FINAL

(17)

ERWIN TOWN LANDFILL
STEUBEN COUNTY

VILLAGE OF PAINTED POST

FINAL FEASIBILITY STUDY

MAY, 2002

STATE OF NEW YORK
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EXECUTIVE SUMMARY

The following Final Feasibility Study (FS) Report on the Erwin Town Landfill was prepared by Barton & Loguidice, P.C. (B&L) on behalf of Steuben County in accordance with the requirements of the Order on Consent for closure of the landfill. The Order was issued by the New York State Department of Environmental Conservation (NYSDEC). The Erwin Town Landfill is listed as a Class 2 site on the New York State Registry of Inactive Hazardous Waste Disposal Sites (Site Number 8-51-003). The facility is located in the Village of Painted Post, Steuben County, New York. This report is provided as the concluding phase of the Remedial Investigation/Feasibility Study (RI/FS) conducted by B&L to evaluate the potential effectiveness of specific remedial alternatives.

The evaluation of remedial alternatives was conducted in accordance with techniques presented in Federal (USEPA) and State (NYSDEC) agency guidance documents. The FS Report presents a culmination of the following major items:

- A summary of the major findings of the Remedial Investigation including the site hydrogeologic conditions, the nature and extent of site contamination, contaminant fate and transport, fish and wildlife impact assessment and the qualitative human health risk evaluation,

- Identification of areas of concern, contaminants of concern, remedial action objectives for media of concern, and associated general response actions,

- Identification of potential remedial technologies available to meet general response actions,

- Development of remedial alternatives from the assortment of identified potential technologies, and initial screening based on restrictions of implementability at the site, and

- Detailed analysis of the remedial alternatives including evaluations of overall protection of human health and the environment; overall compliance with chemical-specific, action-specific and location specific standards, criteria and guidelines (SCGs); long-term effectiveness; reduction in toxicity, mobility and volume; short-term effectiveness; implementability; and cost-benefit.

Identified remedial action objectives included:

- Minimize the volume of leachate generation and possible groundwater contamination,

- Prevent potential dermal contact with or incidental ingestion of exposed waste,

- Protect against future development within the areas of identified groundwater contamination and potential usage of groundwater as a resource, and

- Attainment of SCGs.

Subsequent general response actions included:

- Contain entire waste area by capping,

- Complete removal of the waste volume - off-site disposal,

- Reduction of leachate generation by capping and/or waste removal,

- Impose deed restrictions against the use of the site groundwater as a drinking water supply source.

Potential remedial technology options were discussed separately within two major divisions: 1) those which apply to source control, and 2) the remediation of groundwater, surface water, sediments and surface soils. These include access restrictions, waste containment, waste removal and consolidation, sediment removal, surface water and sediment isolation, surface water containment, groundwater collection with aquifer restoration and the treatment of groundwater.

Several of the technologies listed above were deemed impractical on the basis of the general absence of risk associated with contaminants identified in the site media (groundwater, surface soils). Through this analysis, it was determined that only those technologies which were associated with source control measures were necessary to bring forward into the development of remedial alternatives.

Two remedial alternatives were developed from combinations of applicable source control and institutional technology options. Table ES-1 (presented below and in more detail as Table 4-1 in Section 4) identifies the estimated capital and operational and maintenance costs, as well as the estimated net present value for each alternative.

TABLE ES-1
Remedial Alternative Cost Summary
Erwin Town Landfill Feasibility Study

Remedial Alternative	Capital Costs	Annual O&M Costs	Net Present Value
Alternative I	$0	$0	$0
Alternative II	$1,940,000	$12,400	$2,216,000

The following list summarizes the major items included within each of the two possible remedial alternatives:

- ALTERNATIVE I – No Action, Delist Site

  No remedial action is incorporated into this alternative. Institutional controls would be imposed to prevent the future development of groundwater at the site as a drinking water supply source. The site would be delisted from the New York State Department of Environmental Conservation Registry of Inactive Hazardous Waste Disposal Sites.

- ALTERNATIVE II – Waste Containment Including Capping with Part 360 Geomembrane Cap, Waste Consolidation and Long-Term Monitoring

  A NYSDEC Part 360 Geomembrane (LLDPE) Cap would be installed over the entire limits of waste. Prior to capping, thin waste areas present along the northwestern and southwestern landfill perimeters would be excavated and moved to the top of the landfill to consolidate the limits to be capped. This alternative would employ the use of a geocomposite drainage layer to relieve the potential buildup of excessive water above the LLDPE liner, and therefore, the potential for cap instability. Groundwater monitoring would be performed on a semi-annual basis for 30 years. Institutional controls to restrict the use of the site groundwater as a drinking water source would be implemented.

Recommended Remedial Alternative

Based on the detailed analyses of technical feasibility, implementability, environmental effectiveness and cost presented in Sections 3, 4 and 5 of this report, Alternative I – "No Action" is the recommended remedial alternative. This recommendation is based primarily on the minimal impact the site has rendered to the environment and minimal benefits to be realized with the addition of a supplemental capping system. The existing soil cap satisfies NYSDEC Part 360 regulations in effect at the time the landfill ceased to accept wastes for disposal. The substantial costs associated with the implementation of a capping system to meet current NYSDEC Part 360 regulations for new landfills does not justify the minimal benefit to be gained from an environmental standpoint.

1.0 INTRODUCTION

The Erwin Town Landfill is designated by the New York State Department of Environmental Conservation (NYSDEC) as a Class 2 Inactive Hazardous Waste Disposal Site, and has been listed in the Registry of Inactive Hazardous Waste Disposal Sites in New York under site number 8-51-003. The landfill and its immediate vicinity are the focus of this Feasibility Study (FS) Report.

Steuben County was approved for funding under the New York State Department of Environmental Conservation Title 3 Program to pursue an investigation to characterize the site conditions and to evaluate appropriate remedial actions, if necessary. The Final Remedial Investigation Report, presenting the findings of the site characterization process, was submitted in January of 2002.

1.1 Purpose and Organization

This report provides a detailed evaluation of potential remedial actions based on the findings presented in the Final Remedial Investigation Report (Barton & Loguidice, 2002). The following FS was conducted in accordance with procedures outlined in the following State and Federal publications:

- "Selection of Remedial Actions at Inactive Hazardous Waste Sites". Revised Technical and Administrative Guidance Memorandum (TAGM). NYSDEC – dated May 15, 1990.

- "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites". USEPA – dated February 1991.

- “Accelerated Remedial Actions at Class 2, Non-RCRA Regulated Landfills”. NYSDEC Technical and Administrative Guidance Memorandum HWR-92-4044 – dated March 9, 1992.

- “Inactive Hazardous Waste Disposal Site Remedial Program”. 6NYCRR Part 375. NYSDEC – dated May 1992.

- “Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites”. USEPA OSWER Directive No. 9220.4-10 – dated December 1997.

The development of remedial alternatives was accomplished through various screening stages. Initial screenings were based on general remediation objectives, while subsequent stages evaluated specific alternatives based on implementability and effectiveness in accordance with site conditions and available technology. The FS Report is organized into six sections, as follows:

- SECTION 1.0 – INTRODUCTION: Summarizes the General Site Conditions, Site History and the findings of the Remedial Investigation and Risk Assessment. Establishes applicable or relevant and appropriate New York State and Federal Standards, Criteria and Guidelines (SCGs).

- SECTION 2.0 – REMEDIAL ACTION OBJECTIVES: Presents the site specific areas of concern, the remedial action objective for each area of concern, and discusses the general response actions to identified objectives.

- SECTION 3.0 – PRELIMINARY TECHNOLOGY SCREENING: Identifies and screens available remedial action technologies on the basis of site implementability.

- SECTION 4.0 – DEVELOPMENT AND SCREENING OF ALTERNATIVES: Identifies and screens remedial alternatives on the basis of their effectiveness in attaining SCGs, implementability and cost.

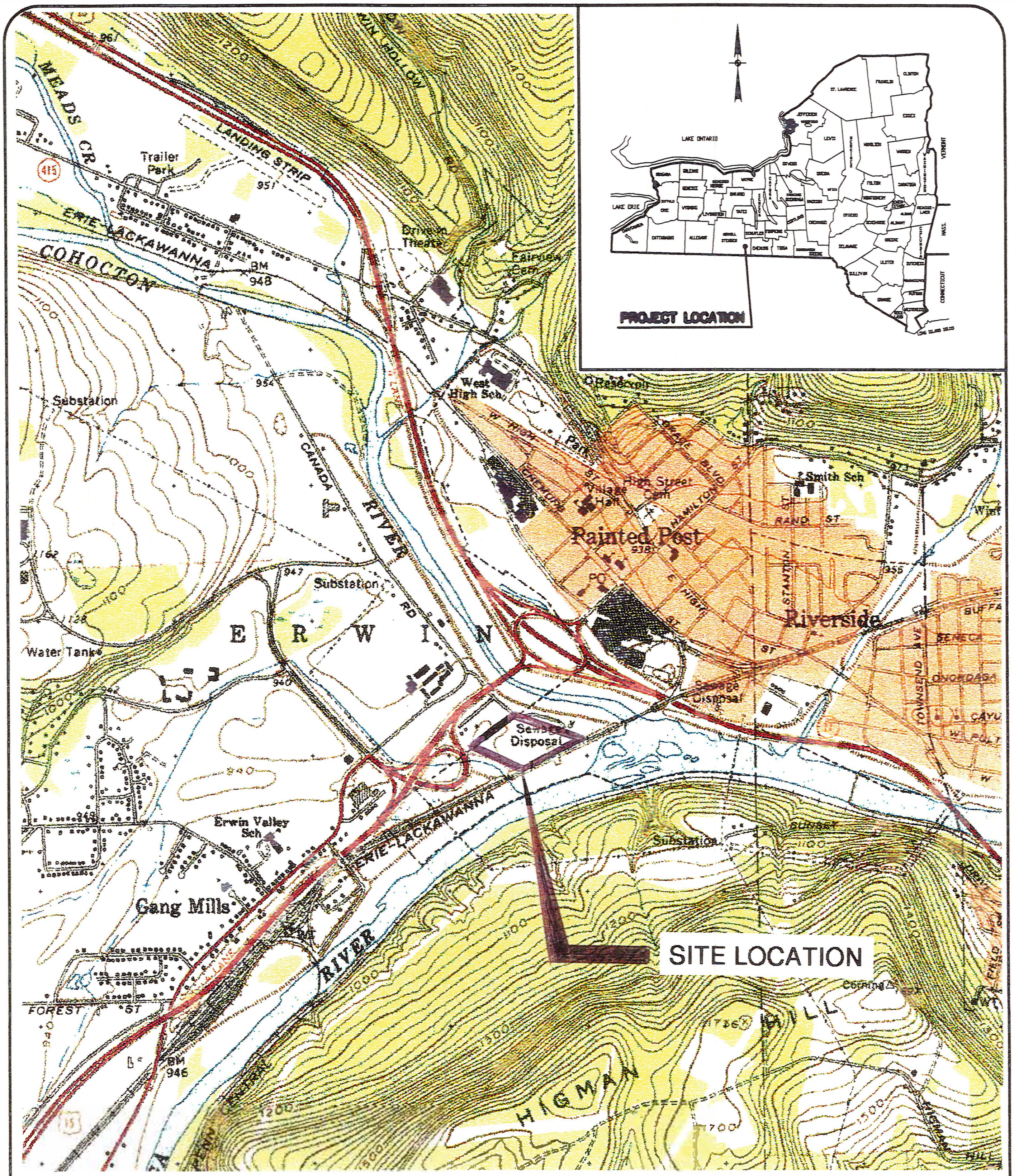
- SECTION 5.0 – DETAILED ANALYSIS OF ALTERNATIVES; Presents a detailed analysis of the remedial alternatives remaining from the previous screening stages. This analysis includes a cost/benefit comparison between alternatives and presents the recommended remedial alternative.

- SECTION 6.0 – REFERENCES

1.2 General Site Conditions

1.2.1 Site Description

The Erwin Town Landfill is located within the corporate limits of the Village of Painted Post, Steuben County, New York. The landfill encompasses an area of approximately 13 acres. The Cohocton and Tioga Rivers are located to the northeast and south, respectively, of the landfill, where they merge approximately 1,000 feet east of the site forming the Chemung River (NYDSEC, 1992). The Village of Painted Post is located approximately ¼ mile northeast and across the Cohocton River. To the southwest is the commercialized Village of Gangs Mills. The nearest residence is located approximately 1,200 feet north/northwest of the limits of waste on Canada Road. A Site Location Map is presented as Figure 1-1.



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ERWIN TOWN LANDFILL
FEASIBILITY STUDY

SITE LOCATION

STEUBEN COUNTY NEW YORK

Figure 1-1

Project No. 268.012

Man-made flood levees (constructed in 1938 by the US Army Corps of Engineers) border the landfill to the north, east and south; US Route 15 is located to the west and northwest; the Town of Erwin Wastewater Treatment Plant to the east; and the Erie-Lackawanna railroad line runs parallel with the southern levee. The natural topography of the site is a flat river valley with an average elevation of 935 feet above sea level. Hills surrounding the river valley reach elevations up to 1,800 feet above sea level. The landfill itself forms a gently sloping, rectangular mound, extending approximately 35 feet above the surrounding topography (NYSDEC, 1995).

1.2.2 Site History

Aerial photographs obtained from the Town of Erwin's Tax Assessor's Office were reviewed by Ecology and Environment Engineering in 1992, indicating prior use of the site for agricultural purposes and as a borrow pit. Prior to the commencement of landfilling activities in 1966, a 4-foot layer of foundry sand from the Ingersoll-Rand Company was placed on the site for use as a landfill base. Additional information suggested the presence of a soil berm, within which wastes were deposited following its construction.

The landfill was first owned and operated by the Town of Erwin from 1966 to 1978. Debris deposited within the landfill at that time consisted of household and industrial solid waste. In 1978, the landfill was leased to Steuben County, which took over operations of the landfill until its closure in 1983. During the period between 1978 and 1983, the main contributors to the landfill were Steuben County, Ingersoll-Rand Company, and Corning Glass Works. Steuben County's primary use of the landfill was for disposal of stumps and brush. The Ingersoll-Rand Company's main waste was foundry sand, which consisted of scrap iron, scrap steel, shot blast dust, silica sand, organic sand binders, ferrous and non-ferrous alloys, firebrick, clay binder sand, refractory washes, and occasional loads of broken concrete. The Corning Glass Works waste included ceramic logs, cullet, wood pallets, sawdust, construction debris including bricks and concrete blocks, cardboard, paper, grinding wastes composed of pumice and cerium-oxide, and sand. Upon closure of the landfill, site maintenance responsibilities were assumed by the Town of Erwin, who reportedly covered the wastes with 2 feet of soil. This activity was performed in accordance with the NYSDEC Part 360 Closure regulations in effect at the time and in accordance with the Erwin Town Landfill operating permit.

1.3 Summary of Remedial Investigation Findings

1.3.1 Site Geology

The uppermost bedrock units in the Painted Post/Corning region are the Upper Devonian age shale, siltstone and sandstone units of the West Falls, Java and Wiscoy Groups. Sediments making up these units were deposited approximately 350 million years ago. The majority of the Tioga and Cohocton River Valleys, as well as the Erwin Town Landfill, are underlain by rock units from the West Falls group, principally the Gardeau Formation, composed of dark gray shales and thin gray siltstones. There are no bedrock outcrops (surface exposures) within the immediate vicinity of the landfill site. The depth to bedrock within the vicinity of the landfill appears to be approximately 100 feet (Waller et al., 1982).

The unconsolidated materials mantling the area occupied by the Erwin Town Landfill consist of reworked glacial drift, deposited during the Wisconsinan ice age, approximately 10,000 to 12,000 years ago. The results of the subsurface investigation, combined with the information from past investigations revealed an initial 9 to 10 foot layer of sandy-silt, with some clay, which grades into (underlain by) a coarse to medium sand and fine gravel layer, with variable amounts of silt. The extent of the sand and gravel layer on site was unable to be determined since borings were terminated at depths of 18 to 22 feet. However, available published information suggests that this layer extends to the top of the bedrock surface.

1.3.2 Site Hydrogeology

The Erwin Town Landfill is located to the north and west of the Tioga and Cohocton Rivers, respectively, where they merge approximately 1,000 feet east of the site, forming the Chemung River. All surface water drainage from the landfill property flows south or east into the tributaries of the Chemung River. A seasonal stream located to the west of the landfill is generally stagnant, except during the spring or periods of high precipitation. This unnamed stream flows directly into the Tioga River, approximately 1,000 feet west of the confluence of the Tioga and Cohocton Rivers, and collects drainage from the west side of the landfill.

The horizontal component of groundwater flow within the overburden at the site appears to be generally radial beneath the landfill (as a result of a minor mounding condition), and then towards the Tioga and Cohocton Rivers, south and east of the site, respectively. Overall, the regional groundwater flow pattern appears to be southeast, consistent with the orientation of the valley aquifer system and groundwater flow within this system.

Hydraulic conductivity values determined for the overburden unit at the site, ranged from 1.32 x 10^{-3} cm/sec to 1.38 x 10^{-5} cm/sec, with a geometric mean of 2.28 x 10^{-4} cm/sec. These values appear low in comparison with the reported yields of municipal water supply wells installed within the valley aquifer system (e.g., one of the Town of Erwin production wells, located within ½ mile north of the landfill, currently produces an average of approximately 800 gallons per minute – pers comm., 2001). However, the depth of the municipal water supply systems which tap into the valley aquifer system far exceed the depth of exploration performed during the Remedial Investigation. The apparent discrepancy between the derived hydraulic conductivity and the potential hydraulic conductivity of the aquifer, therefore, is believed due to the greater percentage of silt within the upper portion of this aquifer, within the which the site's monitoring wells are installed.

1.3.3 Nature and Extent of Site Environmental Impacts

The nature and extent of the site environmental impacts were determined through a variety of site surveys and sampling tasks. The findings of these are briefly summarized below.

Combustible Gas Survey Results

Three separate rounds of combustible gas readings were collected from temporary subsurface probes installed around the perimeter of the landfill. Only minor percentages of combustible gases were detected, registering less than 1 percent of the lower explosive limit (LEL). These results are indicative of the types of wastes encountered during the remedial investigation, which by virtue of their type, represent a very low potential for combustible gas generation.

Radioactivity Survey Results

A full-surface coverage radioactivity survey was completed over the entire landfill to determine and locate the presence, if any, of "hot spots" emitting high concentrations of radioactivity. Subsequent surface soil sampling and laboratory analysis of four locations which recorded twice-higher-than-background concentrations revealed health exposure risks within or below acceptable USEPA ranges.

Groundwater and Surface Soil Conditions

The groundwater and surface soil conditions at the landfill site is summarized below. Tables 1-1 and 1-2 present the analytical data for surface soil and groundwater, respectively. Figure 1-2 presents the layout of investigation locations utilized during the Remedial Investigation to determine the site conditions.

Groundwater – Groundwater samples were collected from each of the existing fourteen monitoring wells as well as from the two new wells installed during the Remedial Investigation. Overall, the groundwater quality appears to have improved since the site conditions were first characterized in the mid-1990's by NYSDEC. Low concentrations of a few volatile organic compounds (VOCs) were detected at site wells MW-A3, MW-1 and MW-4. Of these, only MW-4 (located directly downgradient from the landfill) exhibited specific constituents in excess of groundwater standards. There were no semi-volatile organic compounds (SVOCs) detected in the groundwater above standards.

TABLE 1-1
ERWIN TOWN LANDFILL REMEDIAL INVESTIGATION
SURFACE SOIL ANALYTICAL RESULTS - MAY 2001 SAMPLING
VOLATILE ORGANIC COMPOUNDS

PARAMETER*	TAGM #4046 Clean-up Objective (ppb)	SAMPLE LOCATION (ppb)										
		SS-1	SS-1RE	SS-2	SS-2RE	SS-3	SS-3RE	SS-4	SS-4RE	Duplicate (SS-2)	Duplicate RE (SS-2)	Field Blank (Scoop)
Chloromethane	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Vinyl Chloride	200	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Bromomethane	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Chloroethane	1900	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
1,1-Dichloroethene	400	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Acetone	200	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Carbon Disulfide	2700	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Methylene Chloride	100	13	<6.2	16	<6.3	3.5 J	9.5	13	6.7	16	8.2	<5
trans-1,2-Dichloroethene	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
1,1-Dichloroethane	200	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
2-Butanone	300	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
cis-1,2-Dichloroethene	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Chloroform	300	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
1,1,1-Trichloroethane	800	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Carbon Tetrachloride	600	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Benzene	60	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
1,2-Dichloroethane	100	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Trichloroethene	700	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
1,2-Dichloropropane	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Bromodichloromethane	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
4-Methyl-2-Pentanone	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Toluene	1500	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
t-1,3-Dichloropropene	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
cis-1,3-Dichloropropene	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
1,1,2-Trichloroethane	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
2-Hexanone	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Dibromochloromethane	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Tetrachloroethene	700	<6.2	<6.2	4.5 J	<6.3	3.2 J	4.3 J	<5.9	<5.9	6.6	1.3 J	<5
Chlorobenzene	1700	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Ethyl Benzene	5500	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
m/p-Xylenes	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
o-Xylene	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Styrene	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Bromoform	--	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
1,1,2,2-Tetrachloroethane	800	<6.2	<6.2	<6.3	<6.3	<5.8	<5.8	<5.9	<5.9	<6.2	<6.2	<5
Total VOCs **	10,000	13	ND	20.5	ND	6.7	13.8	13	6.7	22.2	9.5	ND

Notes: * Results are reported in µg/L.
** Total Volatile Organic Compounds
-- Indicates that a clean-up value has not been assigned.
< Indicates that the analyte was not detected above the instrument detection limit.
RE - result of re-analysis following sample dilution.
ND - not detected
B - indicates that the analyte was also detected in the blank.
J - indicates an estimate value.

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TABLE 1-1 cont.

