonawanda Boring No. 7

Project Landfill Design - Subsurface Soil Investigation Date Start 7/25/78

Location Tifft Street, Buffalo, New York Date Finish 7/25/78

Type of Rig Truck Mounted Auger Driller Empire Soils, Inc. Inspector JHK

Depth	Elevation	Casing Blows/ft	Sample No.	Type	Spoon blows 6" Penetr.		Average Blows/ft	Log	Classification "O" Elev. = 600.2	Remarks
			1	SS	3	5			Fill:	loose, dry
					7	4			Black and white mf SAND, some Refuse, some Silt. trace partially decomposed vegetation	
5			2	SS	7	9				loose, dry
					3	2			(wood, plastic, paper, pottery, metal, cinders, glass)	
10			3	SS	1	4				Loose, dry
					8	10				GWT @ 17.2'
15			4	SS	43	100				Saturated at base
20			5	SS	8	6			24'-0" Mottled brown & tan CLAY & SILT, little Sand, little Gravel. Ocean beds of Green-brown mf SAND, some Silt, roots	Firm, saturated
					7	10				
25			6	SS	6	7		CL	26'-0"	
					8	10			Glaciolacustrine Deposits;	
30			7	SS	3	4			Grey varied CLAY & SILT	Firm, saturated
					3	4		CH		
35			8	SS	WT	RODS			Frequent beds of Reddish Clay below 35'-0"	Very Soft, saturated
					WT	HAM				

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TEST BORING LOG

Project No. 8147 Client Recra Research, INc. - Tonawanda Boring No. 7

Project Landfill Design - Subsurface Soil Investigation Date Start 7/25/78

Location Tifft Street, Buffalo, New York Date Finish 7/25/78

Type of Rig Truck Mounted Auger Driller Empire Soils, Inc. Inspector JHK

Depth	Elevation	Casing Blows/ft	Sample No.	Sample Type	Spoon blows 6" Penetr.		Average Blows/ft	Log	Classification "O" Elev. =	Remarks
			9	SS	WT HAM	RODS 2			Grading with little Sand, little Gravel at 40'-0" 43'-0"	Very Soft saturated
45			10	SS	6 8	12 21		SF Clayey	Basal Glaciolacustrine Deposits: Grey cf SAND, some Gravel, some clayey Silt	Med-dense, saturated
50			11	SS	40	100/0"			Refusal at 50'-6" (Bedrock?)	
55										
0										
5										
0										
5										

WEHRAN ENGINEERING

TEST BORING LOG

Project No. 8147 Client Recra Research Inc. - Tonawanda Boring No. 8

Project Landfill Design - Subsurface Soil Investigation Date Start 7/24/78

Location Tifft Street, Buffalo, New York Date Finish 7/24/78

Type of Rig Truck Mounted Auger Driller Empire Soils Inc. Inspector JHK

Depth	Elevation	Casing Blows/ft	Sample No.	Sample Type	Spoon blows 6" Penetr.	Spoon blows 6" Penetr.	Average Blows/ft	Log	Classification "O" Elev. = 590.0	Remarks
			1	SS	7	16			Fill:	moist
					21	20				
			2	SS	4	10			Black and white mf SAND, some Refuse, little Silt, little Gravel	Loose, moist
5					5	4				
			2B	SS	13	9				
					10	4				
									(cinder, flyash, glass, rubber, metal, etc.)	moist GWT @ 8.8'
10			3	SS	3	1				
					2	1				
15									15'-0"	
			4	SS		9				
					12	6				
					3			SP	Brown mf SAND, trace Silt	Medium-dense, saturated
20			5	SS	8	12			21'-0"	
					11	13			Glaciolacustrine Deposits:	
25			6	SS	2	2			Grey varied Silty CLAY to CLAY & SILT	Firm, saturated
					3	4				
									Occasional Laminations of fine Sand and Silt	
30			7	SS	1	2		CH		Soft, saturated
					2	3				
35									Grading at 33'-0" to GREY CLAY	
			8	SS	1	1				Very soft, saturated
					1	1				