ERWIN TOWN LANDFILL REMEDIAL INVESTIGATION
SURFACE SOIL ANALYTICAL RESULTS - MAY 2001 SAMPLING
SEMI-VOLATILE ORGANIC COMPOUNDS

PARAMETER *	TAGM #4046 Clean-up Objective (ppb)	SAMPLE LOCATION (ppb)							
		SS-1	SS-2	SS-3	SS-3 RE	SS-4	SS-4 RE	Duplicate (SS-2)	Field Blank (Scoop)
Phenol	30	<410	<420	<390	<390	<390	<390	<420	<10
bis(2-Chloroethyl)ether	--	<410	<420	<390	<390	<390	<390	<420	<10
2-Chlorophenol	800	<410	<420	<390	<390	<390	<390	<420	<10
1,2-Dichlorobenzene	7,900	<410	<420	<390	<390	<390	<390	<420	<10
1,3-Dichlorobenzene	1,600	<410	<420	<390	<390	<390	<390	<420	<10
1,4-Dichlorobenzene	8,500	<410	<420	<390	<390	<390	<390	<420	<10
2-Methylphenol	100	<410	<420	<390	<390	<390	<390	<420	<10
2,2'-oxybis(1-Chloropropane)	--	<410	<420	<390	<390	<390	<390	<420	<10
3+4-Methylphenols	--	<820	<830	<780	<780	<780	<780	<830	<20
n-Nitroso-di-n-propylamine	--	<410	<420	<390	<390	<390	<390	<420	<10
Hexachloroethane	--	<410	<420	<390	<390	<390	<390	<420	<10
Nitrobenzene	200	<410	<420	<390	<390	<390	<390	<420	<10
Isophorone	4,400	<410	<420	<390	<390	<390	<390	<420	<10
2-Nitrophenol	330	<410	<420	<390	<390	<390	<390	<420	<10
2,4-Dimethylphenol	--	<410	<420	<390	<390	<390	<390	<420	<10
bis(2-Chloroethoxy)methane	--	<410	<420	<390	<390	<390	<390	<420	<10
2,4-Dichlorophenol	400	<410	<420	<390	<390	<390	<390	<420	<10
1,2,4-Trichlorobenzene	3,400	<410	<420	<390	<390	<390	<390	<420	<10
Naphthalene	13,000	<410	<420	<390	<390	<390	<390	<420	<10
4-Chloroaniline	220	<410	<420	<390	<390	<390	<390	<420	<10
Hexachlorobutadiene	--	<410	<420	<390	<390	<390	<390	<420	<10
4-Chloro-3-methylphenol	240	<410	<420	<390	<390	<390	<390	<420	<10
2-Methylnaphthalene	36,400	<410	<420	<390	<390	<390	<390	<420	<10
Hexachlorocyclopentadiene	--	<410	<420	<390	<390	<390	<390	<420	<10
2,4,6-Trichlorophenol	--	<410	<420	<390	<390	<390	<390	<420	<10
2,4,5-Trichlorophenol	100	<410	<420	<390	<390	<390	<390	<420	<10
2-Chloronaphthalene	--	<410	<420	<390	<390	<390	<390	<420	<10
2-Nitroaniline	430	<410	<420	<390	<390	<390	<390	<420	<10
Dimethylphthalate	2,000	<410	<420	<390	<390	<390	<390	<420	<10
Acenaphthylene	41,000	<410	<420	<390	<390	<390	<390	<420	<10
2,6-Dinitrotoluene	1,000	<410	<420	<390	<390	<390	<390	<420	<10
3-Nitroaniline	500	<410	<420	<390	<390	<390	<390	<420	<10

Notes: * Results are reported in μg/kg.
-- Indicates that a clean-up value has not been assigned.
< Indicates that the analyte was not detected above the instrument detection limit.
RE - result of re-analysis following sample dilution.
ND - not detected
B - indicates that the analyte was also detected in the blank.
J - indicates an estimate value.

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TABLE 1-1 cont.
ERWIN TOWN LANDFILL REMEDIAL INVESTIGATION
SURFACE SOIL ANALYTICAL RESULTS - MAY 2001 SAMPLING
SEMI-VOLATILE ORGANIC COMPOUNDS cont.

PARAMETER *	TAGM #4046 Clean-up Objective (ppb)	SAMPLE LOCATION (ppb)							
		SS-1	SS-2	SS-3	SS-3 RE	SS-4	SS-4 RE	Duplicate (SS-2)	Field Blank (Scoop)
Acenaphthene	50,000	<410	<420	<390	<390	84 J	83 J	<420	<10
2,4-Dinitrophenol	200	<410	<420	<390	<390	<390	<390	<420	<10
4-Nitrophenol	100	<410	<420	<390	<390	<390	<390	<420	<10
Dibenzofuran	6,200	<410	<420	<390	<390	45 J	45 J	<420	<10
2,4-Dinitrotoluene	--	<410	<420	<390	<390	<390	<390	<420	<10
Diethylphthalate	7,100	52 J	<420	<390	<390	<390	<390	<420	<10
4-Chlorophenyl-phenylether	--	<410	<420	<390	<390	<390	<390	<420	<10
Fluorene	50,000	<410	<420	<390	<390	55 J	55 J	<420	<10
4-Nitroaniline	--	<410	<420	<390	<390	<390	<390	<420	<10
4,6-Dinitro-2-methylphenol	--	<410	<420	<390	<390	<390	<390	<420	<10
n-Nitrosodiphenylamine	--	<410	<420	<390	<390	<390	<390	<420	<10
4-Bromophenyl-phenylether	--	<410	<420	<390	<390	<390	<390	<420	<10
Hexachlorobenzene	410	<410	<420	<390	<390	<390	<390	<420	<10
Pentachlorophenol	1,000	<410	<420	<390	<390	<390	<390	<420	<10
Phenanthrene	50,000	130 J	100 J	62 J	63 J	290 J	300 J	88 J	<10
Anthracene	50,000	<410	<420	<390	<390	63 J	62 J	<420	<10
Carbazole	--	<410	<420	<390	<390	<390	40 J	<420	<10
Di-n-butylphthalate	8,100	110 J	<420	42 J	44 J	65 J	70 J	<420	1.4
Fluoranthene	50,000	220 J	190 J	72 J	72 J	480	490	180 J	<10
Pyrene	50,000	140 J	130 J	57 J	58 J	650	670	130 J	<10
Butylbenzylphthalate	50,000	<410	<420	<390	<390	<390	<390	<420	<10
3,3'-Dichlorobenzidine	--	<410	<420	<390	<390	<390	<390	<420	<10
Benzo(a)anthracene	224	78 J	67 J	<390	<390	220 J	220 J	72 J	<10
Chrysene	400	98 J	87 J	41 J	42 J	270 J	260 J	90 J	<10
Bis(2-Ethylhexyl)phthalate	50,000	67 J	<420	<390	<390	54 J	54 J	<420	<10
Di-n-octyl phthalate	50,000	<410	<420	<390	<390	<390	<390	<420	<10
Benzo(b)fluoranthene	1,100	77 J	69 J	43 J	<390	270 J	270 J	73 J	<10
Benzo(k)fluoranthene	1,100	130 J	120 J	40 J	48 J	390 J	350 J	120 J	<10
Benzo(a)pyrene	61	94 J	81 J	40 J	41 J	260 J	250 J	89 J	<10
Indeno(1,2,3-cd)pyrene	--	<410	<420	<390	<390	<390	40 J	<420	<10
Dibenzo(a,h)anthracene	14	<410	<420	<390	<390	<390	<390	<420	<10
Benzo(g,h,i)perylene	50,000	<410	<420	<390	<390	120 J	130 J	<420	<10
Total Semi-VOCs **	500,000	1,196	844	397	368	3,316	3,389	842	1.4

Notes: * Results are reported in µg/kg.
** Total Semi-Volatile Organic Compounds
-- Indicates that a clean-up value has not been assigned.
< Indicates that the analyte was not detected above the instrument detection limit.
RE - result of re-analysis following sample dilution.
ND - not detected
B - indicates that the analyte was also detected in the blank.
J - indicates an estimate value.

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TABLE 1-1 cont.

ERWIN TOWN LANDFILL REMEDIAL INVESTIGATION
SURFACE SOIL ANALYTICAL RESULTS - MAY 2001 SAMPLING
TOTAL METALS

PARAMETER *	TAGM #4046 Clean-up Objective (ppm)	Sample Location (ppm)											
		SS-1		SS-2		SS-3		SS-4		Duplicate (SS-2)		Field Blank (Scoop)	
Aluminum	SB	12600		12500		2500		7270		12800		<7.9	E
Antimony	SB	0.41	B	1.1	B	3	B	1.2	B	0.88	B	<3.1	
Arsenic	7.5 or SB	19.6		10.3		12.4		9.1		10.4		<2.5	
Barium	300 or SB	251		196		60.2		104		194		<.3	N
Beryllium	0.16 or SB	0.74	E	0.62	BE	0.1	BE	0.37	BE	0.63	E	<.01	
Cadmium	1 or SB	0.37	B	0.36	B	1.1		0.41	B	0.37	B	<.04	
Calcium	SB	2910		2430		4270		12100		2400		<3.1	
Chromium	10 or SB	18.4		15.9		10.4		11.1		16.1		<.8	
Cobalt	30 or SB	10.5		10.5		3.2	B	8		10.7		<1	
Copper	25 or SB	23.8		20.3		11.4		20.3		20.1		<.8	
Iron	2,000 or SB	23400		22900		9100		15100		22800		15.1	B
Lead	SB	39.4		62.2		236		121		61.4		<2.5	
Magnesium	SB	3730		3510		2160		3540		3530		<7.9	
Manganese	SB	709		789		158		475		801		0.32	B
Mercury	0.1	<.01	N	0.02	N	<.01		<.01		0.03	N	<.02	
Nickel	13 or SB	23.5		20		22.1		15.4		20.2		<1.7	
Potassium	SB	1580	E	1600	E	326	BE	986	E	1740	E	<31	E
Selenium	2 or SB	<.4		0.57	B	0.54	B	<.37		<.4		<3.2	
Silver	SB	1	BN	1.1	BN	0.62	BN	0.69	BN	1.2	BN	<1.3	
Sodium	SB	<33.2		69.4	B	150	B	82.6	B	94.1	B	<267	E
Thallium	SB	<.48		<.49		<.45		<.46		<.49		<3.9	
Vanadium	150 or SB	17.9		16.9		4.5	B	13.4		17.4		<34.9	
Zinc	20 or SB	113		99.3		65.2		84.4		99.8		<.5	
Cyanide	--	0.74		<0.63		<0.58		0.7		<0.62		<0.01	

Notes: * Results are reprted in mg/kg.
-- Indicates that a clean-up value has not been assigned.
< Indicates that the analyte was not detected above the instrument detection limit.
B - indicates that the reported value is less than the Contract Required Detection Limit (CRDL), greater than the instrument detection limit.
E - The reported value is estimated because of the presence of interference.
N - Spiked sample recovery not within control limits.

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TABLE 1-1 cont.
ERWIN TOWN LANDFILL REMEDIAL INVESTIGATION
SURFACE SOIL ANALYTICAL RESULTS - MAY 2001 SAMPLING
PCBs

PARAMETER *	TAGM #4046 Clean-up Objective (ppb)	SAMPLE LOCATION (ppb)					
		SS-1	SS-2	SS-3	SS-4	Duplicate (SS-2)	Field Blank (Scoop)
Aroclor 1016	1000	<21	<21	<19	<20	<21	<0.5
Aroclor 1221	1000	<21	<21	<19	<20	<21	<0.5
Aroclor 1232	1000	<21	<21	<19	<20	<21	<0.5
Aroclor 1242	1000	<21	<21	<19	<20	<21	<0.5
Aroclor 1248	1000	<21	<21	<19	<20	<21	<0.5
Aroclor 1254	1000	<21	<21	<19	<20	<21	<0.5
Aroclor 1260	1000	<21	<21	<19	92	<21	<0.5

Note: * Results are reported in µg/kg.

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TABLE 1-2
ERWIN TOWN LANDFILL REMEDIAL INVESTIGATION
GROUNDWATER ANALYTICAL RESULTS - MAY 2001 SAMPLING
VOLATILE ORGANIC COMPOUNDS

PARAMETER *	6NYCRR Part 703 Groundwater Standard or [Guidance Value]	SAMPLE LOCATION (ppb)								
		MW-A1***	MW-A2***	MW-A3	MW-A4	MW-A5	MW-A6	MW-A7	MW-1	MW-2
Chloromethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Vinyl Chloride	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Bromomethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chloroethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,1-Dichloroethene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Acetone	[50]	<5	<5	<5	<5	<5	<5	<5	<5	<5
Carbon Disulfide	-	<5	<5	<5	<5	<5	<5	<5	<5	<5
Methylene Chloride	5	<5	<5	<5	<5	<5	<5	<5	2	<5
trans-1,2-Dichloroethene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,1-Dichloroethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
2-Butanone	[50]	<5	<5	<5	<5	<5	<5	<5	<5	<5
cis-1,2-Dichloroethene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chloroform	7	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,1,1-Trichloroethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Carbon Tetrachloride	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Benzene	0.7	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,2-Dichloroethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Trichloroethene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,2-Dichloropropane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Bromodichloromethane	[50]	<5	<5	<5	<5	<5	<5	<5	<5	<5
4-Methyl-2-Pentanone	-	<5	<5	<5	<5	<5	<5	<5	<5	<5
Toluene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
trans-1,3-Dichloropropene	-	<5	<5	<5	<5	<5	<5	<5	<5	<5
cis-1,3-Dichloropropene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,1,2-Trichloroethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
2-Hexanone	[50]	<5	<5	<5	<5	<5	<5	<5	<5	<5
Dibromochloromethane	[50]	<5	<5	<5	<5	<5	<5	<5	<5	<5
Tetrachloroethene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chlorobenzene	5	<5	<5	5	<5	<5	<5	<5	<5	<5
Ethyl Benzene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
m/p-Xylenes	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
o-Xylene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Styrene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Bromoform	[50]	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,1,2,2-Tetrachloroethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Total VOCs **	5	<5	<5	5	<5	<5	<5	<5	2	<5

Notes: * Results are reported in µg/L.
** Total Volatile Organic Compounds.
*** MW-A1 and MW-A2 are considered to be background water quality locations.
- Indicates that a standard or guidance value has not been assigned.
< Indicates that the analyte was not detected above the instrument detection limit.
ND - not detected

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TABLE 1-2 cont.
ERWIN TOWN LANDFILL REMEDIAL INVESTIGATION
GROUNDWATER ANALYTICAL RESULTS - MAY 2001 SAMPLING
VOLATILE ORGANIC COMPOUNDS cont.

PARAMETER *	6NYCRR Part 703 Groundwater Standard or [Guidance Value]	SAMPLE LOCATION (ppb)								
		MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	Duplicate (MW-A2)	Trip Blank
Chloromethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Vinyl Chloride	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Bromomethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chloroethane	5	<5	66	<5	<5	<5	<5	<5	<5	<5
1,1-Dichloroethene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Acetone	[50]	<5	<5	<5	<5	<5	<5	<5	<5	<5
Carbon Disulfide	-	<5	<5	<5	<5	<5	<5	<5	<5	<5
Methylene Chloride	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
trans-1,2-Dichloroethene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,1-Dichloroethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
2-Butanone	[50]	<5	<5	<5	<5	<5	<5	<5	<5	<5
cis-1,2-Dichloroethene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chloroform	7	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,1,1-Trichloroethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Carbon Tetrachloride	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Benzene	0.7	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,2-Dichloroethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Trichloroethene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,2-Dichloropropane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Bromodichloromethane	[50]	<5	<5	<5	<5	<5	<5	<5	<5	<5
4-Methyl-2-Pentanone	-	<5	<5	<5	<5	<5	<5	<5	<5	<5
Toluene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
trans-1,3-Dichloropropene	-	<5	<5	<5	<5	<5	<5	<5	<5	<5
cis-1,3-Dichloropropene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,1,2-Trichloroethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
2-Hexanone	[50]	<5	<5	<5	<5	<5	<5	<5	<5	<5
Dibromochloromethane	[50]	<5	<5	<5	<5	<5	<5	<5	<5	<5
Tetrachloroethene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chlorobenzene	5	<5	9.6	<5	<5	<5	<5	<5	<5	<5
Ethyl Benzene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
m/p-Xylenes	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
o-Xylene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Styrene	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Bromoform	[50]	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,1,2,2-Tetrachloroethane	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Total VOCs **	5	<5	75.6	<5	<5	<5	<5	<5	<5	<5

Notes: * Results are reported in µg/L.
** Total Volatile Organic Compounds.
*** MW-A1 and MW-A2 are considered to be background water quality locations.
- Indicates that a standard or guidance value has not been assigned.
< Indicates that the analyte was not detected above the instrument detection limit.
ND - not detected

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TABLE 1-2 cont.
ERWIN TOWN LANDFILL REMEDIAL INVESTIGATION
GROUNDWATER ANALYTICAL RESULTS - MAY 2001 SAMPLING
SEMI-VOLATILE ORGANIC COMPOUNDS

PARAMETER*	6NYCRR Part 703 Groundwater Standard or [Guidance Value]	SAMPLE LOCATION (ppb)								
		MW-A1**	MW-A2 **	MW-A3	MW-A4	MW-A5	MW-A6	MW-A7	MW-1	MW-2
Phenol	1	<10	<10	<10	<10	<10	<10	<10	<10	<10
bis(2-Chloroethyl)ether	1	<10	<10	<10	<10	<10	<10	<10	<10	<10
2-Chlorophenol	1	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,2-Dichlorobenzene	3	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,3-Dichlorobenzene	3	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,4-Dichlorobenzene	3	<10	<10	<10	<10	<10	<10	<10	<10	<10
2-Methylphenol	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,2'-oxybis(1-Chloropropane)	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
3+4-Methylphenols	-	<20	<20	<20	<20	<20	<20	<20	<20	<20
n-Nitroso-di-n-propylamine	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hexachloroethane	5	<10	<10	<10	<10	<10	<10	<10	<10	<10
Nitrobenzene	0.4	<10	<10	<10	<10	<10	<10	<10	<10	<10
Isophorone	[50]	<10	<10	<10	<10	<10	<10	<10	<10	<10
2-Nitrophenol	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dimethylphenol	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
bis(2-Chloroethoxy)methane	5	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dichlorophenol	1	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,2,4-Trichlorobenzene	5	<10	<10	<10	<10	<10	<10	<10	<10	<10
Naphthalene	[10]	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Chloroaniline	5	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hexachlorobutadiene	0.5	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Chloro-3-methylphenol	1	<10	<10	<10	<10	<10	<10	<10	<10	<10
2-Methylnaphthalene	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hexachlorocyclopentadiene	5	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,4,6-Trichlorophenol	1	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,4,5-Trichlorophenol	1	<10	<10	<10	<10	<10	<10	<10	<10	<10
2-Chloronaphthalene	[10]	<10	<10	<10	<10	<10	<10	<10	<10	<10
2-Nitroaniline	5	<10	<10	<10	<10	<10	<10	<10	<10	<10
Dimethylphthalate	[50]	<10	<10	<10	<10	<10	<10	<10	<10	<10
Acenaphthylene	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,6-Dinitrotoluene	5	<10	<10	<10	<10	<10	<10	<10	<10	<10
3-Nitroaniline	5	<10	<10	<10	<10	<10	<10	<10	<10	<10

Notes: * Results are reported in μg/L.
** MW-A1 and MW-A2 are considered to be background water quality locations.
- Indicates that a standard or guidance value has not been assigned.
< Indicates that the analyte was not detected above the instrument detection limit.
J - Indicates an estimated value.

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TABLE 1-2 cont.
ERWIN TOWN LANDFILL REMEDIAL INVESTIGATION
GROUNDWATER ANALYTICAL RESULTS - MAY 2001 SAMPLING
SEMI-VOLATILE ORGANIC COMPOUNDS cont.

PARAMETER*	6NYCRR Part 703 Groundwater Standard or [Guidance Value]	SAMPLE LOCATION (ppb)								
		MW-A1***	MW-A2***	MW-A3	MW-A4	MW-A5	MW-A6	MW-A7	MW-1	MW-2
Acenaphthene	[20]	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dinitrophenol	10	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Nitrophenol	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Dibenzofuran	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dinitrotoluene	5	<10	<10	<10	<10	<10	<10	<10	<10	<10
Diethylphthalate	[50]	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Chlorophenyl-phenylether	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Fluorene	[50]	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Nitroaniline	5	<10	<10	<10	<10	<10	<10	<10	<10	<10
4,6-Dinitro-2-methylphenol	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
n-Nitrosodiphenylamine	[50]	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Bromophenyl-phenylether	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hexachlorobenzene	0.04	<10	<10	<10	<10	<10	<10	<10	<10	<10
Pentachlorophenol	1	<10	<10	<10	<10	<10	<10	<10	<10	<10
Phenanthrene	[50]	<10	<10	<10	<10	<10	<10	<10	<10	<10
Anthracene	[50]	<10	<10	<10	<10	<10	<10	<10	<10	<10
Carbazole	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Di-n-butylphthalate	50	<10	<10	<10	<10	<10	<10	1.1 J	<10	<10
Fluoranthene	[50]	<10	<10	<10	<10	<10	<10	<10	<10	<10
Pyrene	[50]	<10	<10	<10	<10	<10	<10	<10	<10	<10
Butylbenzylphthalate	[50]	<10	<10	<10	<10	<10	<10	<10	<10	<10
3,3'-Dichlorobenzidine	5	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(a)anthracene	[.002]	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chrysene	[0.002]	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bis(2-Ethylhexyl)phthalate	5	1 J	1.5 J	2.2 J	1.7	2.9 J	3 J	3.4 J	1.2 J	3.7 J
Di-n-octyl phthalate	[50]	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(b)fluoranthene	[.002]	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(k)fluoranthene	[.002]	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(a)pyrene	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Indeno(1,2,3-cd)pyrene	[.002]	<10	<10	<10	<10	<10	<10	<10	<10	<10
Dibenzo(a,h)anthracene	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(g,h,i)perylene	-	<10	<10	<10	<10	<10	<10	<10	<10	<10

Notes: * Results are reported in μg/L.
** MW-A1 and MW-A2 are considered to be background water quality locations.
- Indicates that a standard or guidance value has not been assigned.
< Indicates that the analyte was not detected above the instrument detection limit.
J - Indicates an estimated value.

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TABLE 1-2 cont.
ERWIN TOWN LANDFILL REMEDIAL INVESTIGATION
GROUNDWATER ANALYTICAL RESULTS - MAY 2001 SAMPLING
SEMI-VOLATILE ORGANIC COMPOUNDS cont.

PARAMETER*	6NYCRR Part 703 Groundwater Standard or [Guidance Value]	SAMPLE LOCATION (ppb)							
		MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	FIELDBLANK
Phenol	1	<10	<10	<10	<10	<10	<10	<10	<10
bis(2-Chloroethyl)ether	1	<10	<10	<10	<10	<10	<10	<10	<10
2-Chlorophenol	1	<10	<10	<10	<10	<10	<10	<10	<10
1,2-Dichlorobenzene	3	<10	<10	<10	<10	<10	<10	<10	<10
1,3-Dichlorobenzene	3	<10	<10	<10	<10	<10	<10	<10	<10
1,4-Dichlorobenzene	3	<10	1.1 J	<10	<10	<10	<10	<10	<10
2-Methylphenol	-	<10	<10	<10	<10	<10	<10	<10	<10
2,2'-oxybis(1-Chloropropane)	-	<10	<10	<10	<10	<10	<10	<10	<10
3+4-Methylphenols	-	<20	<20	<20	<20	<20	<20	<20	<20
n-Nitroso-di-n-propylamine	-	<10	<10	<10	<10	<10	<10	<10	<10
Hexachloroethane	5	<10	<10	<10	<10	<10	<10	<10	<10
Nitrobenzene	0.4	<10	<10	<10	<10	<10	<10	<10	<10
Isophorone	[50]	<10	<10	<10	<10	<10	<10	<10	<10
2-Nitrophenol	-	<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dimethylphenol	-	<10	<10	<10	<10	<10	<10	<10	<10
bis(2-Chloroethoxy)methane	5	<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dichlorophenol	1	<10	<10	<10	<10	<10	<10	<10	<10
1,2,4-Trichlorobenzene	5	<10	<10	<10	<10	<10	<10	<10	<10
Naphthalene	[10]	<10	<10	<10	<10	<10	<10	<10	<10
4-Chloroaniline	5	<10	<10	<10	<10	<10	<10	<10	<10
Hexachlorobutadiene	0.5	<10	<10	<10	<10	<10	<10	<10	<10
4-Chloro-3-methylphenol	1	<10	<10	<10	<10	<10	<10	<10	<10
2-Methylnaphthalene	-	<10	<10	<10	<10	<10	<10	<10	<10
Hexachlorocyclopentadiene	5	<10	<10	<10	<10	<10	<10	<10	<10
2,4,6-Trichlorophenol	1	<10	<10	<10	<10	<10	<10	<10	<10
2,4,5-Trichlorophenol	1	<10	<10	<10	<10	<10	<10	<10	<10
2-Chloronaphthalene	[10]	<10	<10	<10	<10	<10	<10	<10	<10
2-Nitroaniline	5	<10	<10	<10	<10	<10	<10	<10	<10
Dimethylphthalate	[50]	<10	<10	<10	<10	<10	<10	<10	<10
Acenaphthylene	-	<10	<10	<10	<10	<10	<10	<10	<10
2,6-Dinitrotoluene	5	<10	<10	<10	<10	<10	<10	<10	<10
3-Nitroaniline	5	<10	<10	<10	<10	<10	<10	<10	<10

Notes: * Results are reported in µg/L.
** MW-A1 and MW-A2 are considered to be background water quality locations.
- Indicates that a standard or guidance value has not been assigned.
< Indicates that the analyte was not detected above the instrument detection limit.
J - Indicates an estimated value.

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Consulting Engineers

TABLE 1-2 cont.
ERWIN TOWN LANDFILL REMEDIAL INVESTIGATION
GROUNDWATER ANALYTICAL RESULTS - MAY 2001 SAMPLING
SEMI-VOLATILE ORGANIC COMPOUNDS cont.

PARAMETER *	6NYCRR Part 703 Groundwater Standard or [Guidance Value]	SAMPLE LOCATION (ppb)							
		MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	FIELDBLANK
Acenaphthene	[20]	<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dinitrophenol	10	<10	<10	<10	<10	<10	<10	<10	<10
4-Nitrophenol	-	<10	<10	<10	<10	<10	<10	<10	<10
Dibenzofuran	-	<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dinitrotoluene	5	<10	<10	<10	<10	<10	<10	<10	<10
Diethylphthalate	[50]	<10	<10	<10	<10	1.2 J	<10	<10	<10
4-Chlorophenyl-phenylether	-	<10	<10	<10	<10	<10	<10	<10	<10
Fluorene	[50]	<10	<10	<10	<10	<10	<10	<10	<10
4-Nitroaniline	5	<10	<10	<10	<10	<10	<10	<10	<10
4,6-Dinitro-2-methylphenol	-	<10	<10	<10	<10	<10	<10	<10	<10
n-Nitrosodiphenylamine	[50]	<10	<10	<10	<10	<10	<10	<10	<10
4-Bromophenyl-phenylether	-	<10	<10	<10	<10	<10	<10	<10	<10
Hexachlorobenzene	0.04	<10	<10	<10	<10	<10	<10	<10	<10
Pentachlorophenol	1	<10	<10	<10	<10	<10	<10	<10	<10
Phenanthrene	[50]	<10	<10	<10	<10	<10	<10	<10	<10
Anthracene	[50]	<10	<10	<10	<10	<10	<10	<10	<10
Carbazole	-	<10	<10	<10	<10	<10	<10	<10	<10
Di-n-butylphthalate	50	<10	1.2 J	6.2 J	.5 J	8.7 J	3.4 J	3.7 J	<10
Fluoranthene	[50]	<10	<10	<10	<10	<10	<10	<10	<10
Pyrene	[50]	<10	<10	<10	<10	<10	<10	<10	<10
Butylbenzylphthalate	[50]	<10	<10	<10	<10	<10	<10	<10	<10
3,3'-Dichlorobenzidine	5	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(a)anthracene	[.002]	<10	<10	<10	<10	<10	<10	<10	<10
Chrysene	[0.002]	<10	<10	<10	<10	<10	<10	<10	<10
Bis(2-Ethylhexyl)phthalate	5	4.3 J	<10	1.7 J	1.8 J	2.9 J	1.6 J	1.9 J	<10
Di-n-octyl phthalate	[50]	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(b)fluoranthene	[.002]	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(k)fluoranthene	[.002]	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(a)pyrene	-	<10	<10	<10	<10	<10	<10	<10	<10
Indeno(1,2,3-cd)pyrene	[.002]	<10	<10	<10	<10	<10	<10	<10	<10
Dibenzo(a,h)anthracene	-	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(g,h,i)perylene	-	<10	<10	<10	<10	<10	<10	<10	<10

Notes: * Results are reported in μg/L.
** MW-A1 and MW-A2 are considered to be background water quality locations.
- Indicates that a standard or guidance value has not been assigned.
< Indicates that the analyte was not detected above the instrument detection limit.
J - Indicates an estimated value.

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Consulting Engineers

TABLE 1-2 cont.
ERWIN TOWN LANDFILL REMEDIAL INVESITGATION
GROUNDWATER ANALYTICAL RESULTS - MAY 2001 SAMPLING
TOTAL METALS

PARARMETER *	6NYCRR Part 703 Groundwater Standard or [Guidance Value]	SAMPLE LOCATION (ppb)								
		MW-A1 **	MW-A2 **	MW-A3	MW-A4	MW-A5	MW-A6	MW-A7	MW-1	MW-2
Aluminum	-	5,300	11,500	1,040	9,030	57,300	2,110	64,100	75,900	366
Antimony	3	<3.1	<3.1	14.4 B	<3.1	7.2 B	<3.1	4.5 B	4.7 B	13.6 B
Arsenic	25	10.8	29	23.7	22.9	60.3	10.4	59.6	125	63.4
Barium	1,000	257	480	792	633	1,530	414	2,460	4,920	454
Beryllium	[3]	0.46 B	0.67 B	0.12 B	0.56 B	3.3 B	0.24 B	3 B	4.1 B	0.16 B
Cadmium	5	<.4	<.4	<.4	<.4	<.4	0.46 B	1.5 B	1 B	<.4
Calcium	-	125,000	107,000	145,000	155,000	144,000	98,500	211,000	337,000	124,000
Chromium	50	6.9 B	13.4	2 B	9.9 B	70	<.8	72.1	126	1.5 B
Cobalt	-	6.4 B	9 B	9.5 B	12.1 B	34.4 B	8.6 B	42.6 B	97.8	4.3 B
Copper	200	18.7 B	41.5	18.6 B	45.6	204	20.7 B	205	391	9.5 B
Iron	300	11,400	30,100	17,500	30,200	119,000	14,000	96,900	172,000	24,900
Lead	25	12.2	19.5	45.5	21.6	87.3	10.9	98.8	193	40.9
Magnesium	[35000]	19,200	23,100	57,200	37,800	69,200	14,200	79,400	143,000	80,500
Manganese	300	1,030	3,300	3,850	14,100	5,700	16,200	13,300	29,900	814
Mercury	0.7	<.2	<.2	<.2	<.2	0.25	<.2	0.21	0.22	<.2
Nickel	100	11 B	20.2 B	7.3 B	19.2 B	95.8	7.9 B	103	187	4.2 B
Potassium	-	4,250 BE	5,000 BE	151,000 E	17,000 E	25,200 E	5,100 E	13,800 E	15,800 E	210,000 E
Selenium	10	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
Silver	50	<1.3	<1.3	<1.3	<1.3	<1.3 B	<1.3	<1.3	<1.3	<1.3
Sodium	20,000	132,000 E	73,600 E	523,000 E	123,000 E	101,000 E	91,700 E	492,000 E	80,500 E	502,000 E
Thallium	[0.5]	<3.9	<3.9	<3.9	<3.9	<3.9	<3.9	<3.9	9 B	<3.9
Vanadium	-	<34.9	<34.9	<34.9	<34.9	76.3	<34.9	78.8	122	<34.9
Zinc	[2000]	64.7	119	59.8	116	618	34.8	559	986	45.4
Cyanide	200	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron & Manganese	500	12,430	33,400	21,350	44,300	124,700	30,200	110,200	201,900	25,714

Notes: * Results are reported in µg/L.
** MW-A1 and MW-A2 are considered to be background water quality locations.
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B - indicates that the reported value is less than the Contract Required Detection Limit (CRDL), greater than the instrument detection limit.
E - The reported value is estimated because of the presence of interference.

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Consulting Engineers

TABLE 1-2 cont.
ERWIN TOWN LANDFILL REMEDIAL INVESITGATION
GROUNDWATER ANALYTICAL RESULTS - MAY 2001 SAMPLING
TOTAL METALS cont.

PARARMETER *	6NYCRR Part 703 Groundwater Standard or [Guidance Value]	SAMPLE LOCATION (ppb)								
		MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	Duplicate (MW-A2)	Field Blank
Aluminum	-	6,600	34,700 E	473 E	44,500 E	<7.9 E	97,400 E	81,800 E	11,500	<7.9 E
Antimony	3	1,720	16.2 B	6.7 B	12.4 B	3.5 B	6.1 B	7.3 B	<3.1	<3.1
Arsenic	25	40.6	72.3	<2.5	272	23.1	79.8	58.2	26.8	<2.5
Barium	1,000	940	2,370 N	668 N	2,820 N	1,730 N	2,170 N	1,700 N	512	<.3 N
Beryllium	[3]	0.78 B	1.2 B	<.01	2 B	<.01	3.7 B	3.1 B	0.72 B	<.01
Cadmium	5	1.8 B	1.5 B	<.04	7.9	<.04	5.4	3.7 B	<.4	<.04
Calcium	-	144,000	164,000	159,000	162,000	176,000	234,000	132,000	114,000	<3.1
Chromium	50	29.2	58.5	1.4 B	63.2	<.8	134	102	12.5	<.8
Cobalt	-	10.1 B	31 B	5.5 B	31.2 B	1.1 B	67.9	59.6	8.5 B	<1
Copper	200	34.7	135	15.7 B	104	14.2 B	254	178	42.2	<.8
Iron	300	42,400	71,700	4,400	324,000	5,550	175,000	140,000	29,400	15.1 B
Lead	25	52.1	122	19.5	445	6.8	130	127	17.7	<2.5
Magnesium	[35000]	43,700	79,500	47,300	44,900	47,500	105,000	56,000	24,200	<7.9
Manganese	300	3,760	5,370	3,010	6,760	3,840	14,500	6,400	3,510	0.32 B
Mercury	0.7	<.2	<.02	<.02	0.24	<.02	<.02	<.02	<.2	<.02
Nickel	100	23.8 B	71.8	17.2 B	38.4 B	2.5 B	160	132	19 B	<1.7
Potassium	-	14,200 E	76,500 E	34,400 E	11,900 E	3,120 BE	50,700 E	40,000 E	5,880 E	<31 E
Selenium	10	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
Silver	50	<1.3	<1.3	<1.3	10.4	<1.3	2.6 B	1.8 B	1.5 B	<1.3
Sodium	20,000	259,000 E	726,000 E	532,000 E	148,000 E	245,000 E	251,000 E	186,000 E	80,100 E	<267 E
Thallium	[0.5]	<3.9	<3.9	<3.9	<3.9	<3.9	<3.9	<3.9	<3.9	<3.9
Vanadium	-	<34.9	46.2 B	<34.9	80	<34.9	126	104	<34.9	<34.9
Zinc	[2000]	103	458	31.3	365	66.9	720	589	110	<.5
Cyanide	200	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron & Manganese	500	46,160	77,070	7,410	330,760	9,390	189,500	146,400	32,910	15.42

Notes: * Results are reported in µg/L.
** MW-A1 and MW-A2 are considered to be background water quality locations.
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TABLE 1-2 cont.
ERWIN TOWN LANDFILL REMEDIAL IVESTIGATION
GROUNDWATER ANALYTICAL RESULTS - MAY 2001 SAMPLING
PCBs

PARAMETER *	6NYCRR Part 703 Groundwater Standard or [Guidance Value]	SAMPLE LOCATION (ppb)								
		MW-A1**	MW-A2**	MW-A3	MW-A4	MW-A5	MW-A6	MW-A7	MW-1	MW-2
Aroclor 1016	50	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Aroclor 1221	50	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Aroclor 1232	50	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Aroclor 1242	50	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Aroclor 1248	50	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Aroclor 1254	50	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Aroclor 1260	50	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5

Note: * Results are reported in µg/L.
** MW-A1 and MW-A2 are considered to be background water quality locations.

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TABLE 1-2 cont.
ERWIN TOWN LANDFILL REMEDIAL IVESTIGATION
GROUNDWATER ANALYTICAL RESULTS - MAY 2001 SAMPLING
PCBs cont.

PARAMETER *	6NYCRR Part 703 Groundwater Standard or [Guidance Value]	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	Duplicate (MW-A2)
Aroclor 1016	50	<.5	<.05	<.05	<.05	<.05	<.05	<.05	<.5
Aroclor 1221	50	<.5	<.05	<.05	<.05	<.05	<.05	<.05	<.5
Aroclor 1232	50	<.5	<.05	<.05	<.05	<.05	<.05	<.05	<.5
Aroclor 1242	50	<.5	<.05	<.05	<.05	<.05	<.05	<.05	<.5
Aroclor 1248	50	<.5	<.05	<.05	<.05	<.05	<.05	<.05	<.5
Aroclor 1254	50	<.5	<.05	<.05	<.05	<.05	<.05	<.05	<.5
Aroclor 1260	50	<.5	<.05	<.05	<.05	<.05	<.05	<.05	<.5

Note: * Results are reported in µg/L.
** MW-A1 and MW-A2 are considered to be background water quality locations.

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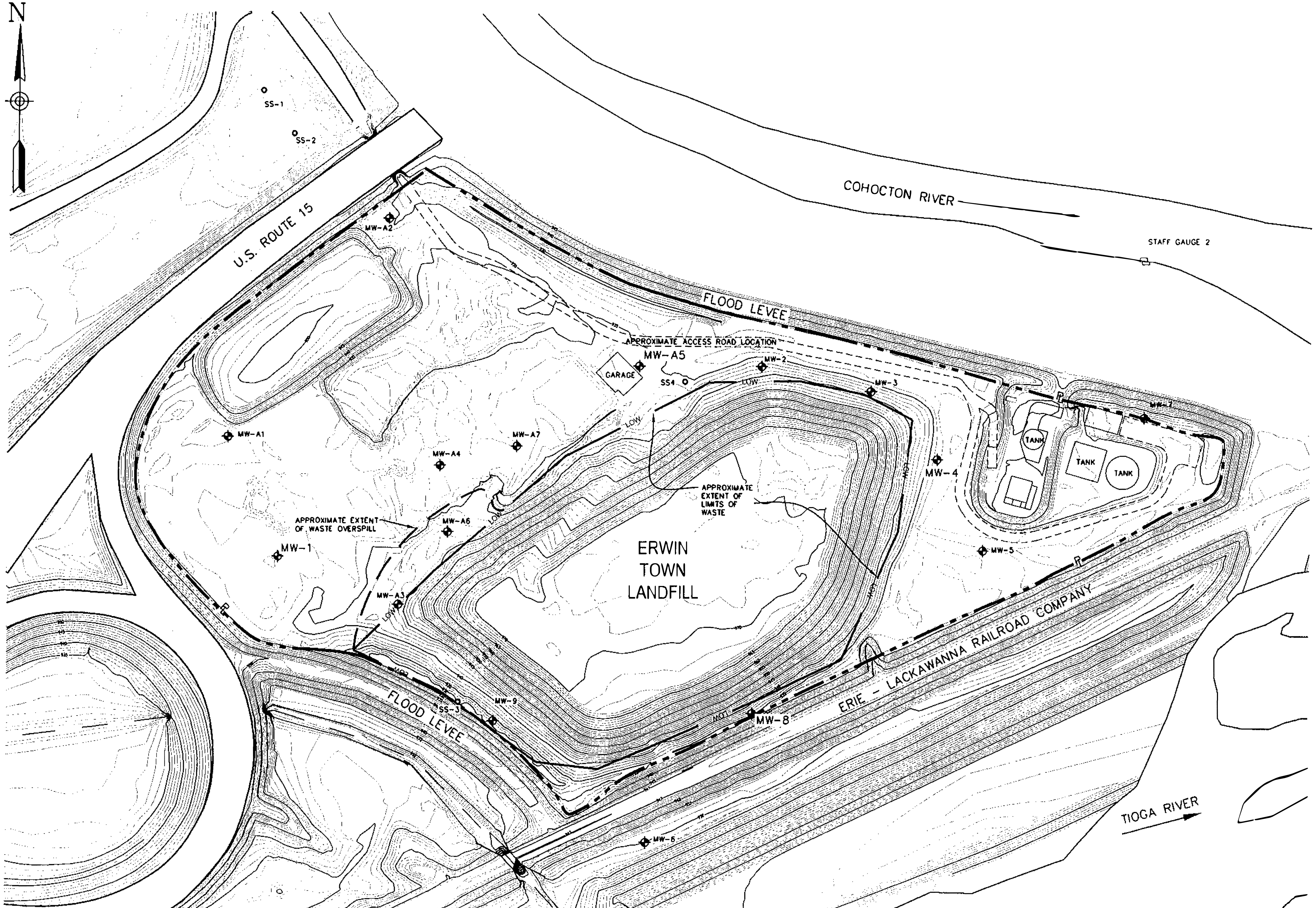

LEGEND

MW-5	=	MONITORING WELL
SS4	=	SURFACE SOIL SAMPLE LOCATION
	=	ACCESS ROAD LOCATION
	=	SURFACE CONTOUR LINES
	=	INTERMITTENT STREAM
PL	=	APPROXIMATE TOWN OF ERWIN PROPERTY BOUNDARY
LOW	=	LIMITS OF WASTE

NOTE:
MW-1, MW-4, MW-8 AND MW-A5 TO BE USED AS LONG-TERM MONITORING LOCATION.

MAPPING SOURCE:
COORDINATES AND ELEVATIONS BASED ON STATION H-26 #8026 FROM NEW YORK STATE D.O.T. CONTROL IN CONNECTION WITH HAMILTON ST. INTERCHANGE ROUTE 17 & RTE 15 PAINTED POST-WEST CITY LN. CORNING PT. 1 NAD 83 HORIZONTAL, NGVD 88 VERTICAL.

200' 100' 0 200' 400'

SCALE: 1" = 200'

FEBRUARY, 2002

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STEUBEN COUNTY DEPARTMENT OF PUBLIC WORKS
ERWIN TOWN LANDFILL
FEASIBILITY STUDY

SITE PLAN

TOWN OF ERWIN — STEUBEN COUNTY, NEW YORK

Figure 1-2

Project No. 268.012

In general, the site's groundwater is highly mineralized, with concentrations of aluminum, calcium, iron, magnesium, manganese, potassium and sodium at levels above standards or guidance values. Since these conditions occur site-wide and irrespective of location, and appear to be a result of excessive turbidity, groundwater impacts with respect to inorganic constituents is not considered to be a significant environmental threat.

There were no PCBs (polychlorinated biphenyls) detected in the groundwater at any of the sampling locations.

Surface Soils – A limited number of surface soil samples were collected during the Remedial Investigation to analyze for potential leachate impacts along the western perimeter of the landfill and to confirm the presence of PCBs identified in surface soil samples collected during previous site investigations. Low levels of VOCs and SVOCs (most detected below recommended NYSDEC clean-up objectives), were identified both in the on-site and background surface soil samples. The similar spectrum of constituents identified at these locations suggests that their presence are not related to an impact from the landfill, but may be a residual effect of past flooding events which occurred in this area.

Inorganic constituents detected in surface soil samples were observed to be within the range of background soil concentrations recorded for the Eastern United States (NYSDEC, 1994).

PCB results confirmed the presence of one Aroclor (identified in surface soil during a previous investigation) at a concentration below the recommended NYSDEC clean-up objective.