WEHRAN ENGINEERING

TEST BORING LOG

Project No. 8147 Client Recra Research, Inc. - Tonawanda Boring No. 8

Project Landfill Design - Subsurface Soil Investigation Date Start 7/24/78

Location Tifft Street, Buffalo, New York Date Finish 7/24/78

Type of Rig Truck Mounted Auger Driller Empire Soils, Inc. Inspector JHK

Depth	Elevation	Casing Blows/ft	Sample No.	Type	Spoon blows 6" Penetr.		Average Blows/ft	Log	Classification "O" Elev. =	Remarks
			9	SS	WT. / 1	HAM. / 2				Very soft saturated
45			10	SS	WT. / 1	HAM. / 1		CH	Grading at 45'-0" to; Alternating laminations and v. thin beds of grey and red Silty CLAY	Very soft, saturated
50			11	SS	WT. / HAM	OF / 2				
55			12	SS	WT. / HAM.	ROD / 2			Grading at 53'-0" to; Brown Silty CLAY 57'-6"	Very soft, saturated
60			13	SS	WT. / HAM / HAM	ROD / 2 / 3		SF Clayey	Basal Glaciolacustrine Deposits: Grey Clayey SILT, some mf Sand, some mf gravel	Soft, becoming progressively stiffer with depth saturated
			14	SS	10	16				
65			15	SS	16	18	150/0"		Refusal at 65'-0" (Bedrock)	
0										
5										

Ground water, as encountered beneath the Alltift Landfill occurs in one of the following three forms;

- as an unconfined, or water-table "aquifer" within the solid waste, itself
- as the confined, bedrock aquifer within the Oatka Creek Shale and the Stafford Limestone, and
- as largely "immobilized" ground water within the confining bed, or aquiclude, represented by the Glaciolacustrine Clay stratum.

The Ground-Water Table

Ground water under unconfined, or water-table, conditions may be found on virtually all portions of the site. It is contained within the solid waste itself, and hence is the result of leachate accumulation within the fill. The base of this upper water-bearing zone corresponds to the top of the Glaciolacustrine Clay stratum. The top of the zone of saturation, or the water table, is a variable surface subject to seasonal fluctuations in response to differential rates of recharge. At the time of our investigation the average thickness of the saturated zone in the fill was approximately 8 to 9 feet. The elevations of the ground-water table are presented in Table 2.

The configuration of the ground-water table at the time of our investigation is depicted on Map No. 2 at the rear of this report. As can be seen, the ground-water levels depict the presence of a marked ground-water mound. The mound is centered near the eastern boundary of the Alltift property. The principal hydrogeologic circumstances leading to development of ground-water mounds are (in order of importance) periferal ground-water discharge and vertical recharge to the ground-water system.

TABLE 2

GROUND-WATER TABLE ELEVATIONS

POINT	Elevation of Ground Surface (ft)	Elevation of Reference Point (ft)	JULY 31, 1978 Depth to Water Surface (ft)	JULY 31, 1978 Elevation of Ground-Water Table (ft)
Boring No. 1	593.2	595.7	13.17	582.5
Boring No. 2	591.2	594.2	9.42	584.8
Boring No. 3	604.7	606.6	25.08	581.5
Boring No. 4	593.0	597.0	16.25	580.8
Boring No. 5	584.3	586.4	4.04	582.4
Boring No. 6	591.2	592.9	9.00	583.9
Boring No. 7	600.2	603.2	20.25	583.0
Boring No. 8	590.0	592.0	10.83	581.2

The fact that a ground-water mound exists leads invariably to two conclusions. The first conclusion is that ground water is moving radially outward from the center of the mound to perimeter ground-water discharge points (which will be discussed momentarily), and secondly that ground-water levels are being continually replenished through recharge of precipitation from the surface. What exists, then, is essentially a steady-state condition where in the rate of recharge to the water-table balances the rate of discharge. Rapid variations in the rate of recharge manifest themselves as fluctuations in the height of the water table, representing a temporary increase in the amount of water held in storage within the saturated zone.

Leachate Generation

In order to estimate the amount of annual leachate generation from the landfill, a water balance was performed employing the techniques developed by C. W. Thornthwaite[4, 5] and applied to solid waste disposal sites by D. G. Fenn.[6] The method takes into account such factors as precipitation, evapotranspiration, soil characteristics, and surface-water runoff in estimating the amount of monthly and annual infiltration into the landfill.

The factors employed in the water balance techniques are defined as follows:

(a) Mean Monthly Air Temperature (T) - average values for Buffalo, New York have been used.[7]

4. Thornthwaite C. W., and J. R. Mather, Instructions and Tables for Potential Evapotranspiration and the Water Balance, pp. 185-311.

5. Thornthwaite, C. W., Average Climatic Water Balance of the Continents, pp. 419-615.

6. Fenn, D. G. et al, Use of the Water Balance Method of Predicting Leachate Generation from Solid Waste Disposal Sites, pp. 1-40.

7. Water Information Center, Climates of the States, pp. 243-264.