1.3.4 Contaminant Fate and Transport

The limited extent of volatile and semi-volatile organic compounds in the site groundwater is consistent with the results observed from past investigations at the site. This finding is not surprising given the probable composition and the main contributors to the landfill during its life of operation. There is no evidence that the low levels of VOCs and SVOCs are migrating great distances beyond the limits of waste associated with the landfill. Their attenuation is likely controlled by the effects of adsorption onto soil particles, and hydrodynamic dispersion and dilution within the groundwater.

The extent that elevated inorganic concentrations in the groundwater was observed also appears to be controlled by natural attenuation factors likely occurring short distances away from the landfill perimeter. Reducing conditions appear to be present immediately adjacent to the waste limits. Beyond these limits, it is anticipated that conditions would favor the oxidation of most of these minerals, further controlling their downgradient migration. A return to aerobic conditions within a relatively short distance from the landfill perimeter is also consistent with an environment more conducive to the biodegradation of persistent, yet low concentration, VOCs detected along a portion of the downgradient perimeter of the landfill.

1.3.5 Fish and Wildlife Impact Analysis

The Fish and Wildlife Impact Analysis evaluated environmental, terrestrial and aquatic resources within the vicinity of the landfill and the surrounding environment. The study found no adverse effects to the productivity, biomass, diversity, or abundance of fish and wildlife resources. Additionally, the study found that vegetation communities on and within the vicinity of the landfill were healthy and robust, and showed no evidence of landfill leachate impact.

1.3.6 Qualitative Human Health Risk Evaluation

The objective of the qualitative human health risk evaluation was to identify concentrations in the site media, present in excess of allowable standards or guidance values, and to determine if receptors are present which could complete an exposure pathway for the identified constituent. The results from this evaluation determined that the concentrations in the surface soils were below that which would establish an exposure risk. Finally, it was determined that the low concentrations of volatile and semi-volatile organic compounds in the soil and groundwater were insufficient to generate an inhalation exposure pathway.

1.4 Standards, Criteria and Guidelines (SCGs)

The successful development and implementation of remedial alternatives is based on the compliance of each alternative with New York State and Federal standards, criteria and guidelines (SCGs). In addition, each alternative must exhibit the ability to comply with the following three separate categories of SCGs:

a. Chemical-Specific SCGs: These include health or risk-based concentration limits or ranges of concentrations for the site-specific chemicals of concern, that establish the acceptable levels at which organic and inorganic parameters can be present within or discharged to specific media.

b. Location-Specific SCGs: These include restrictions placed on potential remediation technologies as a result of the geographical or physical position of a landfill with respect to the surrounding environment. Wetland, coastal areas and floodplain restrictions are the most common location-specific SCGs for municipal landfill sites. Restrictions may also be placed on right-of-way and easements with respect to "shared" access areas.

c. Action-Specific SCGs: These include regulations and guidelines to be followed during the development and implementation of specific remedial technologies. These may include landfill closure construction regulations (e.g., NYSDEC Part 360), and institutional controls.

2.0 REMEDIAL ACTION OBJECTIVES

The following section presents the site-specific area of concern, the remedial action objectives for each area of concern, and discusses the general response actions to identified objectives.

Remedial action objectives have been established for each medium on the basis of the nature and extent of site conditions, the potential for human and environmental exposure, and to delineate media-specific standards, criteria and guidelines (SCGs) which must be attained. General response actions have been subsequently formulated for each objective, identifying a variety of nonspecific alternatives that could potentially attain pre-determined SCGs.

2.1 Waste Disposal Areas

2.1.1 Areas of Concern

The Erwin Town Landfill is listed by the NYSDEC as an Inactive Hazardous Waste Disposal Site. However, the RI did not identify the location of specific hazardous waste or areas within the waste mass warranting "hot spot" remediation. Therefore, for purposes of identifying possible remedial action objectives for the waste, it will be assumed that any waste remediation technology will be applied to the entire limits of waste as identified on Figure 1-2.

2.1.2 Exposure Routes and Receptors

The identified potential receptors for the waste are trespassers, residents, recreationists and/or wildlife that come in direct contact with the waste.

2.1.3 Standards, Criteria and Guidelines for Waste Disposal Areas

The SCG for solid waste management facilities is 6 NYCRR Part 360. The applicable clause of the current Part 360 specific to the Erwin Town Landfill requires that the landfill meet closure regulations which were in effect when the landfill closed in 1983. The closure requirement in effect in 1983 was 24-inches of cover material, with the upper 6-inches suitable to sustain vegetation.

2.1.4 Remedial Action Objectives

The remedial action objectives for the waste disposal area are:

- Minimize the volume of leachate generation and possible groundwater impacts, and

- Prevent potential dermal contact with or incidental ingestion of exposed waste.

2.1.5 General Response Guidelines

The general response actions for the waste that could potentially meet the remedial action objectives are:

- Contain entire waste area by capping,

- Complete removal of the waste volume - off-site disposal, and

- Fencing waste area to prevent trespassing.

2.2 Groundwater

2.2.1 Areas of Concern

The Remedial Investigation identified only slight impacts to groundwater as a result of landfill leachate. Of the sixteen-well monitoring network, MW-4 was the only well at which groundwater standards were exceeded: chloroethane at 66 ppb and chlorobenzene at 9.6 ppb (the SCG for each compound is 5 ppb). This condition appears to be very localized, however, since there was no evidence of VOC concentrations at MW-5, located a short distance away and downgradient from the impacted well. No semi-volatile organic compounds were detected above groundwater standards. Slight impacts to groundwater from inorganic constituents were also found, however, most were detected within the range of background values demonstrated at the site. No environmental threat associated with semi-volatile organic compounds was found.

No environmental threats were identified due to groundwater contamination. As a result, the groundwater media is not considered an area of concern, and therefore, groundwater remediation will not be considered. Natural attenuation will serve as the mechanism through which the minimal impacts to groundwater will be remediated. Natural attenuation will be discussed further in Section 3.

2.2.2 Exposure Routes and Receptors

As indicated above, there are no exposure routes associated with groundwater since there are no municipal or private water supply wells that would intercept groundwater migrating away from the landfill.

2.2.3 Standards, Criteria and Guidelines for Groundwater

The following SCGs were used to develop general response actions to remedial objectives for groundwater:

- 6 NYCRR Parts 700-705 -- Water Quality Regulations for Surface Waters and Groundwaters. NYSDEC - dated September, 1991.

- Technical and Operational Guidance Series 1.1.1. "Water Quality Standards and Guidance Values". NYSDEC - dated June, 1998.

2.2.4 Remedial Action Objectives

The remedial action objectives for groundwater are:

- protect against future development within the areas of identified groundwater impacts and potential usage of groundwater as a resource, and

- attainment of SCGs.

2.2.5 General Response Actions

The general response actions for groundwater that could potentially meet the remedial action objectives are:

- reduction of leachate generation by capping and/or waste removal, and

- impose deed restrictions against the use of the site groundwater as a drinking water source.

2.3 Surface Soils

2.3.1 Areas of Concern

For surface soils, most of the parameters detected during the Remedial Investigation were reported below their associated clean-up guidance as stated in NYSDEC TAGM #4046, or within the range of background concentrations. As a result, this media did not meet initial criteria to be considered as a possible risk to human health or the environment. Additionally, the parameters detected in the surface soil samples were not found at any significant concentration in the groundwater at the site. This suggests that the surface soil constituents are bound to the soil particles, and do not migrate downward to the water table. Therefore, the surface soils at the site are not considered areas of concern with respect to future remediation.

2.3.2 Standards, Criteria and Guidelines for Surface Soils

The following SCGs were used to develop general response actions to remedial objectives for surface soils:

- Technical and Administrative Guidance Memorandum #4046 - "Determination of Soil Cleanup Objectives and Cleanup Levels". NYSDEC Division of Hazardous Waste Remediation – dated January, 1994.

- Sediment Criteria – "Technical guidance for Screening Contaminated Sediments". NYSDEC – dated November, 1993.

2.3.3 Remedial Action Objectives

The surface soils at the site are not considered areas of concern. As a result, it is not necessary to develop remedial action objectives for this media.

2.3.4 General Response Action

The surface soils at the site are not considered areas of concern. Therefore, it is not necessary to develop general response actions for this media.

3.0 PRELIMINARY TECHNOLOGY SCREENING

3.1 Introduction

In February of 1991, the U.S. Environmental Protection Agency released Directive EPA OSWER 9355.3-11, "Conducting Remedial Investigations/ Feasibility Studies for CERCLA Municipal Landfill Sites" (USEPA, 1991). This document was prepared in order to assist in the development of remedial technologies and to streamline the remedy selection process for cleanups at municipal solid waste landfills. Since that time, a growing number of sites similar to the Erwin Town Landfill (i.e., with limited extent and severity of site impacts) have fallen into a general category of remediation which includes natural attenuation as the mechanism through which mild groundwater, surface water, sediment and soil impacts are remediated. This trend prompted the development of Directive EPA OSWER 9200.4-17, "Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites" (USEPA, 1997).

The previous section indicated that the groundwater and surface soil media would not be considered as areas of concern. As a result, it will not be necessary to evaluate groundwater or surface soil remediation technologies as part of this discussion. However, capping of the landfill to meet current NYSDEC Part 360 standards for new landfills will be reviewed as a remedial technology since this alternative may offer additional benefits to the site with respect to the attainment of SCGs.

The implementation of source control measures has been demonstrated to enhance the effects of natural attenuation by limiting the amount of "new" leachate generation within the waste by redirecting surface water runoff away from the waste. However, sites exhibiting minimal impacts to groundwater and other media, obviously benefit less from this strategy. At the Erwin Town Landfill, the Fish & Wildlife Impact Analysis found no adverse effect to the productivity, biomass, diversity, or abundance of nearby fish and wildlife resources. Additionally, the study found that vegetation communities on or within the vicinity of the landfill were healthy and robust, and showed no evidence of landfill leachate impacts. These results, combined with the apparent minimal environmental impacts detected in the site media, imply that little benefit would be realized through the implementation of source control technologies. The cost-benefit analysis, presented in Section 5 of this report, discusses the advantages and disadvantages of source control implementation at the Erwin Town Landfill.

3.2 Source Control

3.2.1 Access Restrictions

3.2.1.1 Deed Restrictions

Deed restrictions are used to limit the extent of future land development and/or use of specified properties. The Erwin Town Landfill occupies a parcel also accommodating the Town of Erwin Wastewater Treatment Plant. For this property, deed restrictions would be imposed to prevent the potential future usage of the site for the development of groundwater for private or public water supplies. Applications for development of the property for other uses (e.g., recreation, staging areas for materials used by the Town Highway Department, emergency vehicles, etc.) will need to be evaluated on an individual basis.

3.2.1.2 Fencing

Fencing is often used to physically limit access to the landfill site or specific areas on site. In addition, signs may be posted at the limits of designated areas to warn potential trespassers of possible health hazards associated with these areas.

The landfill site is located within a moderately populated area, adjacent to the confluence of the Cohocton and Tioga Rivers. Currently, there is no fence that completely encloses the site to restrict access, with the exception of the gate placed across the tunnel opening beneath U.S. Route 15. However, flood levees surround the property on three sides, while U.S. Route 15 is situated along the property's northwestern boundary. Access is further restricted by the presence of the Tioga River along the southern property boundary, and by the Cohocton River to the north. With these controls already in place (restricting vehicular access to the tunnel beneath U.S. Route 15), the existing site conditions provide effective barriers to sight and sound, and help to limit access to the site. As a result, it does not appear necessary to consider additional fencing as part of source control technologies. A sign, however, posted at the site entrance indicating the presence of the Erwin Town Landfill as a closed Inactive Hazardous Waste Disposal Site, will be considered as a possible source control measure.

3.2.2 Waste Containment

A properly designed landfill cap provides satisfactory waste containment while reducing surface water (precipitation) infiltration, controls emissions of explosive gases and odors, limits the potential damage caused by vectors, and eliminates possible dermal contact and incidental ingestion of exposed waste by foraging wildlife.

During the Remedial Investigation (RI), a test pit program was completed to identify the limits of waste associated with the Erwin Town Landfill. Previous site information indicated that a soil berm had been constructed at the perimeter of the landfill area to waste disposal, with an initial layer of foundry sand placed within the disposal area to serve as the landfill base. The test pit program confirmed the presence of the berm along most of the perimeter of the landfill and the presence of this base layer of foundry sand on which the waste was placed. This program also identified that a portion of waste existed beyond the inferred position of the soil berm along the northwestern and southwestern landfill perimeters, as a likely result of waste overflow. These areas of waste appear to range in depth from 2-3 feet along the southwestern landfill perimeter to approximately 10 feet deep at the western corner, within the vicinity of MW-A3 and MW-A6.

In most situations, it is more cost-effective to consolidate waste areas that are less than 10 feet in thickness. Therefore, all of the capping scenarios discussed below will include consolidation of the overspill areas within the main waste mass, and not part of the final capping system. The types of materials present in these areas do not suggest the presence of hazardous wastes nor do they represent a concern from a public health standpoint. Waste consolidation will be discussed in greater detail later in this section.

3.2.2.1 Evaluation of Capping Technologies

Two alternative cap designs were evaluated on the basis of performance criteria (i.e., reduction of infiltration into the waste; slope stability) and cost. These included a NYSDEC 6 NYCRR Part 360 geomembrane capping system, and a Part 360 soil capping system. Two additional scenarios were evaluated, using variations of the Part 360 geomembrane and soil caps, in which a granular drainage layer or composite geonet was included above the barrier layer to relieve pore-water pressure and improve stability.

The cost evaluation of each alternative capping technology incorporates means by which to relieve the potential buildup of landfill derived gases from within the waste, as well as drainage controls to direct surface water from the cap. Landfill gases are typically managed through the installation of gas vents at a frequency of one vent per acre, in combination with a 12-inch thick granular gas-venting layer, installed between the waste and the cap barrier system. A greater frequency of four gas vents per acre is presented in the "Guidance on Landfill Closure Regulatory Relief" (NYSDEC, 1993a) as an acceptable variance from Part 360 closure regulations.

The combustible gas survey completed as part of the Remedial Investigation detected only minor concentrations (less than 1% of the lower explosive limit) around the landfill perimeter. Since the bulk of the material reportedly disposed of in the landfill is considered inert in nature (e.g., glass, ceramics, bricks, concrete, etc.), future gas generation, if any, is expected to be minimal. Therefore, all capping scenarios evaluated herein will incorporate the gas venting system as suggested by the "Guidance on Landfill Closure Regulatory Relief".

The surface water control and collection system will include sideslope diversion berms, perimeter drainage channels and corner down chutes. This system will be designed to direct runoff to the corner down chutes as quickly as possible to prevent erosion and saturation of the cap's soil layers.

The "enclosed" nature of the site (due the presence of the flood levees) will require the construction of a culvert, through one of the levees, in order to discharge surface water away from the landfill perimeter. According to the site layout, the most reasonable location for this culvert would be at the southern end of the levee which extends from the U.S. Route 15 traffic circle to the Erie-Lackawanna railroad embankment. From this point, surface water would discharge beneath the levee, and would then be conveyed to the Tioga River by way of the existing surface water runoff collection feature opposite the levee from the landfill.

Finally, annual operation and maintenance (O&M) costs of $5,000 were estimated for the various capping alternatives as part of the 30-year post-closure monitoring period. These costs will account for periodic mowing, minor erosion repair, and other miscellaneous maintenance activities. A detailed cost analysis for the various remedial alternatives is presented in Section 5.

3.2.2.1.1 NYSDEC Part 360 Geomembrane Cap

NYSDEC 6 NYCRR Part 360-2.13(r) states that a geomembrane cover system must consist of, at a minimum, the following: a geomembrane with a minimum thickness of 40 mil that is chemically and physically resistant to the materials it may come in contact with; a barrier protection layer at least 24 inches thick (with the bottom six inches "reasonably free of stones"); and a six-inch thick topsoil layer. For the purpose of performing various analyses regarding cap performance and cost estimation, double-textured linear low density polyethylene (LLDPE) was chosen as the representative geomembrane component. At the time of final design, alternative geomembranes may be considered for the geomembrane component of the capping system. In no case, however, will an alternative geomembrane with inferior performance characteristics be utilized. The evaluation of this capping alternative is discussed in the following sections.

3.2.2.1.1.1 HELP Model Evaluation

The USEPA Hydrologic Evaluation of Landfill Performance (HELP) Model Version 3.05a (Schroeder et al., 1996) was used to estimate the amount of infiltration which will enter the waste for this capping scenario. The HELP model is a quasi-two-dimensional water balance computer model that distributes incident precipitation within a user-specified cap cross-section into surface water runoff, evapotranspiration, lateral drainage, soil moisture storage, and infiltration. The model is limited to the analysis of the distribution of water within the specified cross-section and is not capable of incorporating surface runoff and lateral drainage from an upslope cross-section.

The cross-section input into the HELP model was defined according to Part 360-2.13(r). Default climatological data were selected within the HELP model for the Ithaca, New York Weather Station. The default average annual rainfall for this station is 40.16 inches per year. This climatological data is considered to closely approximate the conditions at the Erwin Town Landfill site. The average slope and slope length of the landfill cap were input as 30% and 120 feet, respectively.

The permeability of the top 30 inches of the cap (6 inches of topsoil and 24 inches of barrier protection soil) was set equal to $1x10^{-5}$ cm/sec. This value was chosen to represent a conservative effective permeability of typical cover soils after frost action and the effects of root structure have been considered.

Table 3-1, presented below, summarizes the HELP model results for this capping option. As shown, this design will reduce the amount of infiltration into the waste to approximately 0.47% of the incident precipitation, yielding a performance effectiveness of 99.53%. The entire package of HELP model output data is included as Appendix A.

3.2.2.1.1.2 Slope Stability Analysis

The stability of this capping system was analyzed, using conservative values for cohesion, adhesion and interface friction angle, to determine the long-term factor of safety against sliding. This evaluation was performed using a two-dimensional stability analysis (Giroud & Beech, 1990). The peak daily maximum head (generated using the HELP model) was input into the equations to simulate the saturated portion of the soil layer above the LLDPE geomembrane.

TABLE 3-1

SUMMARY OF HELP MODEL RESULTS – ERWIN TOWN LANDFILL FEASIBILITY STUDY

WATER BALANCE COMPONENT	PART 360 LLDPE CAP			PART 360 SOIL CAP	
	W/O Drainage	Granular Drainage	Drainage Net	W/O Drainage	Granular Drainage
Precipitation (in/acre)	40.16	40.16	40.16	40.16	40.16
(%)	100.00	100.00	100.00	100.00	100.00
Runoff (in/acre)	16.16	15.90	15.56	15.60	15.90
(%)	40.24	39.59	38.75	38.84	39.59
Evapotranspiration (in/acre)	23.18	21.88	17.94	21.93	21.83
(%)	57.72	54.48	44.67	54.61	54.36
Lateral Drainage (in/acre)	0.55	2.42	6.42	0.45	1.90
(%)	1.37	6.03	15.99	1.12	4.73
Infiltration (in/acre)	0.19	0.08	0.05	1.90	0.61
(%)	0.47	0.20	0.13	4.73	1.52
Peak Daily Head maximum (in)	29.80	7.14	0.005	30.00*	6.99

Note: *Maximum peak daily head values exceeded the thickness of the barrier protection layer above the LLDPE or soil barrier.

Table 3-2, presented below, summarizes the stability analysis results. The HELP model simulation of this cap design resulted in complete saturation of the barrier protection layer under daily maximum head conditions. The stability for this condition results in a factor of safety lower than 1.5 and, therefore, does not meet recommended stability criteria. As a result, this capping option will not be considered as a viable remediation technology at this site, and will not be evaluated for cost.

Appendix B includes the engineering calculations completed as part of the analysis of the capping system stability.

TABLE 3-2

SUMMARY OF STABILITY ANALYSIS RESULTS – ERWIN TOWN LANDFILL FEASIBILITY STUDY

STABILITY ANALYSIS COMPONENT	PART 360 LLDPE CAP			PART 360 SOIL CAP	
	W/O Drainage	Granular Drainage	Drainage Net	W/O Drainage	Granular Drainage
Peak Daily Head Maximum (in)	29.80	7.14	0.005	30.00[1]	6.99
Critical Interface Location[2] Friction Angle	LLDPE/PC 24°	LLDPE/LGD 26°	LLDPE/NET 28°	BS/PC 30°	BS/LGD 30°
Factor of Safety PDMH[3]	1.03	1.62	1.73	0.68	1.28

Notes: 1 This value represents complete saturation of the barrier protection layer; actual value in excess of 30 inches.
2 LLDPE = Linear Low Density Poly-Ethylene geomembrane (textured); PC = Protective Cover; LGD = Lateral Granular Drainage Soil; NET = Geocomposite Drainage Net (geofabric/net/geofabric); BS = Barrier Soil.
3 Factor of Safety for PDMH (Peak Daily Maximum Head).

3.2.2.1.2 NYSDEC Part 360 Geomembrane Cap With Soil Drainage Layer

The evaluation of this capping alternative included a 12-inch thick soil drainage layer above the geomembrane. This reduces the protective cover layer thickness from 30 inches to 18 inches. All other components are the same as for the above scenario.

3.2.2.1.2.1 HELP Model Evaluation

The HELP Model input data used to estimate the amount of infiltration which will enter the waste under this capping scenario was identical to that for the above scenario with the exception that the bottom 12 inches of the barrier protection layer was designated as a granular drainage layer with a permeability of $1x10^{-3}$ cm/sec. This layer was incorporated into the cap design to relieve the buildup of water above the LLDPE and to prevent slope stability problems associated with the saturation of these soils.

Table 3-1 (presented above) indicates that this design will reduce the amount of infiltration into the waste to approximately 0.20% of the incident precipitation, yielding a performance effectiveness of 99.80%.

3.2.2.1.2.2 Slope Stability Analysis

The stability of this capping system was analyzed in the same manner as above. This analysis indicates that the peak daily maximum head condition will yield a factor of safety in excess of 1.5. Therefore, this capping option will be retained for further evaluation in this study. Appendix B includes the engineering calculations completed as part of the analysis of the capping system stability.

3.2.2.1.3 NYSDEC Part 360 Geomembrane Cap With Drainage Net

The evaluation of this capping alternative included a 0.6-inch thick drainage net layer directly above the geomembrane. The protective cover layer thickness remains at 30 inches, as per the original components for the initial geomembrane scenario.

3.2.2.1.3.1 HELP Model Evaluation

The HELP Model input data used to estimate the amount of infiltration which will enter the waste under this capping scenario was identical to that for the above scenario with the exception that the drainage net was added between the 30-inch barrier protection layer and the LLDPE barrier. The drainage net was designated a permeability of 3.3×10^{-1} cm/sec. This layer was incorporated into the cap design to relieve the buildup of water above the LLDPE and to prevent slope stability problems associated with the saturation of these soils.

Table 3-1 (presented above) indicates that this design will reduce the amount of infiltration into the waste to approximately 0.13% of the incident precipitation, yielding a performance effectiveness of 99.87%.

3.2.2.1.3.2 Slope Stability Analysis

The stability of this capping system was analyzed in the same manner as previously described. This analysis indicates that the peak daily maximum head condition will yield a factor of safety in excess of 1.5. Therefore, this capping option will be retained for further evaluation in this study. Appendix B includes the engineering calculations completed as part of the analysis of the capping system stability.

3.2.2.1.4 NYSDEC Part 360 Soil Cap

NYSDEC Part 360-2.13(q) states that low permeability barrier soil covers must consist of, at a minimum, the following: 18 inches of soil having a maximum remolded permeability of $1x10^{-7}$ cm/sec, a 24-inch thick barrier protection layer, and a 6-inch topsoil layer. The evaluation of this capping alternative is discussed below.

3.2.2.1.4.1 HELP Model Evaluation

The cap cross-section defined by Part 360-2.13(q) was used as input for the HELP Model, with specified properties for each of the soil units included. The remaining HELP model input data were identical to those used to evaluate the previous capping alternatives.

The permeability of the top 30 inches of soil (6 inches of topsoil and 24 inches of barrier protection soil) was similarly set equal to $1x10^{-5}$ cm/sec to properly represent the expected in-field conditions of this material. The permeability of the 18 inches of barrier soil was modeled at $1x10^{-7}$ cm/sec as defined by Part 360-2.13(q)(1).

The results of this model (Table 3-1) indicate that a Part 360 soil cap will reduce the amount of infiltration into the waste to approximately 4.73% of the incident precipitation, yielding a performance effectiveness of 95.27%. This analysis, therefore, indicates that the soil cap will not be as effective as the geomembrane cap at reducing the amount of infiltration into the waste.

3.2.2.1.4.2 Slope Stability Analysis

The stability of this capping system was analyzed in the same manner as previously described. Table 3-2 presents the summary of the stability analysis results. The HELP model indicated that the peak daily maximum head results in completed saturation of the barrier protection layer. This condition results in a slope stability factor of safety of less than 1.5. This cap design, therefore, does not satisfy the recommended stability criteria, and as a result will not be considered to be viable capping option. Appendix B includes the engineering calculations completed as part of the analysis of the capping system stability.

3.2.2.1.5 NYSDEC Part 360 Soil Cap With Drainage Layer

The evaluation of this capping alternative included a 12-inch thick drainage layer above the barrier soil.

3.2.2.1.5.1 HELP Model Evaluation

The HELP Model input data used to estimate the amount of infiltration entering the waste under this capping scenario was identical to that for the above scenario with the exception that the bottom 12 inches of the barrier protection layer was designated as a granular drainage layer with a permeability of 1×10^{-3} cm/sec. This layer was incorporated in the design to prevent slope stability problems caused by the saturation of soil above the barrier soil.

Table 3-1 indicates that this design will reduce the amount of infiltration into the waste to approximately 1.52% of the incident precipitation, yielding a performance effectiveness of 98.48%. Subsequently, the analysis shows that incorporation of the drainage layer results in a more effective capping system than the cap alternative above, which does not include a drainage layer.

3.2.2.1.5.2 Slope Stability Analysis

The stability of this capping system was analyzed in the same manner as previously described. Table 3-2 presents the summary of the stability analysis results. The

HELP model indicated that the peak daily maximum head results in completed saturation of the barrier protection layer. This condition results in a slope stability factor of safety of less than 1.5. This cap design, therefore, does not satisfy the recommended stability criteria, and as a result will not be considered to be viable capping option. Appendix B includes the engineering calculations completed as part of the analysis of the capping system stability.

3.2.2.2 Capping Cost Analysis and Cap Design Selection

Appendix C includes the cost estimates prepared for the two capping options determined to exhibit recommended stability criteria and reasonable performance at limiting infiltration. Table 3-3, presented below, summarizes these costs.

TABLE 3-3

SUMMARY OF CAP ALTERNATIVES AND CONSTRUCTION COSTS
ERWIN TOWN LANDFILL FEASIBILITY STUDY

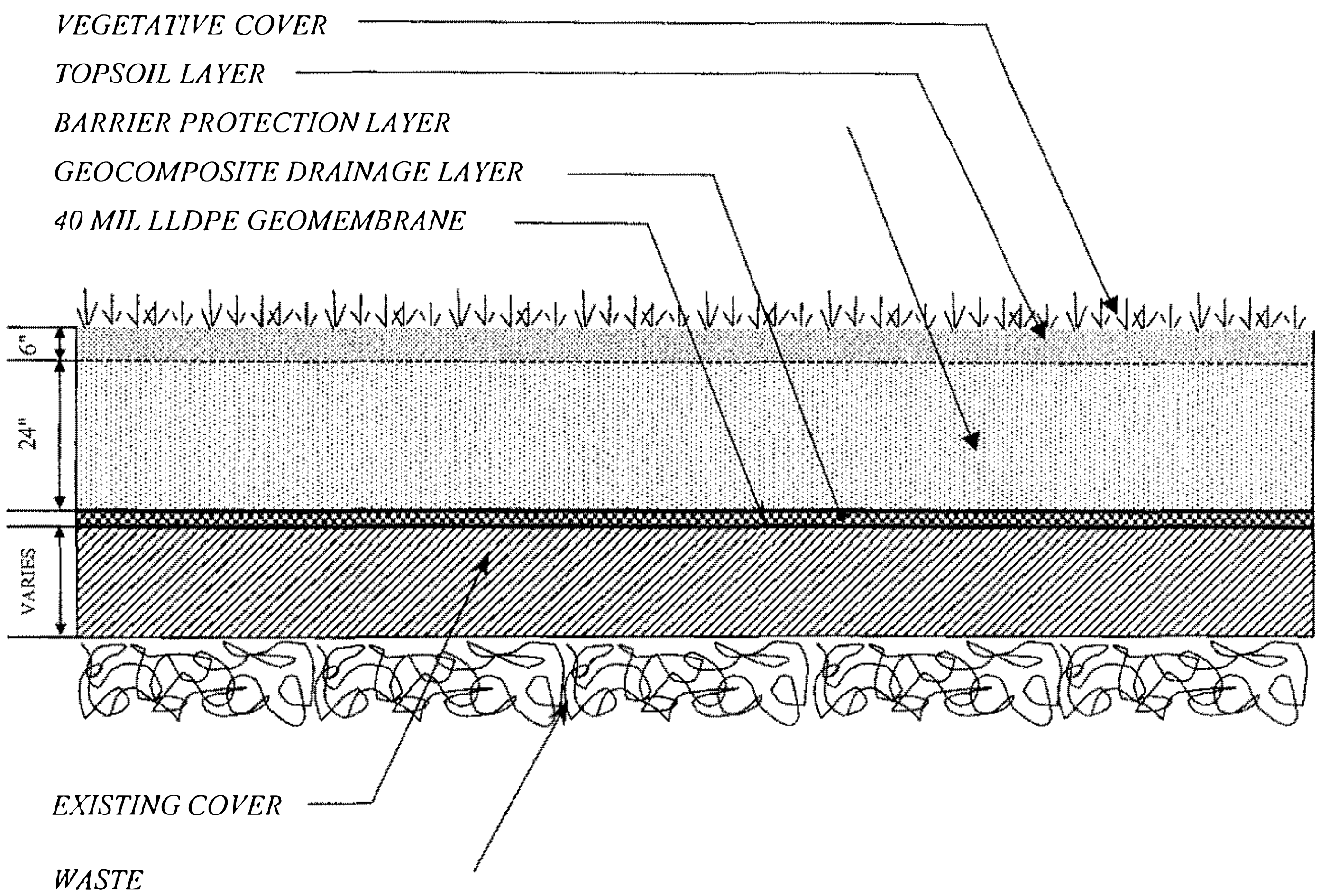
CAP ALTERNATIVE	INFILTRATION REDUCTION	ESTIMATED CONSTRUCTION COSTS*
Part 360 LLDPE Cap w/Granular Drainage Soil	99.80 %	$ 1,781,000
Part 360 LLDPE Cap w/Composite Drainage Net	99.87 %	$ 1,725,000

Note: *Construction costs are for capping only and include 15% for Engineering, Legal & Miscellaneous costs, and 15% for contingency.

Table 3-3 shows that both caps demonstrate similar levels of performance regarding the reduction of infiltration into the waste. However, since the LLDPE cap with the composite drainage net is slightly more effective at reducing infiltration, and at a lower overall cost, this appears to be the most appropriate of the capping options for the Erwin Town Landfill. This cap will be included as a standard element of each remedial alternative developed in the next section. Figure 3-1 presents a schematic drawing of the Part 360 LLDPE cap with a geocomposite drainage layer.

3.2.2.3 Estimated Reduction in Landfill Leachate Generation

Experience has shown that the installation of an impermeable cap to cover landfilled waste, virtually eliminates future incident precipitation from entering the waste and creating "new" leachate. This is obviously a direct result of the cap's effectiveness at redirecting most of the previous rainwater and snowmelt infiltration into surface water runoff, as demonstrated in Table 3-1. For landfills having a leachate collection system, an appropriate cap results in a measurable difference in the volume of new leachate generated. This difference is typically observed within the first five years following installation of the final cover system, as annual leachate volumes diminish. For landfills in operation prior to regulatory requirements for having a leachate collection system, improvements in water quality often indicate the effectiveness of the capping system at reducing infiltration into the waste. Additionally, observed decreases in the "mounding" effect of the leachate/water table within the waste mass following the implementation of an appropriate capping system can indicate the reduction in new leachate generation as the existing volume of leachate within the waste dissipates in the absence of a continual source.



NOTE: This cap to be installed over the limits of the Erwin Town Landfill.

Barton & Loguidice, P.C.
Consulting Engineers

Erwin Town Landfill
Feasibility Study

NYSDEC Part 360 LLDPE CAP
with Geocomposite Drainage Layer

Steuben County New York

Figure 3-1

Project No. 268.012

Table 3-1 previously indicated that the Part 360 LLDPE capping system using a geocomposite drainage layer above the geomembrane, reduces the volume of infiltrated water to approximately 0.13% of the incident precipitation. The effectiveness of this cover system will obviously be translated into a direct reduction in new leachate generated as less water is allowed to infiltrate into the waste.

At many landfill sites, this reduction can benefit the operation from both a cost standpoint and as an environmental improvement. A reduction in the leachate generation can result in lower costs associated with off-site disposal or on-site treatment of collected leachate. At the Erwin Town Landfill, however, there is no leachate collection. Therefore, no savings would be realized with respect to a reduction in the volume of leachate generated at the site. In addition, most of the site groundwater already exhibits background water quality conditions, and there were no chronic leachate outbreaks observed at the landfill. Therefore, a reduction in new leachate generated within the landfill would not result in a significant improvement in environmental conditions associated with the landfill. Further discussions regarding the cost-benefit relationship of the implementation of the preferred capping technology will be presented later in Section 5.

3.2.3 Waste Removal

Waste removal, as a means of hazardous waste remediation, typically involves knowledge of specific buried waste locations (drums, hazardous waste cells, etc.). The excavation of these identified wastes serves as a direct source control. Subsequent management of the excavated waste materials is normally accomplished either through on-site treatment and disposal, or transportation to and disposal at a permitted off-site facility.

For facilities where the location of hazardous waste components is unknown, the removal of hazardous wastes will necessarily involve the excavation of the entire waste mass. This is typically not performed at landfill sites having a waste volume in excess of 100,000 cubic yard (USEPA, 1991). A rough estimate of the waste volume in the Erwin Town Landfill suggests a volume in the order of 500,000 cubic yards. As a result, waste removal technologies will not be considered as a viable remedial alternative for the Erwin Town Landfill.

3.2.4 Removal of Sediments/Surface Soils

The removal of sediments and/or surface soils at municipal landfill sites is typically implemented when risk evaluations conclusively show that there are associated threats to human health, wildlife or the environment if left unremediated. At the Erwin Town Landfill, it has been determined that the surface soils are not associated with risks for any possible exposure scenario to human health, wildlife or the environment. Therefore, the removal of sediments or surface soils will not be considered further in this study.

3.2.5 Surface Water/Sediment Isolation

Physical isolation of surface waters and sediments is often associated with a need to ensure the elimination of all current and future contact with contaminated media from humans and wildlife. The results of the Remedial Investigation did not indicate that the site surface water or sediments reflected a significant threat to human health or wildlife. Therefore, surface water/ sediment isolation will not be considered further in this study.

3.2.6 Surface Water Containment

Containment of surface water is often utilized to eliminate the transport of contaminants to downstream locations where documented risks exceed acceptable hazard indices. The results of the Remedial Investigation did not indicate that the site surface water reflected a significant threat to human health or wildlife. Therefore, surface water containment will not be considered further in this study.

3.3 Groundwater Remediation

3.3.1 Groundwater Collection/Aquifer Restoration

Groundwater remediation and related treatment technologies are considered at sites documenting unacceptable risks to human health, wildlife or the environment. As previously stated, most of the site water quality is representative of background conditions. Additionally, there were no exposure pathways deemed to be complete due to the presence of municipal water supply systems within the surrounding areas of the landfill, and the lack of private or municipal well systems within areas where a direct contaminant migration pathway from the landfill could be realized. As a result, groundwater remediation and related collection and treatment technologies associated with the closure of the Erwin Town Landfill will not be considered as part of this study.

3.3.2 Treatment Technologies

As stated above, groundwater remediation through active collection and aquifer restoration activities is not necessary at this site. It is important to note that mechanisms exist naturally in the groundwater, surface water and sediment, which continue to "treat" impacted media even in the absence of active remediation. These processes are most commonly termed as mechanisms of natural attenuation.

3.3.2.1 Natural Attenuation

The technology behind this option requires little more than allowing constituent concentrations to decrease through natural means such as biodegradation, cation exchange, chemical precipitation, adsorption, volatilization and/or transformation. The results of the Remedial Investigation suggest that natural attenuation is occurring within the surface water and groundwater, limiting migration to relatively short distances away from the landfill. In the absence of required active groundwater or surface water remediation, natural attenuation will serve as the mechanism through which landfill related risks are controlled.

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

Remedial alternatives were developed on the basis of the preliminary evaluations for various remedial technologies presented in Section 3. Each alternative includes a combination of appropriate technologies designed to meet each aforementioned remedial objective. This section concludes with an introduction to the site-specific SCGs to be used during the detailed analysis of alternatives in Section 5. Table 4-1 presents a summary of those remedial alternatives and their associated costs to be carried through for a detailed suitability analysis with respect to the goals of the remediation program.

4.1 Presentation of Alternatives

4.1.1 ALTERNATIVE I – No Action, Delist Site

This alternative assumes that no remedial action would take place at the landfill site. The existing landfill cover is in compliance with NYSDEC 6 NYCRR Part 360 Closure regulations in effect at the time that the facility ceased to accept wastes for disposal, and in accordance with Erwin Town Landfill operating permit. The existing cap serves to cover all wastes so that there are no exposures to wildlife or the public. Additionally, the nature of the wastes present in the landfill is dominated by inert materials (e.g., glass, ceramics) typically not associated with hazardous wastes or the potential to generate high-strength leachate. This is evidenced by the existing water quality at the site, which shows only minor impacts despite the absence of a landfill liner or leachate collection system. Therefore, in order to develop a baseline cost from which other remedial alternatives can be compared, the "No Action" alternative will be retained throughout the remainder of this study.

TABLE 4-1
Summary of Remedial Alternatives and Order-of-Magnitude Costs
Feasibility Study
Erwin Town Landfill, Steuben County, NY

REMEDIAL ALTERNATIVES	DESCRIPTION OF ASSOCIATED ACTIVITIES	CAPITAL COSTS*	ANNUAL O&M COSTS	NET PRESENT VALUE**
ALTERNATIVE I - No Action, Delist Site				
	TOTALS	$0	$0	$0
ALTERNATIVE II - Waste Containment Including Capping with Part 360 Geomembrane Cap, Waste Consolidation and Long-Term Monitoring	a - Capping of Erwin Town Landfill	$1,725,000	$5,000	
	b - Surface Water Management	$152,000	NA	
	c - Monitoring Well Replacement/Gas Monitoring Wells	$5,000	NA	
	d - Institutional Controls	$1,000	NA	
	e - Long-Term Monitoring	$1,000	$7,400	
	TOTALS	$1,884,000	$12,400	$2,160,000

Notes: * Capital costs reflect 2002 dollars and have been adjusted using a 15% factor for both engineering and contingency.
** Net Present Value based on a 5.0% interest rate for the initial investment amount, and a 3% annual inflation rate for O&M costs over a 30-year period for groundwater monitoring and site maintenance.
Capital and Net Present Worth Costs have been rounded to the nearest thousand dollars.

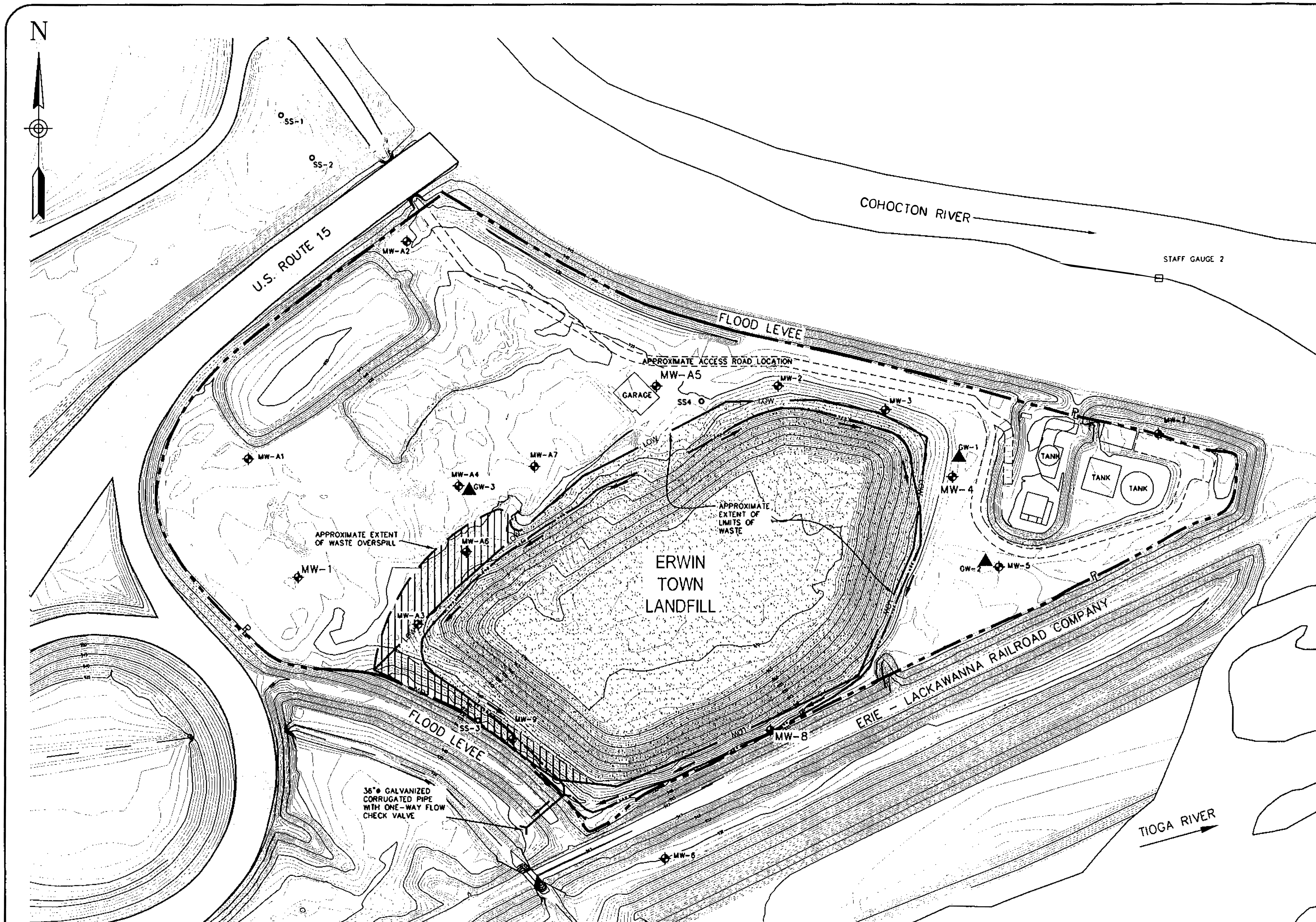
It is proposed that, under this alternative, the site would enter into the "delisting" process. Since the results of the Remedial Investigation/Feasibility Study demonstrated that there are no significant risks to human health or the environment, and that further site remediation would result in minimal benefits to the existing site conditions, the site no longer meets the criteria for placement on the Registry of Inactive Hazardous Waste Disposal Sites.

4.1.2 ALTERNATIVE II – Waste Containment Including Capping with Part 360 Geomembrane Cap, Waste Consolidation and Long-Term Monitoring

This alternative has been developed from a combination of the following components:

- Waste Consolidation – As part of this alternative, wastes within the "overspill" areas along the northwestern and southwestern waste boundaries would be excavated and consolidated with the main waste mound as shown of Figure 4-1. Consolidation of these waste areas would improve the irregular boundary along the northwestern perimeter and create space along the southwestern perimeter for construction vehicle traffic as well as future surface water control structures. Since the wastes in these areas are less than 10 feet thick, consolidation is favored over capping due to cost savings.

- Containment – A Part 360 LLDPE cap (as described previously) including a passive gas venting system (four gas vents per acre) would be installed around the newly consolidated waste boundaries. Since capping may increase the potential for gases



LEGEND

MW-5	=	MONITORING WELL
SS4	=	SURFACE SOIL SAMPLE LOCATION
	=	ACCESS ROAD LOCATION
	=	STORAGE TANK AND BUILDING BORDERS
	=	SURFACE CONTOUR LINES
	=	INTERMITTENT STREAM
PL	=	APPROXIMATE TOWN OF ERWIN PROPERTY BOUNDARY
LOW	=	LIMITS OF WASTE
	=	APPROXIMATE EXTENT OF PART 360 CAP
	=	PROPOSED DRAINAGE SWALE (ARROWS INDICATE FLOW DIRECTION)
	=	PROPOSED WASTE CONSOLIDATION AREAS
GW-1	=	PROPOSED GAS MONITORING WELL

NOTE:
MW-1, MW-4, MW-8 AND MW-A5 TO BE USED AS LONG-TERM MONITORING LOCATION.

MAPPING SOURCE:
COORDINATES AND ELEVATIONS BASED ON STATION H-26 #8026 FROM NEW YORK STATE D.O.T. CONTROL IN CONNECTION WITH HAMILTON ST. INTERCHANGE ROUTE 17 & RTE 15 PAINTED POST-WEST CITY LN. CORNING PT. 1 NAD 83 HORIZONTAL, NGVD 88 VERTICAL.

200' 100' 0 200' 400'

SCALE: 1" = 200'

FEBRUARY, 2002

Barton & Loguidice, P.C.
Consulting Engineers
290 Elwood Davis Road / Box 3107, Syracuse, New York 13220

STEUBEN COUNTY DEPARTMENT OF PUBLIC WORKS
ERWIN TOWN LANDFILL
FEASIBILITY STUDY

ALTERNATIVE II - LAYOUT OF REMEDIAL ACTIVITIES

TOWN OF ERWIN STEUBEN COUNTY, NEW YORK

Figure 4-1

Project No. 268.012

I:\Shared\200\268012\268012.dwg 05/22/2002 03:55:46 PM mk generated within the waste mass to migrate horizontally within the subsurface (despite the relief of this build-up through the gas venting system), it will be necessary to install an appropriate number of perimeter gas monitoring wells to detect this condition. Two gas monitoring well will be positioned to detect gas migration toward the wastewater treatment facility, and another will be located between the landfill U.S. Route 15. A variance from NYSDEC 6 NYCRR Part 360 requirements will be submitted for Department approval prior to the completion of the Remedial Design. If odors or gas migration becomes a problem following capping, the proposed passive gas venting system could be easily retrofitted to an active system. Active gas management using gas flaring or conversion-to-energy techniques are proven solutions to odor problems or subsurface gas migration.

- Storm Water Management – The landfill capping system, described above, includes mid-slope diversion berms, down chutes and perimeter swales to control the discharge of surface water from the site. As runoff collects within the perimeter drainage swales it will be diverted via gravity drainage toward the southwestern corner of the site. At this point, gravity drainage will carry the surface water through a 36-inch corrugated galvanized culvert beneath the flood levee bordering the southwestern landfill perimeter. A one-way flow control gate will be fitted to the downstream end of the culvert to prevent the backflow of water toward the landfill side of the culvert. Water will discharge from the culvert into the drainage swale on the other side of the levee. This drainage swale diverts surface water to the Tioga River.

The details of the Storm Water Management System, including calculations for sizing of the down chutes, perimeter swales and culverts, will be presented as part of the Final Remedial Design. Preliminary costs for storm water management are presented as part of the capping cost estimate.

- Long-Term Monitoring – The present array of monitoring wells situated around the perimeter and in upgradient/background areas of the site appears to be adequate for long-term monitoring purposes. From this array, and given the generally benign nature of the site water quality, it appears appropriate to select a subset from this array to represent locations to be monitored during the post-closure period. MW-4 and MW-8 will be retained as downgradient monitoring locations, while MW-A1 and MW-A5 will serve as upgradient locations.

- Institutional Controls – A deed restriction will be filed as an institutional control to implicitly prohibit the development of a drinking water source within the property limits within areas directly downgradient from the landfill.

5.0 DETAILED ANALYSIS OF ALTERNATIVES

The purpose of this section is to evaluate the two possible remedial alternatives using the criteria presented within NYSDEC's 1990 revised TAGM – Selection of Remedial Actions at Inactive Hazardous Waste Sites. For each alternative, the following criteria were addressed:

- overall protection of human health and the environment,
- overall compliance with chemical-specific, action-specific and location-specific SCGs,
- long-term effectiveness and permanence,
- reduction of toxicity, mobility or volume,
- short-term effectiveness,
- implementability, and
- cost (including analysis of benefit to the environment and the community).

Total estimated costs representing the major work items included within individual alternatives have been presented on Table 4-1 in the preceding section. Derivation of these costs is presented individually in Appendix C, where applicable.

5.1 ALTERNATIVE I – No Action, Delist Site

The existing soil cover meets current NYSDEC Part 360 landfill closure regulations since the existing capping system is in compliance with the regulations in effect at the time that wastes were no longer accepted at the landfill.

5.1.1 Overall Protection of Human Health and the Environment

The qualitative human health risk evaluation concluded that there are no apparent significant threats that the landfill poses in its existing condition. Therefore, the present state of the landfill adequately provides for the overall protection of human health and the environment.

5.1.2 Overall Compliance with Chemical-Specific, Action-Specific and Location-Specific SCGs

The existing landfill cover is in compliance with NYSDEC 6 NYCRR Part 360 for municipal solid waste landfills. The applicable clause of the current Part 360 specific to the Erwin Town Landfill requires that the landfill meet closure regulations which were in effect when the landfill closed in 1983. The closure requirement in effect when the landfill closed in 1983 was 24-inches of cover material, with the upper 6-inches suitable to sustain vegetation. Hence, the "No Action" alternative satisfies action-specific SCGs.

Although chemical-specific SCGs are exceeded within limited areas of the site with respect to groundwater, there appears to be a natural tendency for the majority of these constituents to be attenuated within a relatively short distance from the source of generation. This appears to be a function of the available natural attenuation processes occurring within the subsurface resulting in a rapid decrease in concentration away the waste area. These include adsorption, hydrodynamic dispersion, dilution, oxidation, volatilization and bioremediation. As a result, any improvements, realized through the implementation of upgraded capping system, would be minimal. The "No Action" alternative, while in compliance with action-specific SCGs, allows for the continued generation of "new" leachate resulting from uncontrolled infiltration into the waste. However, as a result of the discussion above, this condition would not suggest an increase in risk to human health, wildlife or the environment.

There are no location-specific SCGs assigned to this alternative.

5.1.3 Long-Term Effectiveness and Permanence

The site already demonstrates acceptable water quality conditions, and therefore, the requirement that the remedial alternative meet this criterion is not applicable. Natural attenuation mechanisms will continue to maintain these conditions.

5.1.4 Reduction of Toxicity, Mobility or Volume

The existing site conditions imply that there is little to be gained by introducing technology options to meet this criterion. In addition, since there is no option to limit, reduce or eliminate the generation of "new" leachate, natural attenuation will serve as the mechanism through which environmental impacts remain minimal.

5.1.5 Short-Term Effectiveness

In addition to evaluating the short-term effects to human health and the environment, this criterion is used to evaluate the short-term protection of the community and workers during implementation of the closure program. Since there is no action under this alternative, this criterion does not apply.

5.1.6 Implementability

Since there is no action proposed under this alternative, this criterion does not apply.

5.1.7 Cost-Benefit Analysis

The cost versus benefit analysis supports the "No Action" alternative for the following reasons:

- The site does not represent a significant threat to human health or the environment, and;
- Any benefits gained through the implementation of a higher remedial alternative such as a capping system is minimal.

5.2 ALTERNATIVE II – Waste Containment Including Capping with Part 360 Geomembrane Cap, Waste Consolidation and Long-Term Monitoring

This alternative incorporates the construction of a Part 360 LLDPE Cap over the Erwin Town Landfill waste limits, excavation and consolidation of thin waste areas contiguous to the main waste area, long-term monitoring and institutional controls.

Construction of the standard Part 360 LLDPE Cap will be performed in the following manner:

- The existing vegetation and topsoil will be stripped from all areas to be capped. Topsoil will be separated and stockpiled for later replacement as part of the new topsoil layer. During this activity. Rocks and debris will be removed from the surface of the remaining soil cover prior to placement of the LLDPE geomembrane.

- All wastes from within the “overspill” areas will be excavated and consolidated with the main waste area.

- Clean fill will be backfilled into the deeper of the two overspill areas; new topsoil will be placed at the surface of both consolidation areas.

- Four shallow gas vents per acre will be installed into the waste following the removal of the topsoil layer. The installation of a greater number of gas vents will account for the omission of the gas venting layer. This omission will be addressed as a variance to Part 360 during the Remedial Design. Three perimeter gas monitoring wells will be installed to detect gases within the subsurface in the event migration occurs away from the landfill following capping.

- A 40-mil thick LLDPE geomembrane will be installed directly over the prepared intermediate cover layer.

- A geocomposite drainage layer will be placed over the LLDPE cap to allow for the release of potential pore-water pressure buildup within the overlying barrier protection layer. A buildup of pore-water pressure could potentially result in slope instability. Discharge from this system will be tied into surface water controls at the landfill perimeter.

- A 24-inch barrier protection layer will be installed over the geocomposite drainage layer. A series of sideslope diversion berms will be constructed during the placement of this layer in order to facilitate surface water runoff toward the down chutes located at each of the four major corners of the landfill. A 6-inch topsoil layer (placed as a combination of new and the existing topsoil layer) will be placed above the barrier protection layer. The topsoil layer will be seeded, mulched and fertilized to promote the growth of a hearty vegetation layer.

- Following the placement of the topsoil layer, the final extensions of the gas vents ("goosenecks") will be fitted to complete the cap system.

- Several of the site monitoring wells are located very close to the limits of waste and would likely require abandonment prior to capping to make room for construction equipment traffic. For the purposes of developing appropriate costs, it is assumed that two of the monitoring wells would need to be replaced as part of this alternative.

Site monitoring will continue for a 30-year period using four of the existing site groundwater monitoring locations previously mentioned for this alternative. Each of the four wells will be sampled on a semi-annual basis and analyzed alternately for NYSDEC Part 360 1988 Baseline and Routine water quality parameters. Appendix C presents the estimated annual costs associated with sampling and testing for each location.

5.2.1 Overall Protection of Human Health and the Environment

As previously discussed, the existing site conditions do not represent associated risks to human health, wildlife or the environment. The placement of deed restrictions and the posting of signs indicating the presence of the landfill will prevent the future development of these properties and the associated use of groundwater for public or private water supplies.

Construction of the landfill cap system and the consolidation of thin waste areas will serve to reduce the volume of leachate generated within the waste mass. Typically, this allows for site contaminants within the groundwater to naturally degrade at a faster rate as opposed to a situation where leachate generation is left uncontrolled. At the Erwin Town Landfill, however, it has been demonstrated that since the site groundwater is near background conditions at most locations, the addition of an improved capping system would have little benefit from a water quality standpoint.

5.2.2 Overall Compliance with Chemical-Specific, Action-Specific and Location-Specific SCGs

This alternative will satisfy the closure requirements specified in NYSDEC 6 NYCRR Part 360 for municipal solid waste landfills.

Although it is assumed that chemical-specific SCGs would be attained after closure, it cannot be determined with any accuracy, how long this will take. Since exceedances of groundwater standards are limited both in area and contaminant concentrations, the attainment of SCGs with respect to groundwater may not be realized within a significantly shorter timeframe than if the "No Action" alternative is chosen for this site closure.

The construction of the flood levees which surround the landfill site by the U.S. Army Corps of Engineers in 1938, was intended to prevent future flooding. Despite periodic breaches of these levees historically, the landfill area has not taken on the typical qualities of a wetland, floodplain or a coastal area. Additionally, there are no right-of-ways or easements within the immediate vicinity of the landfill which would impede construction. Therefore, there does not appear to be any location-specific SCGs associated with any remedial activities undertaken with respect to the closure of the landfill.

5.2.3 Long-Term Effectiveness and Permanence

This alternative would provide the means to limit, reduce or eliminate the generation of "new" leachate, and it's discharge to the groundwater. However, given the relatively benign nature and extent of the observed groundwater conditions, limiting, reducing or eliminating the generation of "new" leachate is not expected to materially contribute to a more rapid attainment of chemical-specific SCGs.

5.2.4 Reduction of Toxicity, Mobility or Volume

The construction of the landfill cap will serve to greatly reduce the volume of leachate generated by limiting the infiltration of incident precipitation into the waste. In general, the toxicity of the leachate discharging from the landfill would be significantly reduced as fresh groundwater from upgradient locations is allowed to dilute groundwater concentrations. Also, implementation of an impermeable capping system will often result in a lowering of the groundwater mound beneath the landfill as recharge is limited, creating a shallower horizontal hydraulic gradient, and as a result, slower groundwater velocities. Slower groundwater velocities will often enhance the residence time and the subsequent attenuation effects (e.g., dilution, dispersion, adsorption, biodegradation, transformation, and chemical precipitation) on certain organic and inorganic constituents. However, at this site, it does not appear that the uncontrolled discharge of leachate to the groundwater, or the presence of slightly mounded groundwater table beneath the waste, has had a significant impact to the environment with respect to concentrations. Therefore, the installation of a Part 360 cap system at this site is likely to offer only minimal benefit to the existing site conditions.

5.2.5 Short-Term Effectiveness

At the Erwin Town Landfill, there is no immediate need for remediation of exposed wastes. Additionally, it is unlikely that short-term attainment of SCGs would be realized through the construction of a Part 360 capping system. As a result, it is not expected that this alternative will be associated with any short-term effectiveness.

5.2.6 Implementability

Landfill closures have been performed under similar site conditions by a variety of contractors. There appears to be adequate space at the top of the landfill to accommodate placement of the wastes from the proposed consolidation areas, without compromising the integrity or stability of the final cap system. Manufactured materials such as the LLDPE geomembrane, the geocomposite drainage layer and the gas vents are readily available, and will be supplied by the construction contractor. Long-term water quality monitoring and institutional controls do not impose implementability constraints.

5.2.7 Cost-Benefit Analysis

The technologies presented in this alternative represent the baseline requirements to meet current NYSDEC Part 360 regulations for municipal landfill closures. Capping of the landfill will also promote a reduction in the volume of "new" leachate generated within the waste, and as a result, the continual discharge of leachate to the groundwater. However, the existing minimal impacts to the environment does not justify the costs associated with capping the landfill.

5.3 Summary of Cost-Benefit Analyses for Possible Remedial Alternatives

The previous discussions identified the probable benefits to the environment and the wildlife communities with respect to the implementation of either the "No Action" or the "Capping" alternative. The relationship between the apparent benefit and the estimated capital and O&M costs associated with each alternative provides the basis on which the more appropriate remedy should be selected. The analysis of this relationship leads to the following conclusions:

- Institutional controls and deed restrictions will provide the best option to eliminate the possibility of contaminated groundwater being utilized for public or private water supply sources, and

- Both alternatives exhibit acceptable benefits to the environment, since the existing site conditions do not represent a significant environmental impact or a risk to human health or wildlife. However, the costs associated with capping the site are obviously significantly greater than the "No Action" alternative. Since capping the site will not offer an associated greater environmental benefit, the "No Action" alternative provides the best cost-benefit relationship.

5.4 Recommended Remedial Alternative

Based on the detailed analyses of technical feasibility, implementability, environmental effectiveness and cost presented in sections 3, 4 and 5 of this report, Alternative I – "No Action, Delist Site" is the recommended remedial alternative. This alternative will meet all of the remedial objectives set forth for this project by implementing specific institutional controls, and establishing a long-term monitoring program to track site conditions during the post-closure period.

It is recommended as part of this alternative that the landfill site be delisted from the New York State Registry of Inactive Hazardous Waste Disposal Sites due to the lack of a significant environmental impact and the absence of any apparent risk to human health, wildlife or the environment.

6.0 REFERENCES

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APPENDIX A

HELP MODEL OUTPUT DATA FOR POTENTIAL CAPPING OPTIONS

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                  HELP MODEL VERSION 3.05a  (5 JUNE 1996)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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******************************************************************************


PRECIPITATION DATA FILE:     c:\help305\DATA4.D4
TEMPERATURE DATA FILE:       c:\help305\DATA7.D7
SOLAR RADIATION DATA FILE:   c:\help305\DATA13.D13
EVAPOTRANSPIRATION DATA:     c:\help305\DATA11.D11
SOIL AND DESIGN DATA FILE:   c:\help305\geomemd.D10
OUTPUT DATA FILE:            C:\HELP305\geomemd.OUT


TIME:  15:14      DATE:   8/16/2001


******************************************************************************

     TITLE:  268.012 ERWIN LF FS: Part 360 Geomembrane w Drainage

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                  =      6.00   INCHES
           POROSITY                   =      0.4530 VOL/VOL
           FIELD CAPACITY             =      0.1900 VOL/VOL
           WILTING POINT              =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.4306 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.999999975000E-05 CM/SEC
```

```
                       LAYER  2
                       --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =      12.00    INCHES
POROSITY                     =       0.4530 VOL/VOL
FIELD CAPACITY               =       0.1900 VOL/VOL
WILTING POINT                =       0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.2661 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                       LAYER  3
                       --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =      12.00    INCHES
POROSITY                     =       0.4170 VOL/VOL
FIELD CAPACITY               =       0.0450 VOL/VOL
WILTING POINT                =       0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0552 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
SLOPE                        =      30.00    PERCENT
DRAINAGE LENGTH              =     120.0     FEET


                       LAYER  4
                       --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  36
THICKNESS                    =       0.04    INCHES
POROSITY                     =       0.0000 VOL/VOL
FIELD CAPACITY               =       0.0000 VOL/VOL
WILTING POINT                =       0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY          =       1.00    HOLES/ACRE
FML INSTALLATION DEFECTS     =       1.00    HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 30.% AND A SLOPE LENGTH OF 120. FEET.

SCS RUNOFF CURVE NUMBER	=	73.10	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	6.408	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	8.988	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.566	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	6.440	INCHES
TOTAL INITIAL WATER	=	6.440	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM ITHACA NEW YORK

STATION LATITUDE	=	42.40	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	130	
END OF GROWING SEASON (JULIAN DATE)	=	279	
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.30	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	74.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00	%

NOTE: PRECIPITATION DATA FOR ITHACA NEW YORK WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ITHACA NEW YORK

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
22.20	22.70	32.20	44.50	54.80	64.30
68.80	67.10	60.20	49.60	39.30	27.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ITHACA NEW YORK AND STATION LATITUDE = 42.40 DEGREES

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ANNUAL TOTALS FOR YEAR 1974

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37N02	134382N578	100N00
RUNOFF	13.337	48411.N53	36.03
EVAPOTRANSPIRATION	21.080	76520N062	56N94
DRAINAGE COLLECTED FROM LAYER 3	2.3457	8515N009	6.34
PERCN/LEAKAGE THROUGH LAYER 4	0.N84467	306.N15	0.23
AVGN HEAD ON TOP OF LAYER 4	0.4928		
CHANGE IN WATER STORAGE	0.N73	628.940	0.47
SOIL WATER AT START OF YEAR	7.520	27299.189	
SOIL WATER AT END OF YEAR	7.694	27928.129	
SNOW WATER AT START OF YEAR	0.000	0.N00	0.00
SNOW WATER AT END OF YEAR	0.N00	0.N00	0.00
ANNUAL WATER BUDGET BALANCE	0.N000	-0.N02	0.00

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ANNUAL TOTALS FOR YEAR 1975

	INCHES	CU. FEET	PERCENT
PRECIPITATION	40.98	148757N406	100N00
RUNOFF	14N313	51956N266	34N93
EVAPOTRANSPIRATION	23.N57	83695N375	56.26
DRAINAGE COLLECTED FROM LAYER 3	2.N361	8480.N11	5.70
PERCN/LEAKAGE THROUGH LAYER 4	0.N81712	296.N15	0.20
AVGN HEAD ON TOP OF LAYER 4	0.4908		
CHANGE IN WATER STORAGE	1.193	4328.N04	2.91
SOIL WATER AT START OF YEAR	7.694	27928.N29	
SOIL WATER AT END OF YEAR	6.N63	23825N143	
SNOW WATER AT START OF YEAR	0.000	0.N00	0.00
SNOW WATER AT END OF YEAR	2.323	8431N890	5.67
ANNUAL WATER BUDGET BALANCE	0.N000	0.N39	0.00

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ANNUAL TOTALS FOR YEAR 1976

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.45	161353.516	100.00
RUNOFF	19.653	71340.117	44.21
EVAPOTRANSPIRATION	24.613	89344.781	55.37
DRAINAGE COLLECTED FROM LAYER 3	2.5175	9138.479	5.66
PERC./LEAKAGE THROUGH LAYER 4	0.086218	312.973	0.19
AVGN HEAD ON TOP OF LAYER 4	0.5265		
CHANGE IN WATER STORAGE	-2NN20	-8782N865	-5.44
SOIL WATER AT START OF YEAR	6.N63	23825N143	
SOIL WATER AT END OF YEAR	4.812	174N8NN80	
SNOW WATER AT START OF YEAR	2.323	8431N890	5.23
SNOW WATER AT END OF YEAR	1.655	6006.088	3.72
ANNUAL WATER BUDGET BALANCE	0.N000	0.025	0.00

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ANNUAL TOTALS FOR YEAR 1977

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.30	168069.031	100.00
RUNOFF	20.030	72709.898	43.26
EVAPOTRANSPIRATION	21.938	79635.203	47.38
DRAINAGE COLLECTED FROM LAYER 3	1.8996	6895.461	4.10
PERC./LEAKAGE THROUGH LAYER 4	0.063239	229.559	0.14
AVG. HEAD ON TOP OF LAYER 4	0.3985		
CHANGE IN WATER STORAGE	2.369	8598.874	5.12
SOIL WATER AT START OF YEAR	4.812	17468.080	
SOIL WATER AT END OF YEAR	8.570	31108.898	
SNOW WATER AT START OF YEAR	1.655	6006.088	3.57
SNOW WATER AT END OF YEAR	0.266	964.143	0.57
ANNUAL WATER BUDGET BALANCE	0.0000	0.030	0.00

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ANNUAL TOTALS FOR YEAR 1978

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.04	116305.187	100.00
RUNOFF	12.179	44211.008	38.01
EVAPOTRANSPIRATION	18.695	67863.945	58.35
DRAINAGE COLLECTED FROM LAYER 3	3.0134	10938.536	9.41
PERC./LEAKAGE THROUGH LAYER 4	0.101132	367.108	0.32
AVG. HEAD ON TOP OF LAYER 4	0.6308		
CHANGE IN WATER STORAGE	-1.949	-7075.392	-6.08
SOIL WATER AT START OF YEAR	8.570	31108.898	
SOIL WATER AT END OF YEAR	4.980	18078.867	
SNOW WATER AT START OF YEAR	0.266	964.143	0.83
SNOW WATER AT END OF YEAR	1.906	6918.781	5.95
ANNUAL WATER BUDGET BALANCE	0.0000	-0.013	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1974 THROUGH 1978

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.80	2.09	2.65	2.37	3.03	4.00
	4.17	4.03	5.43	4.15	2.36	3.07
STD. DEVIATIONS	2.10	0.80	0.63	0.94	0.94	1.09
	2.81	0.59	2.99	1.70	1.22	0.78
RUNOFF						
TOTALS	0.690	0.591	3.393	2.380	0.454	1.090
	1.327	1.091	2.232	1.575	0.380	0.700
STD. DEVIATIONS	0.829	0.758	1.353	2.705	0.318	0.601
	1.542	0.163	1.984	1.246	0.443	0.942
EVAPOTRANSPIRATION						
TOTALS	0.436	0.476	0.415	1.108	2.927	3.621
	4.974	2.436	2.441	1.586	1.003	0.455
STD. DEVIATIONS	0.055	0.051	0.124	0.524	0.533	0.581
	0.919	0.760	0.476	0.086	0.122	0.118
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0950	0.0287	0.0106	0.2863	0.7490	0.4061
	0.2133	0.1545	0.0729	0.0519	0.1702	0.1840
STD. DEVIATIONS	0.1133	0.0344	0.0130	0.3183	0.4529	0.2757
	0.1153	0.0502	0.0266	0.0244	0.3427	0.3479
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0041	0.0016	0.0008	0.0085	0.0216	0.0134
	0.0084	0.0067	0.0037	0.0027	0.0057	0.0062
STD. DEVIATIONS	0.0041	0.0016	0.0008	0.0090	0.0126	0.0082
	0.0037	0.0017	0.0011	0.0008	0.0100	0.0101

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4						
AVERAGES	0.2358	0.0786	0.0263	0.7339	1.8581	1.0410
	0.5293	0.3833	0.1868	0.1286	0.4362	0.4566
STD. DEVIATIONS	0.2812	0.0947	0.0321	0.8161	1.1235	0.7068
	0.2862	0.1245	0.0681	0.0606	0.8785	0.8630

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1974 THROUGH 1978

	INCHES		CU. FEET	PERCENT
PRECIPITATION	40.16	(5.757)	145773.5	100.00
RUNOFF	15.902	(3.6768)	57725.85	39.600
EVAPOTRANSPIRATION	21.877	(2.2158)	79411.88	54.476
LATERAL DRAINAGE COLLECTED FROM LAYER 3	2.42246	(0.40154)	8793.540	6.03233
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.08335	(0.01353)	302.574	0.20756
AVERAGE HEAD ON TOP OF LAYER 4	0.508	(0.084)		
CHANGE IN WATER STORAGE	-0.127	(2.0394)	-460.31	-0.316

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PEAK DAILY VALUES FOR YEARS 1974 THROUGH 1978

	(INCHES)	(CU. FT.)
PRECIPITATION	3.13	11361.900
RUNOFF	2.558	9285.8916
DRAINAGE COLLECTED FROM LAYER 3	0.04903	177.98235
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.001296	4.70309
AVERAGE HEAD ON TOP OF LAYER 4	3.771	
MAXIMUM HEAD ON TOP OF LAYER 4	7.138	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	7.10	25775.8906

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4135
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0807

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1978

LAYER	(INCHES)	(VOL/VOL)
1	2.0740	0.3457
2	1.8906	0.1575
3	0.5658	0.0472
4	0.0000	0.0000
SNOW WATER	1.906	

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**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                  HELP MODEL VERSION 3.05a  (5 JUNE 1996)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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******************************************************************************


PRECIPITATION DATA FILE:     c:\help305\DATA4.D4
TEMPERATURE DATA FILE:       c:\help305\DATA7.D7
SOLAR RADIATION DATA FILE:   c:\help305\DATA13.D13
EVAPOTRANSPIRATION DATA:     c:\help305\DATA11.D11
SOIL AND DESIGN DATA FILE:   c:\help305\GEONET.D10
OUTPUT DATA FILE:            C:\HELP305\GEONET.OUT


TIME:  15:17     DATE:   8/16/2001


******************************************************************************

     TITLE:  268.012 ERWIN LF FS: Part 360 Geomembrane w Composite

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =       6.00   INCHES
          POROSITY                     =       0.4530 VOL/VOL
          FIELD CAPACITY               =       0.1900 VOL/VOL
          WILTING POINT                =       0.0850 VOL/VOL
          INITIAL SOIL WATER CONTENT   =       0.1223 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC
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                         LAYER  2
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             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2207 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.899999975000E-04 CM/SEC


                         LAYER  3
                         --------

               TYPE 2 - LATERAL DRAINAGE LAYER
                 MATERIAL TEXTURE NUMBER  20
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   10.0000000000     CM/SEC
SLOPE                       =     30.00   PERCENT
DRAINAGE LENGTH             =    120.0    FEET


                         LAYER  4
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               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  36
THICKNESS                   =      0.04   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD
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GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTUREN# 6 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 30.% AND A SLOPE LENGTH OF 120. FEETN

SCS RUNOFF CURVE NUMBER	=	73.10	
FRACTION OF AREA ALLOWING RUNOFF	=	100N0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	20N0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.510	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.N60	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.N00	INCHES
INITIAL SNOW WATER	=	0.N00	INCHES
INITIAL WATER IN LAYER MATERIALS	=	6.N31	INCHES
TOTAL INITIAL WATER	=	6.N31	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM ITHACA NEW YORK

STATION LATITUDE	=	42.40	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	130	
END OF GROWING SEASON (JULIAN DATE)	=	279	
EVAPORATIVE ZONE DEPTH	=	20N0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10N30	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	74N00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	75N00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00	%

NOTEN PRECIPITATION DATA FOR ITHACA NEW YORK WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ITHACA NEW YORK

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
22.20	22.70	32.20	44.50	54.80	64.30
68.80	67.10	60.20	49.60	39.30	27.60

NOTEN SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ITHACA NEW YORK AND STATION LATITUDE = 42.40 DEGREES

ANNUAL TOTALS FOR YEAR 1974

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.02	134382.578	100.00
RUNOFF	12.493	45350.781	33.75
EVAPOTRANSPIRATION	18.665	67753.984	50.42
DRAINAGE COLLECTED FROM LAYER 3	5.7146	20744.049	15.44
PERC./LEAKAGE THROUGH LAYER 4	0.050434	183.N077	0.14
AVG. HEAD ON TOP OF LAYER 4	0.0004		
CHANGE IN WATER STORAGE	0.097	350.743	0.26
SOIL WATER AT START OF YEAR	6.088	22099.783	
SOIL WATER AT END OF YEAR	6.185	22450.527	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.056	0.00

ANNUAL TOTALS FOR YEAR 1975

	INCHES	CU. FEET	PERCENT
PRECIPITATION	40.98	148757.406	100.00
RUNOFF	13.649	49545.852	33.31
EVAPOTRANSPIRATION	19.288	70014.906	47.07
DRAINAGE COLLECTED FROM LAYER 3	6.1780	22426.070	15.08
PERC.N/LEAKAGE THROUGH LAYER 4	0.048603	176.428	0.12
AVG. HEAD ON TOP OF LAYER 4	0.0004		
CHANGE IN WATER STORAGE	1.817	6594.156	4.43
SOIL WATER AT START OF YEAR	6.185	22450.527	
SOIL WATER AT END OF YEAR	5.678	20612.793	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	2.323	8431N890	5.67
ANNUAL WATER BUDGET BALANCE	0.0000	-0.003	0.00

ANNUAL TOTALS FOR YEAR 1976

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.45	161353.516	100.00
RUNOFF	18.659	67732.187	41.98
EVAPOTRANSPIRATION	19.M91	70753N695	43.85
DRAINAGE COLLECTED FROM LAYER 3	8.N666	29281N928	18N15
PERC./LEAKAGE THROUGH LAYER 4	0.N58250	211N448	0.13
AVGN HEAD ON TOP OF LAYER 4	0.N005		
CHANGE IN WATER STORAGE	-1.N25	-6625N842	-4N11
SOIL WATER AT START OF YEAR	5.678	20612N793	
SOIL WATER AT END OF YEAR	4.521	16412N752	
SNOW WATER AT START OF YEAR	2.323	8431N890	5.23
SNOW WATER AT END OF YEAR	1.N55	6006N088	3.72
ANNUAL WATER BUDGET BALANCE	0.N000	0.N00	0.00

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ANNUAL TOTALS FOR YEAR 1977

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.30	168069.031	100.00
RUNOFF	21.060	76446.523	45.49
EVAPOTRANSPIRATION	17.403	63174.246	37.59
DRAINAGE COLLECTED FROM LAYER 3	4.3594	15824.554	9.42
PERC.N/LEAKAGE THROUGH LAYER 4	0.041802	151.742	0.09
AVGN HEAD ON TOP OF LAYER 4	0.N003		
CHANGE IN WATER STORAGE	3.436	12471.919	7.42
SOIL WATER AT START OF YEAR	4.521	16412.752	
SOIL WATER AT END OF YEAR	9.346	33926.617	
SNOW WATER AT START OF YEAR	1.655	6006.088	3.57
SNOW WATER AT END OF YEAR	0.266	964.143	0.57
ANNUAL WATER BUDGET BALANCE	0.0000	0.040	0.00

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ANNUAL TOTALS FOR YEAR 1978

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32N04	116305.N87	100N00
RUNOFF	11.N51	43382N184	37N30
EVAPOTRANSPIRATION	14NN36	53854N742	46.30
DRAINAGE COLLECTED FROM LAYER 3	7.7979	28306.484	24.34
PERCN/LEAKAGE THROUGH LAYER 4	0.N54891	199.N55	0.17
AVGN HEAD ON TOP OF LAYER 4	0.N005		
CHANGE IN WATER STORAGE	-2NN600	-9437N456	-8.11
SOIL WATER AT START OF YEAR	9.346	33926N617	
SOIL WATER AT END OF YEAR	5.106	18534N521	
SNOW WATER AT START OF YEAR	0.266	964N143	0.83
SNOW WATER AT END OF YEAR	1.906	6918N781	5.95
ANNUAL WATER BUDGET BALANCE	0.N000	-0NN021	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1974 THROUGH 1978

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.80	2.09	2.65	2.37	3.03	4.00
	4.17	4.03	5.43	4.15	2.36	3.07
STD. DEVIATIONS	2.10	0.80	0.63	0.94	0.94	1.09
	2.81	0.59	2.99	1.70	1.22	0.78
RUNOFF						
TOTALS	0.688	0.547	3.237	1.892	0.509	1.126
	1.373	1.144	2.292	1.612	0.414	0.728
STD. DEVIATIONS	0.769	0.953	1.264	2.239	0.335	0.633
	1.568	0.074	1.987	1.237	0.487	0.052
EVAPOTRANSPIRATION						
TOTALS	0.038	0.476	0.434	1.050	2.757	3.232
	4.078	1.365	1.588	1.221	0.849	0.048
STD. DEVIATIONS	0.055	0.051	0.109	0.529	0.718	0.846
	1.099	0.789	0.920	0.479	0.336	0.030
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.2068	0.0906	0.0654	0.0554	0.7510	0.2545
	0.2416	1.0187	1.2107	0.9708	0.6465	0.7113
STD. DEVIATIONS	0.0499	0.0122	0.0061	0.1966	0.8056	0.1107
	0.0654	0.7290	0.6203	0.5542	0.4033	0.4996
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0033	0.0021	0.0019	0.0021	0.0049	0.0034
	0.0030	0.0065	0.0070	0.0063	0.0047	0.0055
STD. DEVIATIONS	0.0004	0.0002	0.0001	0.0011	0.0033	0.0009
	0.0004	0.0022	0.0018	0.0016	0.0018	0.0022
AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)						
DAILY AVERAGE HEAD ON TOP OF LAYER 4						
AVERAGES	0.0001	0.0001	0.0000	0.0001	0.0005	0.0002
	0.0002	0.0008	0.0009	0.0007	0.0005	0.0005
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0002	0.0006	0.0001
	0.0001	0.0006	0.0005	0.0004	0.0003	0.0004

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1974 THROUGH 1978

	INCHES		CU. FEET	PERCENT
PRECIPITATION	40.16	(5.N57)	145773.5	100N00
RUNOFF	15.902	(3.6770)	57725N30	39.N99
EVAPOTRANSPIRATION	21.N32	(2.2707)	79248N73	54.N64
LATERAL DRAINAGE COLLECTED FROM LAYER 3	1.89632	(0.28740)	6883N633	4.72214
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.N0569	(0.N8088)	2198N672	1.N0828
AVERAGE HEAD ON TOP OF LAYER 4	0.N97	(0.059)		
CHANGE IN WATER STORAGE	-0.078	(1.9514)	-282N83	-0.N94

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PEAK DAILY VALUES FOR YEARS 1974 THROUGH 1978

	(INCHES)	(CU. FT.)
PRECIPITATION	3.13	11361.900
RUNOFF	2.558	9285.8916
DRAINAGE COLLECTED FROM LAYER 3	0.04801	174.26884
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.004099	14.88023
AVERAGE HEAD ON TOP OF LAYER 4	3.692	
MAXIMUM HEAD ON TOP OF LAYER 4	6.995	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	7.10	25775N8906
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.4135
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0807

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1978

LAYER	(INCHES)	(VOL/VOL)
1	2.0758	0.3460
2	2.0298	0.1691
3	0.6006	0.0500
4	7.6860	0.4270
SNOW WATER	1.906	

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                  HELP MODEL VERSION 3.05a  (5 JUNE 1996)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     c:\help305\DATA4.D4
TEMPERATURE DATA FILE:       c:\help305\DATA7.D7
SOLAR RADIATION DATA FILE:   c:\help305\DATA13.D13
EVAPOTRANSPIRATION DATA:     c:\help305\DATA11.D11
SOIL AND DESIGN DATA FILE:   c:\help305\SOILCAP.D10
OUTPUT DATA FILE:            C:\HELP305\SOILCAP.OUT


TIME:  15:20     DATE:   8/16/2001


******************************************************************************

     TITLE:  268.012 ERWIN LF FS: Part 360 Soil Cap w/o Drainage

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                 LAYER  1
                                 --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   0
           THICKNESS                 =      6.00   INCHES
           POROSITY                  =      0.4570 VOL/VOL
           FIELD CAPACITY            =      0.1310 VOL/VOL
           WILTING POINT             =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.4325 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.999999975000E-05 CM/SEC
```

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                    LAYER  2
                    --------

      TYPE 1 - VERTICAL PERCOLATION LAYER
         MATERIAL TEXTURE NUMBER   0
THICKNESS                  =     12.00    INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2282 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.999999975000E-05 CM/SEC


                    LAYER  3
                    --------

        TYPE 2 - LATERAL DRAINAGE LAYER
         MATERIAL TEXTURE NUMBER   0
THICKNESS                  =     12.00    INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2267 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.999999975000E-05 CM/SEC
SLOPE                      =     30.00    PERCENT
DRAINAGE LENGTH            =    120.0     FEET


                    LAYER  4
                    --------

          TYPE 3 - BARRIER SOIL LINER
         MATERIAL TEXTURE NUMBER  16
THICKNESS                  =     18.00    INCHES
POROSITY                   =      0.4270 VOL/VOL
FIELD CAPACITY             =      0.4180 VOL/VOL
WILTING POINT              =      0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000001000E-06 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 30.% AND A SLOPE LENGTH OF 120. FEET.

SCS RUNOFF CURVE NUMBER	=	73.10	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	6.502	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.060	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.700	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	18.433	INCHES
TOTAL INITIAL WATER	=	18.433	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM ITHACA NEW YORK

STATION LATITUDE	=	42.40	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	130	
END OF GROWING SEASON (JULIAN DATE)	=	279	
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.30	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	74.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00	%

NOTE: PRECIPITATION DATA FOR ITHACA NEW YORK WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ITHACA NEW YORK

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
22.20	22.70	32.20	44.50	54.80	64.30
68.80	67.10	60.20	49.60	39.30	27.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ITHACA NEW YORK AND STATION LATITUDE = 42.40 DEGREES

ANNUAL TOTALS FOR YEAR 1974

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.02	134382.578	100.00
RUNOFF	13.379	48565.355	36.14
EVAPOTRANSPIRATION	20.317	73751.398	54.88
DRAINAGE COLLECTED FROM LAYER 2	3.3762	12255.765	9.12
PERC./LEAKAGE THROUGH LAYER 4	0.000040	0.145	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0709		
CHANGE IN WATER STORAGE	-0.052	-190.027	-0.14
SOIL WATER AT START OF YEAR	18.433	66911.578	
SOIL WATER AT END OF YEAR	18.381	66721.547	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.066	0.00

ANNUAL TOTALS FOR YEAR 1975

	INCHES	CU. FEET	PERCENT
PRECIPITATION	40.98	148757.406	100.00
RUNOFF	14.080	51111.184	34.36
EVAPOTRANSPIRATION	22.602	82045.125	55.15
DRAINAGE COLLECTED FROM LAYER 2	3.1254	11345.345	7.63
PERC./LEAKAGE THROUGH LAYER 4	0.000037	0.136	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0654		
CHANGE IN WATER STORAGE	1.172	4255.654	2.86
SOIL WATER AT START OF YEAR	18.381	66721.547	
SOIL WATER AT END OF YEAR	17.230	62545.312	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	2.323	8431.890	5.67
ANNUAL WATER BUDGET BALANCE	0.0000	-0.030	0.00

ANNUAL TOTALS FOR YEAR 1976

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.45	161353.516	100.00
RUNOFF	19.537	70918.398	43.95
EVAPOTRANSPIRATION	23.344	84738.719	52.52
DRAINAGE COLLECTED FROM LAYER 2	3.1543	11450.049	7.10
PERC./LEAKAGE THROUGH LAYER 4	0.000038	0.136	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0660		
CHANGE IN WATER STORAGE	-1.585	-5753.882	-3.57
SOIL WATER AT START OF YEAR	17.230	62545.312	
SOIL WATER AT END OF YEAR	16.313	59217.234	
SNOW WATER AT START OF YEAR	2.323	8431.890	5.23
SNOW WATER AT END OF YEAR	1.655	6006.088	3.72
ANNUAL WATER BUDGET BALANCE	0.0000	0.095	0.00

ANNUAL TOTALS FOR YEAR 1977

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.30	168069.031	100.00
RUNOFF	20.073	72863.305	43.35
EVAPOTRANSPIRATION	19.778	71793.422	42.72
DRAINAGE COLLECTED FROM LAYER 2	4.3875	15926.517	9.48
PERC./LEAKAGE THROUGH LAYER 4	0.000050	0.182	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0922		
CHANGE IN WATER STORAGE	2.062	7485.561	4.45
SOIL WATER AT START OF YEAR	16.313	59217.234	
SOIL WATER AT END OF YEAR	19.764	71744.742	
SNOW WATER AT START OF YEAR	1.655	6006.088	3.57
SNOW WATER AT END OF YEAR	0.266	964.143	0.57
ANNUAL WATER BUDGET BALANCE	0.0000	0.039	0.00

ANNUAL TOTALS FOR YEAR 1978

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.04	116305.187	100.00
RUNOFF	12.244	44443.961	38.21
EVAPOTRANSPIRATION	17.852	64802.902	55.72
DRAINAGE COLLECTED FROM LAYER 2	3.7418	13582.673	11.68
PERC./LEAKAGE THROUGH LAYER 4	0.000043	0.157	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0780		
CHANGE IN WATER STORAGE	-1.797	-6524.505	-5.61
SOIL WATER AT START OF YEAR	19.764	71744.742	
SOIL WATER AT END OF YEAR	16.327	59265.598	
SNOW WATER AT START OF YEAR	0.266	964.143	0.83
SNOW WATER AT END OF YEAR	1.906	6918.781	5.95
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1974 THROUGH 1978

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.80	2.09	2.65	2.37	3.03	4.00
	4.17	4.03	5.43	4.15	2.36	3.07
STD. DEVIATIONS	2.10	0.80	0.63	0.94	0.94	1.09
	2.81	0.59	2.99	1.70	1.22	0.78
RUNOFF						
TOTALS	0.701	0.598	3.382	2.385	0.443	1.046
	1.317	1.101	2.234	1.576	0.375	0.704
STD. DEVIATIONS	0.848	0.767	1.360	2.678	0.312	0.629
	1.556	0.166	1.989	1.247	0.440	0.951
EVAPOTRANSPIRATION						
TOTALS	0.438	0.476	0.421	1.084	2.942	3.603
	5.014	2.042	2.155	1.064	0.814	0.428
STD. DEVIATIONS	0.055	0.051	0.119	0.496	0.546	0.094
	0.863	0.678	0.493	0.123	0.101	0.090
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.0978	0.0422	0.0307	0.1959	0.7923	0.2835
	0.2076	0.4756	0.3515	0.2743	0.4232	0.3825
STD. DEVIATIONS	0.0366	0.0099	0.0051	0.2405	0.5934	0.0902
	0.0746	0.1372	0.1584	0.1100	0.5026	0.2948
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	0.0243	0.0115	0.0076	0.0502	0.1965	0.0727
	0.0515	0.1180	0.0901	0.0680	0.1085	0.0949
STD. DEVIATIONS	0.0091	0.0026	0.0013	0.0616	0.1472	0.0231
	0.0185	0.0340	0.0406	0.0273	0.1288	0.0731

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1974 THROUGH 1978

	INCHES		CU. FEET	PERCENT
PRECIPITATION	40.16	(5.757)	145773.5	100.00
RUNOFF	15.862	(3.6629)	57580.44	39.500
EVAPOTRANSPIRATION	20.779	(2.2184)	75426.31	51.742
LATERAL DRAINAGE COLLECTED FROM LAYER 2	3.55704	(0.52558)	12912.070	8.85762
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00004	(0.00001)	0.151	0.00010
AVERAGE HEAD ON TOP OF LAYER 3	0.074	(0.011)		
CHANGE IN WATER STORAGE	-0.040	(1.6856)	-145.44	-0.100

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              PEAK DAILY VALUES FOR YEARS 1974 THROUGH 1978
  ------------------------------------------------------------------------
                                                   (INCHES)      (CU. FT.)
                                                  ----------   -------------
   PRECIPITATION                                    3.13        11361.900

   RUNOFF                                           2.575        9346.6699

   DRAINAGE COLLECTED FROM LAYER  2                 0.11252       408.46429

   PERCOLATION/LEAKAGE THROUGH LAYER  4             0.000001        0.00402

   AVERAGE HEAD ON TOP OF LAYER  3                  0.865

   MAXIMUM HEAD ON TOP OF LAYER  3                  1.700

   LOCATION OF MAXIMUM HEAD IN LAYER  2
         (DISTANCE FROM DRAIN)                      0.0 FEET

   SNOW WATER                                       7.10        25775.8906

   MAXIMUM VEG. SOIL WATER (VOL/VOL)                        0.4327

   MINIMUM VEG. SOIL WATER (VOL/VOL)                        0.0859

    ***  Maximum heads are computed using McEnroe's equations.  ***

         Reference:  Maximum Saturated Depth over Landfill Liner
                     by Bruce M. McEnroe, University of Kansas
                     ASCE Journal of Environmental Engineering
                     Vol. 119, No. 2, March 1993, pp. 262-270.

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                 FINAL WATER STORAGE AT END OF YEAR 1978
   ----------------                      ----------------------------------
                LAYER        (INCHES)       (VOL/VOL)
                -----        --------       ---------
                  1           5.5139         0.2297
                  2           0.5647         0.0471
                  3           0.0000         0.0000
                  4          10.2480         0.4270
               SNOW WATER     1.906

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**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                  HELP MODEL VERSION 3.05a  (5 JUNE 1996)
**
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     c:\help305\DATA4.D4
TEMPERATURE DATA FILE:       c:\help305\DATA7.D7
SOLAR RADIATION DATA FILE:  c:\help305\DATA13.D13
EVAPOTRANSPIRATION DATA:     c:\help305\DATA11.D11
SOIL AND DESIGN DATA FILE:  c:\help305\SOILCAPD.D10
OUTPUT DATA FILE:           C:\HELP305\SOILCAPD.OUT


TIME:  15:22     DATE:   8/16/2001


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     TITLE:  268.012 EWRIN LF FS: Part 360 Soil Cap w Drainage

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   0
          THICKNESS                  =      6.00   INCHES
          POROSITY                   =      0.4530 VOL/VOL
          FIELD CAPACITY             =      0.1900 VOL/VOL
          WILTING POINT              =      0.0850 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.4306 VOL/VOL
          EFFECTIVE SATN HYD. COND.  =  0.999999975000E-05 CM/SEC
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                          LAYER  2
                          --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     12.00   INCHES
POROSITY                     =      0.4530 VOL/VOL
FIELD CAPACITY               =      0.1900 VOL/VOL
WILTING POINT                =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2661 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                          LAYER  3
                          --------

              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     12.00   INCHES
POROSITY                     =      0.4170 VOL/VOL
FIELD CAPACITY               =      0.0450 VOL/VOL
WILTING POINT                =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0495 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
SLOPE                        =     30.00   PERCENT
DRAINAGE LENGTH              =    120.0    FEET


                          LAYER  4
                          --------

                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  16
THICKNESS                    =     18.00   INCHES
POROSITY                     =      0.4270 VOL/VOL
FIELD CAPACITY               =      0.4180 VOL/VOL
WILTING POINT                =      0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000001000E-06 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTUREN# 6 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 30N% AND A SLOPE LENGTH OF 120. FEET.

SCS RUNOFF CURVE NUMBER	=	73N10	
FRACTION OF AREA ALLOWING RUNOFF	=	100N0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	5.727	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.140	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.N60	INCHES
INITIAL SNOW WATER	=	0.N00	INCHES
INITIAL WATER IN LAYER MATERIALS	=	15N741	INCHES
TOTAL INITIAL WATER	=	15N741	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM ITHACA NEW YORK

STATION LATITUDE	=	42.40 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	130
END OF GROWING SEASON (JULIAN DATE)	=	279
EVAPORATIVE ZONE DEPTH	=	20.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	10.30 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	75.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00 %

NOTE: PRECIPITATION DATA FOR ITHACA NEW YORK WAS ENTERED FROM THE DEFAULT DATA FILEN

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ITHACA NEW YORK

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
22.20	22.70	32.20	44.50	54.80	64.30
68.80	67.10	60.20	49.60	39.30	27.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ITHACA NEW YORK AND STATION LATITUDE = 42.40 DEGREES

****

ANNUAL TOTALS FOR YEAR 1974

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.02	134382.578	100.00
RUNOFF	12.815	46516.648	34.62
EVAPOTRANSPIRATION	20.241	73473.336	54.67
DRAINAGE COLLECTED FROM LAYER 3	0.2920	1060.127	0.79
PERC./LEAKAGE THROUGH LAYER 4	1.665995	6047.563	4.50
AVG. HEAD ON TOP OF LAYER 4	6.1367		
CHANGE IN WATER STORAGE	2.007	7284.904	5.42
SOIL WATER AT START OF YEAR	16.134	58566.754	
SOIL WATER AT END OF YEAR	18.141	65851.656	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.007	0.00

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ANNUAL TOTALS FOR YEAR 1975

	INCHES	CU. FEET	PERCENT
PRECIPITATION	40.98	148757.406	100.00
RUNOFF	13.533	49123.168	33.02
EVAPOTRANSPIRATION	24.450	88754.586	59.66
DRAINAGE COLLECTED FROM LAYER 3	0.4870	1767.927	1.19
PERC./LEAKAGE THROUGH LAYER 4	1.949376	7076.235	4.76
AVG. HEAD ON TOP OF LAYER 4	10.2528		
CHANGE IN WATER STORAGE	0.561	2035.501	1.37
SOIL WATER AT START OF YEAR	18.141	65851.656	
SOIL WATER AT END OF YEAR	16.379	59455.270	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	2.323	8431.890	5.67
ANNUAL WATER BUDGET BALANCE	0.0000	-0.006	0.00

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ANNUAL TOTALS FOR YEAR 1976

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.45	161353.516	100.00
RUNOFF	18.450	66973.430	41.51
EVAPOTRANSPIRATION	25.379	92125.180	57.10
DRAINAGE COLLECTED FROM LAYER 3	0.4807	1745.069	1.08
PERC./LEAKAGE THROUGH LAYER 4	1.943626	7055.361	4.37
AVG. HEAD ON TOP OF LAYER 4	10.0950		
CHANGE IN WATER STORAGE	-1.803	-6545.580	-4.06
SOIL WATER AT START OF YEAR	16.379	59455.270	
SOIL WATER AT END OF YEAR	15.244	55335.492	
SNOW WATER AT START OF YEAR	2.323	8431.890	5.23
SNOW WATER AT END OF YEAR	1.655	6006.088	3.72
ANNUAL WATER BUDGET BALANCE	0.0000	0.059	0.00

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ANNUAL TOTALS FOR YEAR 1977

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.30	168069N031	100N00
RUNOFF	20.728	75242.828	44.77
EVAPOTRANSPIRATION	19.439	70563N547	41.98
DRAINAGE COLLECTED FROM LAYER 3	0.4591	1666.637	0.99
PERC./LEAKAGE THROUGH LAYER 4	1.908782	6928N877	4.12
AVGN HEAD ON TOP OF LAYER 4	9.6642		
CHANGE IN WATER STORAGE	3.765	13667N201	8.13
SOIL WATER AT START OF YEAR	15N244	55335N492	
SOIL WATER AT END OF YEAR	20.398	74044N641	
SNOW WATER AT START OF YEAR	1.655	6006N088	3.57
SNOW WATER AT END OF YEAR	0.266	964N143	0.57
ANNUAL WATER BUDGET BALANCE	0.0000	0.034	0.00

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ANNUAL TOTALS FOR YEAR 1978

	INCHES	CUN FEET	PERCENT
PRECIPITATION	32.04	116305.187	100.00
RUNOFF	12.482	45308.582	38.96
EVAPOTRANSPIRATION	20.N36	73094N922	62N85
DRAINAGE COLLECTED FROM LAYER 3	0.5386	1954.987	1.68
PERC./LEAKAGE THROUGH LAYER 4	2.024268	7348.093N	6.32
AVG. HEAD ON TOP OF LAYER 4	11.3285		
CHANGE IN WATER STORAGE	-3.141	-11401.369	-9.80
SOIL WATER AT START OF YEAR	20.398	74044.641	
SOIL WATER AT END OF YEAR	15.617	56688.633	
SNOW WATER AT START OF YEAR	0.266	964.143	0.83
SNOW WATER AT END OF YEAR	1.906	6918.781	5.95
ANNUAL WATER BUDGET BALANCE	0.0000	-0.021	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1974 THROUGH 1978

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.80	2.09	2.65	2.37	3.03	4.00
	4.17	4.03	5.43	4.15	2.36	3.07
STD. DEVIATIONS	2.10	0.80	0.63	0.94	0.94	1.09
	2.81	0.59	2.99	1.70	1.22	0.78
RUNOFF						
TOTALS	0.688	0.638	3.282	2.223	0.451	1.040
	1.316	1.080	2.220	1.571	0.380	0.711
STD. DEVIATIONS	0.861	0.912	1.513	2.466	0.319	0.631
	1.546	0.170	1.982	1.237	0.441	0.967
EVAPOTRANSPIRATION						
TOTALS	0.439	0.476	0.425	1.117	2.892	3.429
	4.971	2.792	2.486	1.509	0.952	0.441
STD. DEVIATIONS	0.056	0.051	0.117	0.548	0.684	0.689
	0.772	0.998	0.329	0.184	0.076	0.099
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0333	0.0283	0.0290	0.0284	0.0451	0.0451
	0.0428	0.0399	0.0372	0.0402	0.0400	0.0423
STD. DEVIATIONS	0.0094	0.0084	0.0088	0.0090	0.0183	0.0187
	0.0143	0.0064	0.0036	0.0061	0.0071	0.0040
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.1538	0.1370	0.1475	0.1433	0.1709	0.1676
	0.1677	0.1634	0.1561	0.1639	0.1602	0.1669
STD. DEVIATIONS	0.0136	0.0128	0.0128	0.0131	0.0265	0.0272
	0.0208	0.0093	0.0052	0.0088	0.0104	0.0058

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AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
DAILY AVERAGE HEAD ON TOP OF LAYER 4						
AVERAGES	8.2497	7.7095	7.1849	7.2779	11.1765	11.5696
	10.6287	9.8910	9.5392	9.9852	10.2503	10.4828
STD. DEVIATIONS	2.3240	2.2566	2.1913	2.3075	4.5298	4.8061
	3.5436	1.5873	0.9242	1.5030	1.8286	0.9928

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1974 THROUGH 1978

	INCHES		CU. FEET	PERCENT
PRECIPITATION	40.16	(5.757)	145773.5	100.00
RUNOFF	15.601	(3.7475)	56632.93	38.850
EVAPOTRANSPIRATION	21.929	(2.7624)	79602N31	54.607
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.45150	(0.09378)	1638.929	1.12430
PERCOLATION/LEAKAGE THROUGH LAYER 4	1.89841	(0.13657)	6891.226	4.72735
AVERAGE HEAD ON TOP OF LAYER 4	9.495	(1.975)		
CHANGE IN WATER STORAGE	0.278	(2.7950)	1008.13	0.692

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PEAK DAILY VALUES FOR YEARS 1974 THROUGH 1978

	(INCHES)	(CU. FT.)
PRECIPITATION	3.13	11361.900
RUNOFF	2.556	9278.8154
DRAINAGE COLLECTED FROM LAYER 3	0.00291	10.56969
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.007633	27.70880
AVERAGE HEAD ON TOP OF LAYER 4	22.393	
MAXIMUM HEAD ON TOP OF LAYER 4	37.453	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	10.6 FEET	
SNOW WATER	7.10	25775.8906
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.4500
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0612

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1978

LAYER	(INCHES)	(VOL/VOL)
1	2.0475	0.3413
2	1.0585	0.0882
3	4.8247	0.4021
4	7.6860	0.4270
SNOW WATER	1.906	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                  HELP MODEL VERSION 3.05a  (5 JUNE 1996)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      c:\help305\DATA4.D4
TEMPERATURE DATA FILE:        c:\help305\DATA7.D7
SOLAR RADIATION DATA FILE:    c:\help305\DATA13.D13
EVAPOTRANSPIRATION DATA:      c:\help305\DATA11.D11
SOIL AND DESIGN DATA FILE:    c:\help305\RCRA.D10
OUTPUT DATA FILE:             C:\HELP305\RCRA.OUT


TIME:  15:24     DATE:   8/16/2001


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     TITLE:  268.012 ERWIN LF FS: RCRA COMPOSITE (Geomembrane) CAP

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
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                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   0
           THICKNESS                 =      24.00    INCHES
           POROSITY                  =       0.4530 VOL/VOL
           FIELD CAPACITY            =       0.1900 VOL/VOL
           WILTING POINT             =       0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.3180 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  = 0.999999975000E-05 CM/SEC
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LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0461 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02 CM/SEC
SLOPE	=	30.00 PERCENT
DRAINAGE LENGTH	=	120.0 FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 36

THICKNESS	=	0.04 INCHES
POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY	=	1.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4270 VOL/VOL
FIELD CAPACITY	=	0.4180 VOL/VOL
WILTING POINT	=	0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 30.% AND A SLOPE LENGTH OF 120. FEET.

SCS RUNOFF CURVE NUMBER	=	73.10	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	6.408	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	8.988	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.566	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	14.057	INCHES
TOTAL INITIAL WATER	=	14.057	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM ITHACA NEW YORK

STATION LATITUDE	=	42.40	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	130	
END OF GROWING SEASON (JULIAN DATE)	=	279	
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.30	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	74.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00	%

NOTE: PRECIPITATION DATA FOR ITHACA NEW YORK WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ITHACA NEW YORK

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
22.20	22.70	32.20	44.50	54.80	64.30
68.80	67.10	60.20	49.60	39.30	27.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ITHACA NEW YORK AND STATION LATITUDE = 42.40 DEGREES

ANNUAL TOTALS FOR YEAR 1974

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.02	134382.578	100.00
RUNOFF	13.337	48411.953	36.03
EVAPOTRANSPIRATION	21.080	76520.062	56.94
DRAINAGE COLLECTED FROM LAYER 3	1.7156	6227.761	4.63
PERC./LEAKAGE THROUGH LAYER 4	0.682535	2477.602	1.84
AVG. HEAD ON TOP OF LAYER 4	0.3604		
CHANGE IN WATER STORAGE	0.205	745.206	0.55
SOIL WATER AT START OF YEAR	14.688	53316.868	
SOIL WATER AT END OF YEAR	14.893	54061.871	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.008	0.00

ANNUAL TOTALS FOR YEAR 1975

	INCHES	CU. FEET	PERCENT
PRECIPITATION	40.98	148757.406	100.00
RUNOFF	14.313	51956.266	34.93
EVAPOTRANSPIRATION	23.057	83695.375	56.26
DRAINAGE COLLECTED FROM LAYER 3	1.8101	6570.685	4.42
PERC./LEAKAGE THROUGH LAYER 4	0.615623	2234.710	1.50
AVG. HEAD ON TOP OF LAYER 4	0.3806		
CHANGE IN WATER STORAGE	1.185	4300.339	2.89
SOIL WATER AT START OF YEAR	14.893	54061.871	
SOIL WATER AT END OF YEAR	13.755	49930.320	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	2.323	8431.890	5.67
ANNUAL WATER BUDGET BALANCE	0.0000	0.037	0.00

ANNUAL TOTALS FOR YEAR 1976

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.45	161353.516	100.00
RUNOFF	19.653	71340.317	44.21
EVAPOTRANSPIRATION	24.613	89344.781	55.37
DRAINAGE COLLECTED FROM LAYER 3	1.9595	7113.150	4.41
PERC./LEAKAGE THROUGH LAYER 4	0.603189	2189.574	1.36
AVG. HEAD ON TOP OF LAYER 4	0.4097		
CHANGE IN WATER STORAGE	-2.379	-8634.138	-5.35
SOIL WATER AT START OF YEAR	13.755	49930.320	
SOIL WATER AT END OF YEAR	12.045	43721.984	
SNOW WATER AT START OF YEAR	2.323	8431.890	5.23
SNOW WATER AT END OF YEAR	1.655	6006.088	3.72
ANNUAL WATER BUDGET BALANCE	0.0000	0.026	0.00

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ANNUAL TOTALS FOR YEAR 1977

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.30	168069.031	100.00
RUNOFF	20.030	72709.617	43.26
EVAPOTRANSPIRATION	21.867	79376.078	47.23
DRAINAGE COLLECTED FROM LAYER 3	1.6337	5930.499	3.53
PERC./LEAKAGE THROUGH LAYER 4	0.472440	1714.957	1.02
AVG. HEAD ON TOP OF LAYER 4	0.3429		
CHANGE IN WATER STORAGE	2.297	8337.830	4.96
SOIL WATER AT START OF YEAR	12.045	43721.984	
SOIL WATER AT END OF YEAR	15.731	57101.762	
SNOW WATER AT START OF YEAR	1.655	6006.088	3.57
SNOW WATER AT END OF YEAR	0.266	964.143	0.57
ANNUAL WATER BUDGET BALANCE	0.0000	0.047	0.00

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ANNUAL TOTALS FOR YEAR 1978

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.04	116305.187	100.00
RUNOFF	12.179	44208.551	38.01
EVAPOTRANSPIRATION	18.542	67307.359	57.87
DRAINAGE COLLECTED FROM LAYER 3	2.3626	8576.072	7.37
PERC./LEAKAGE THROUGH LAYER 4	0.654689	2376.520	2.04
AVG. HEAD ON TOP OF LAYER 4	0.4934		
CHANGE IN WATER STORAGE	-1.698	-6163.387	-5.30
SOIL WATER AT START OF YEAR	15.731	57101.762	
SOIL WATER AT END OF YEAR	12.392	44983.734	
SNOW WATER AT START OF YEAR	0.266	964.143	0.83
SNOW WATER AT END OF YEAR	1.906	6918.781	5.95
ANNUAL WATER BUDGET BALANCE	0.0000	0.071	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1974 THROUGH 1978

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.80	2.09	2.65	2.37	3.03	4.00
	4.17	4.03	5.43	4.15	2.36	3.07
STD. DEVIATIONS	2.10	0.80	0.63	0.94	0.94	1.09
	2.81	0.59	2.99	1.70	1.22	0.78
RUNOFF						
TOTALS	0.890	0.591	3.393	2.380	0.454	1.090
	1.327	1.091	2.232	1.575	0.380	0.699
STD. DEVIATIONS	0.829	0.758	1.353	2.705	0.318	0.601
	1.542	0.163	1.984	1.246	0.443	0.942
EVAPOTRANSPIRATION						
TOTALS	0.436	0.476	0.415	1.108	2.927	3.621
	4.977	2.413	2.153	1.585	0.977	0.445
STD. DEVIATIONS	0.055	0.051	0.124	0.524	0.533	0.581
	0.812	0.734	0.485	0.085	0.100	0.101
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0487	0.0020	0.0000	0.2755	0.7065	0.3427
	0.1316	0.0657	0.0047	0.0153	0.1503	0.1533
STD. DEVIATIONS	0.0810	0.0045	0.0000	0.3104	0.4365	0.2566
	0.0984	0.0357	0.0076	0.0334	0.3343	0.3241
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0415	0.0081	0.0000	0.0376	0.0924	0.0959
	0.0985	0.0968	0.0420	0.0171	0.0283	0.0477
STD. DEVIATIONS	0.0525	0.0181	0.0000	0.0391	0.0515	0.0278
	0.0208	0.0177	0.0307	0.0119	0.0488	0.0485

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4						
AVERAGES	0.1208	0.0055	0.0000	0.7062	1.7528	0.8785
	0.3265	0.1630	0.0122	0.0381	0.3852	0.3803
STD. DEVIATIONS	0.2010	0.0122	0.0000	0.7957	1.0828	0.6577
	0.2442	0.0886	0.0194	0.0828	0.8569	0.8040

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1974 THROUGH 1978

	INCHES		CU. FEET	PERCENT
PRECIPITATION	40.16	(5.757)	145773.5	100.00
RUNOFF	15.562	(4.0599)	56491.50	38.753
EVAPOTRANSPIRATION	17N937	(1.9152)	65110.31	44.665
LATERAL DRAINAGE COLLECTED FROM LAYER 3	6.N2331	(1.53398)	23316.617	15.99510
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.05080	(0.00629)	184.390	0.12649
AVERAGE HEAD ON TOP OF LAYER 4	0.000	(0.000)		
CHANGE IN WATER STORAGE	0.185	(2.5017)	670.70	0.460

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PEAK DAILY VALUES FOR YEARS 1974 THROUGH 1978

	(INCHES)	(CU. FT.)
PRECIPITATION	3.13	11361N900
RUNOFF	2.578	9357.9893
DRAINAGE COLLECTED FROM LAYER 3	0.32345	1174.12939
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.N00760	2.N5798
AVERAGE HEAD ON TOP OF LAYER 4	0.N07	
MAXIMUM HEAD ON TOP OF LAYER 4	0.005	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	7.10	25775N8906
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.4169
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0850

*** Maximum heads are computed using McEnroeNs equationsN ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1978

LAYER	(INCHES)	(VOL/VOL)
1	0.6595	0.1099
2	4.4446	0.1852
3	0.0012	0.0201
4	0.N000	0.N000
SNOW WATER	1.906	

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